A STUDY OF THE PROBLEM SOLVING BY EXPERT AND BEGINNING BASKETBALL COACHES DURING COMPETITION

By

ILSE SANNEN MASON

(Under the direction of PAUL G. SCHEMPP)

ABSTRACT

This study investigated the problem solving of high school basketball coaches during competition and, in particular, examined and compared the problem representation and problem solutions phases of the problem solving process of expert and novice coaches. Four expert coaches and four beginning coaches were asked to think-aloud while observing game footage. In task one, the coaches observed 4 segments from a collegiate game, while in task two they observed segments from their own team's game. Analysis of the verbal data revealed that during the problem representation phase, both expert and beginning coaches used five 'building blocks' to represent the problems: (a) descriptions, (b) analytics, (c) connections, (d) solution-oriented statements, and (e) anticipation, prediction, and speculation statements. However, differences among experts and beginners regarding the use of these blocks and the subcategories within each block were found. Expert coaches utilized more connections with event or experiences beyond the game, verbalized intent statements and uttered more specific references to the score and time throughout the game. The nuances in the use of the building blocks extended itself into the solution phase of their problem solving. Expert coaches were more likely to modify or abandon their strategic game plan under continuous accumulating circumstances; the experts continually focused their solutions on a bigger picture beyond the particular game; and the expert coaches applied a forward-working approach towards the problems their team encountered.

INDEX WORDS: Expertise, Problem solving, Problem representation, Problem Solutions, Basketball coaches, Coaches (athletics), Coaching

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DEDICATION

This dissertation is dedicated to my mom, CHRISTIANE VANDIJCK,
who unfortunately left this world too early, in October of 2009.
Yet I promised her that I would finish and graduate with a PhD,
thus I dedicate this dissertation to her.

She left this wonderful poem for me reminding me of “The Fall of Life”:
(Translated in English)

The Fall of life can become the most beautiful season
If you approach every day without worries
Like it is the first time or the last time
When you take care of daily tasks and you meet people
If you don’t put yesterday’s burdens back on your shoulders
And you don’t worry about tomorrow
If you don’t let the opportunity to make someone happy pass you by
If you experience friendship as a rich gift
And stay faithful to each other in good and bad days, through the length of years
The older you become, there is more past and increasingly less future
Use your rich past for your future, so your future will one day have a rich past too
God we thank you for this fall time
Give us eyes to see all the beauty
Give us a memory to preserve worthy memories in our heart
Give us people around us to help us
To keep believing that you are the Lord of life

Mom.

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Jesus, you guide me every step of the way and will continue to direct my path through this life.

‘Count it all joy, my brothers, when you meet trials of various kinds,
for you know that the testing of your faith produces steadfastness’ (James 1: 2-3).

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CHAPTER 1

INTRODUCTION

Expertise is considered the ultimate goal for achievement whether in athletics, academics or any other endeavor. Experts are the best in their domain and display a unique set of characteristics that set them apart and that contribute to their continuous and sustained success (Ericsson, 2006). Over the last thirty years, and across a variety of domains such as chess (deGroot, 1978), physics (Chi, Feltovich & Glaser, 1981), medicine (Patel & Groen, 1986), computer programming (Adelson, 1984) and athletics (Huber, 1997) the factors that set experts apart have been identified. Differentiating characteristics can be summarized into seven distinct qualities (Chi, Glaser & Farr, 1988). These characteristics include: (a) large domain-specific knowledge base, (b) existence of a structured knowledge organization, (c) superior memory, (d) use of metastatements and self-monitoring, (e) efficiency in problem solving, and (f) the depth of the problem representation.

Problem solving has often been examined in information-processing research with a focus on one of two distinct stages of the problem-solving process (Gick, 1986). In the first stage a problem is defined and analyzed based upon the individual's knowledge and previous experiences. Gick (1986) referred to this process as the *problem representation*. In the second stage of the problem-solving process an individual constructs and implements a solution to the particular problem and this is referred to the *problem solution*. As indicated, across various domains problem solving has been proven to be a cognitive process in which experts excel in comparison to their non-expert counterparts (Chi, Glaser, & Farr, 1988).

Similar and supporting findings in regard to experts' problem representation have emerged in the various areas as physics (Chi, Feltovich et al., 1981), computer programming (Adelson, 1984), and medicine (Patel & Groen, 1986). Comparison of the problem representation of experts and their novice counterparts has brought forth distinctions regarding the structure of the representation (both depth and connections), their knowledge organization and the use of metacognition. When confronted with a problem, experts tended to construct a problem representation that is rich, hierarchical structured, goal-oriented, and based on underlying features (Chi, Feltovich et al., 1981; McPherson, 1999). Experts saw the problems in terms of the underlying principles and deeper structures and categorized problems not based on the superficial features and problem-types, but based on those underlying principles (Chi, Feltovich et al., 1981).

Additionally, experts were able to make connections and links between different concepts and aspects of their knowledge (Huber, 1997) and formed schemata based on their declarative and procedural knowledge (Chi, Feltovich et al., 1981). Experts don't just see what is, but what it is about. In stark contrast, novices were more likely to represent a problem based on superficial, obvious features (Chi, Feltovich et al., 1981), they were less likely to categorize problems based on underlying concepts and failed to make interconnection (McPherson, 1999; Auclair, 2007).

Given that a problem representation has been defined as "a cognitive structure corresponding to a problem, constructed by a solver on the basis of his domain-related knowledge and its organization" (Chi, Feltovich, & Glaser, 1981, p.122), it has been no surprise that research on expert problem representation has highlighted the differences between experts and novices' knowledge structures. In experts, information is stored in chunks or large meaningful structures that facilitate the recall of information (Chase & Simon, 1973). The availability of effectively organized knowledge-rich schemata aids the experts in their problem-solving (Chase & Simon, 1973).

While solving a problem, experts also display more frequently the use of metastatements regarding the problem solving process and references to prior knowledge (Coleman & Shore, 1991). In summary, expert problem representation research has shed light on how experts and novices attempt to understand (Ericsson, 2006), interpret (Bedard & Chi, 1992), describe, and analyze (Heller & Reif, 1984) a problem.

When comparing the problem solution phase of the problem solving process, experts were faster at solving a problem and displayed more accuracy in their problem solving than novices. Chi, Glaser and Rees (1981) highlighted the quantitative differences between expert and novice problem solving by the experts' superior time to a solution, the time between responses, and the accuracy of the experts' exceptional performance. Studies on problem solving in the medical field found that experts diagnose with more accuracy (Patel & Groen, 1986) and categorized problems they encounter differently (Hardiman, Dufresne & Mestre, 1989).

Experts also stood out by the strategies used to come to a solution (Chi, 2006). A strategy is "a coherent set of steps for solving a problem" (Schunn, McGregor & Saner, 2005, p. 1377). Experts preferred a forward-thinking strategy, whereas novices preferred a backward-working strategy to find a solution (Smith & Good, 1984; Elson, 2003). In a forward-thinking approach the problem solvers work from the initial state (problem) toward the goal state or solution. In a backward working approach the problem solver works from goal state (solution) to initial state through trial and error. According to Reimann and Chi (1989, p. 169) experts "spend more time planning, and producing processes that are more forward-thinking, more accurate, and more efficient" due to the triggering and instantiation of their available schemata. Experts differentiated themselves in the way they solve problems. The experts clearly possess "characteristics, skills, and knowledge that distinguishes experts form less experienced people" (Ericsson, 2006. p.3).

In sports, the role of the coach is viewed as one that requires a particular set of diverse skills and attributes to be successful. Coaches have been researched in regard to what the coaches do or are expected to do, what coaches think, who they are, and how we study coaches (Gilbert, 2002). From 1970 until 2001, there has been an increase in the research on coaching cognition (from 31% to 41%) with an emphasis was on perception, knowledge and attitudes. Coaches' decision making only accounted for an average of 8% of the coach cognition research (Gilbert, 2002).

Decision making or problem solving research on coaches has provided some insight in the decision making of basketball and ice hockey coaches during games. Duke and Corlett (1992) used a questionnaire with Likert scale to determine the primary reason for calling a timeout in basketball. However, they constructed the questions based on six pre-determined reasons: (a) offensive game events, (b) defensive game events, (c) attentional state of players, (d) emotional state of players, (e) physical state of players, and (f) strategy. Results indicated that successful coaches were most likely to call a timeout for offensive game events (Duke and Corlett, 1992). Ice hockey coaches make the majority of their decision during games based on subjective field information such as team performance, player performance, coach's previous action (Gilbert, 1999).

Furthermore, the problem solving of expert coaches has displayed similarities to expert problem solving research. Expert gymnastics coaches focused on managerial aspects of the decisions rather than obvious characteristics of the situation (Vergeer and Lyle, 2009). Expert gymnastics coaches also incorporated decision rules into their problem representation (Vergeer and Lyle, 2009), much like the procedural knowledge imbedded in physics experts' problem representation (Chi, Feltovich et al, 1981). Jones, Housner and Kornspan's (1997) found that although all coaches used similar strategies and most frequently followed their practice plan, the experienced coaches in their study were less likely to deviate from the plan when minor problems arose.

Although part of the coaching process is considered an art (Woodman, 1994), a large part of coaching expertise is built through an extensive period of deliberate practice and experience (Ericsson, 2006). Given the complexity of sports and game situations, an expert performance approach (where tasks that represent those complex situations and capture mechanisms that mediate the superior performance) is an appropriate and preferred method for studying expert coaches. Various avenues have been explored in the research line of coaching and in particular coaching expertise. Research suggested that experts stand out and excel in their coaching behaviors (Cushion & Jones, 2001; Smith & Cushion, 2006), short-term memory (McCullick, Schempp, Hsu, Jung, Vickers & Schuknecht, 2006), knowledge structures (Cote, Salmela, Trudel, Baria & Russell, 1995), and decision making (Gilbert, Trudel & Haughian, 1999; Vergeer & Lyle, 2009).

The research on expert coaches' problem solving and decision making during the game has shed some light on reasons for the decision making and revealed some information about the processes involved. However, little remained known about how expert and novice basketball coaches differ qualitatively in their problem representation and problem solutions when confronted with problem situations during the game. The research on areas outside of coaching however, suggested perhaps that problem solving during games differs qualitatively among coaches with different expertise level and is a distinct characteristic of expert coaches. Research on the problem solving process of coaches during competition would close the gap between the existing expert problem solving research and existing coaches' decision making research.

Therefore, the purpose of this study was to analyze and compare how expert and beginning coaches represent problem solving situations and solve problems during games. The following research questions guided this study:

1. How do expert and beginning coaches represent a problem situation? What characterizes expert and beginning coaches' problem representation?
2. How do the expert and beginning coaches' problem solutions differ?

Definitions

Problem Representation phase is when an individual constructs "a cognitive structure corresponding to a problem, constructed by a solver on the basis of his domain-related knowledge and its organization" (Chi, Feltovich, and Glaser, 1981, p. 122).

Problem Solution phase is when an individual constructs and implements a solution to the particular problem

Problem strategy is “a coherent set of steps for solving a problem” (Schunn, McGregor, & Saner, 2005, p. 1377).

CHAPTER 2

REVIEW OF LITERATURE

This study examined the decision making of expert and beginning coaches. Specifically, the purpose of this study was to analyze and compare how expert and beginning coaches represent problem solving situations and solve problems during games. The following research questions guided this study:

1. How do expert and beginning coaches represent a problem situation? What characterizes expert and beginning coaches' problem representation?

2. How do the expert and beginning coaches' problem solutions differ?

Solving the problems one encounters in daily life is inevitable; however in certain professions coming up with the most effective solution to a problem can be crucial to a positive outcome. For instance, a pilot's ability to make decisions quickly and solve problems effectively when an aircraft malfunctions is a matter of life or death; or a coach's ability to determine the best strategy against an opponent and solve problems in the 'heat of the moment' could decide the outcome of the game. Problem solving, and in particular expert problem solving has been researched extensively in a variety of areas over the past several decades. Experts perform superior to others within their area of expertise. Expertise refers to 'the manifestation of skills and understanding resulting from the accumulation of a large body of knowledge' (Chi, 2006, p. 167). Expertise has also been identified by "characteristics, skills, and knowledge that distinguishes experts from less experienced people" (Ericsson, 2006, p. 3). Across a variety of domains such as chess (deGroot, 1978), physics (Chi, Feltovich & Glaser, 1981), medicine (Hardiman, Dufresne & Mestre, 1989), computer programming (Adelson, 1984) and athletics (Huber, 1997) factors that set experts apart have been identified and can be summarized into seven distinct qualities (Chi, Glaser & Farr, 1988). These characteristics include: (a) large domain-specific knowledge base, (b) existence of a structured knowledge organization, (c) superior memory, (d) use of metastatements and self-monitoring, (e) efficiency in problem solving, and (f) the depth of the problem representation.

Throughout expertise literature there have been some pivotal shifts in the focus of the research. Early scholars Newell, Shaw & Simon (1958) initiated the shift from stimulus-response theory into a focus on information-processing. Moreover, the attention has through the years shifted onto the representation and organization of knowledge. Although, the processes with problem solving are very much linked and interdependent (Novick & Bassok, 2005); problem solving has often been examined in information-processing research as two distinct stages in the problem-solving process (Gick, 1986). In the first stage a problem is defined and analyzed based upon the individual's knowledge and previous experiences. Gick (1986) referred to this process as the *problem representation*. In the second stage of the problem-solving process an individual constructs and implements a solution to the particular problem and this is referred to the *problem solution*. Others have described the problem solving process as a flexible cyclical process with seven steps: (a) problem identification, (b) problem definition and representation, (c) strategy formulation, (d) organization of information, (e) allocation of resources, (f) monitoring and evaluation (Sternberg, 2003). Within each phase, scholarship in the area of expertise has provided theories to assist in better understanding the problem solving process. In this particular study, the focus within the problem solving cycle is on the steps of problem definition and representation and the strategy formulation.

As evident in the purpose statement, this study encompassed problem solving and expert coaching. Therefore, this chapter is constructed in four main sections: (a) expert problem representation, (b) expert problem solving solution, (c) summary of expert problem solving research and (d) expert coaching research. The section on problem representation will provide a better understanding of the qualitative differences in the problem representation of experts and novices; while the second section will shed light on what appears to make experts more efficient problem solvers. Third, a summary of expert problem solving research will be provided. Next, the linkages between expert problem solving and the characteristics observed in expert coaches will be discussed. In closing, a summary of related coaching research is presented.

Expert Problem Representation

Expert problem representation is an area often researched and is instrumental in the problem solving process. In this section an overview of the conceptual findings imminent to expert problem representation is provided: (a) definition of problem representation, (b) deep structure focus, (c) interlinking of concepts, (d) application of knowledge, and (e) metacognition. This section will conclude with a summary of findings related to expert problem representation.

Definition

According to Chi, Feltovich et al. (1981), *problem representation* is defined as "a cognitive structure corresponding to a problem" (p. 122). The scholars described that the cognitive structure of the problem solver is guided on the "basis of his domain-related knowledge and [the] organization [of the knowledge]" (p. 122). The quality of one's problem representation plays an important role in one's ability to solve a problem: "one of the most important determinants of the ease with which a problem can be solved, or whether it can be solved at all, is the way the solver constructs a mental representation of the problem" (Kahney, 1993; p. 34).

Deep Structure Focus

A seminal study by Chi, Feltovich et al. (1981) examined expert problem representation, in other words, how experts and novices in physics represented and categorized problems. Eight PhD. students served as the experts in this study and eight undergraduates formed the novice group. The participants underwent four tasks including: (a) problem sorting, (b) sorting problems with surface similarity, (c) contents of schemata, and (d) feature identification (Chi, Feltovich et al., 1981). In the first task, the participants were asked to sort cards with physics problems written on them. They were directed to sort the problems into groups based on the similarities of the solution (Chi, Feltovich et al., 1981). Quantitative features of this task revealed no differences in the number of categories created by the participants groups (novice vs. expert); however an important observation was that the experts took longer to sort the problems than the novice participants. Cluster analysis on the sorted problems indicated that the novices tended to sort their problems based on superficial characteristics of the problem, such as keywords in the description or types of objects described in the problem (e.g., use of pulley). In contrast, experts tended to sort the problems based on underlying principles of physics, physic laws and concepts, such as the use of Newton's Law of Motion to solve problems (Chi, Feltovich et al., 1981). During a second task, a similar sorting exercise, novices again sorted problems mainly based on the superficial features regardless of the underlying structure and the experts categorized the problems regarding the deeper structures regardless of the similar superficial features (Chi, Feltovich et al., 1981).

This study by Chi and colleagues (1981) laid the foundation for an accepted theory on experts' problem representation. Research on problem representation has since continued to show that experts differ in the categorization of problems by the depth with which they represent a problem.

Three groups with varying expertise in the field of genetics (biology faculty, genetic counselors, and undergraduates) were asked to solve genetics problems (Smith, 1992). The experts (biology faculty) displayed a categorization of the problems based on the principles needed to solve the problem and the novices (undergraduates) centered their attention to the features (knowns and unknowns) of the problems as displayed by their verbatim use of the problem statement. Although the genetic counselors did accentuate the solution strategies, their problem categorization lacked a consistent use of principles and was more similar to that of the students (Smith, 1992).

Yarlas ans Sloutsky (2000) investigated the problem representation of experts and novices when matching arithmetic equations based on similarity. Experts categorized the problems in terms of the deeper principles. Results showed that participants with similar age and intelligence differed in their representation. The data also indicated that expertise - rather than age or general intelligence - was a distinguishing factor. Furthermore, an additional experiment explored two possible explanations for the differences in representation: the lack of knowledge and the availability of more surface features over deeper relational features. However, by unmasking the deeper principles (removing surface features) results showed that the participants did not lack an understanding of those principles, and additionally results also defused the possible explanation that the availability of surface feature contributed to the differences in performance between experts and novices.

When given a triad judgment task, expert and novice teachers displayed similar problem representations than those found in other domains (Hogan, 2004). Problems were categorized by the expert teachers based on structural features such as theoretical underpinning, while the novices identified surface features such as the grade level or subject taught as to represent the given problem and were unable to elaborate on causes of the disciplinary issues. Furthermore, experts were more effective in their recall and perception of relevant information in the classroom.

Rabinowitz, and Hogan (2008) also used a triad judgment task as they compared students with varied levels of experience in statistics for their problem representation. They found that students with less than 4 courses taken, tended to lean on surface features to represent problems, and the students with 4 or more courses didn't consistently rely on either the superficial, nor the structural features. However, students with more experience tended to rely more on the structural features. All students were somewhat affected by the presence of surface similarity features and all students noticed the structural feature when competing features were eliminated.

In a study on problem solving in mathematics, nine experts (professors) and nineteen novices (undergraduate students) were asked to sort 32 problems (Schoenfeld & Herrmann, 1982). Hierarchical cluster analysis revealed that the experts sorted the problems more consistent as was shown by the high level of agreement among the experts' problem representations. They based the sorting on the deeper mathematical principles needed for the solution, whereas the novices sorted the problem based on the descriptors in the problem or the surface features. A second experiment indicated that specific term-long instruction on problem solving strategies influenced the novices' problem representation to resemble that of the experts.

Although research indicated a clear distinction between the richness of the experts' and novices' problem representation, resemblances between experts and good novices were reported when de Jong, Ferguson-Hessler (1991) examined the knowledge organization in good (staff) and poor (students) physics problem solvers. All 98 undergraduate students (good and poor problem solvers) and four expert problem solvers (staff) were asked to compile coherent piles from the 65 physics elements and provide the reason for doing so. Results indicated that the good novices structured their knowledge around the problem-types much in accordance with the 'ideal' sorting of 12 pre-determined problem-types and the experts.

Furthermore, findings from Chi, Feltovich, et al. (1981) were supported when expert and novice physists were given a similarity judgment task, and data indicated that the novices relied primarily on the surface features (Hardiman et al., 1989). When the novices were relying on the deep structures to categorize the problems, their problem solving performance increased and resembled a problem categorization similar to that of the experts.

In summary, findings in a variety of research areas such as physics (de Jong & Ferguson-Hessler, 1991; Hardiman et al., 1989), mathematics (Schoenfeld & Herrmann, 1982); statistics (Rabinowitz & Hogan, 2008); teaching (Hogan, 2004); other sciences (Smith, 1992) highlighted the in-depth and conceptual problem representation of experts based on structural features inherent to the problem, beyond the mere superficial features of a problem or problem statement that formed the basis for the problem representation of the novices.

Interlinking of Concepts

Experts and novices also differed in the presence of interconnection between the concepts of a problem (Chi, Feltovich, et al.1981). These findings have been reiterated throughout various studies and research areas. Thirty-two medical students were confronted with a complex medical problem and were asked to provide a summary of the case and to formulate the problem (Auclair, 2007). The problem formulation and its accuracy were analyzed in relationship with the presence of essential elements, higher-order concepts and relations between the concepts. Results indicated that higher-order concepts and relations between concepts were significantly related to the students' diagnostic accuracy. Participants who failed to provide an accurate diagnosis only reported facts and failed to report the relations between concepts.

The procedural knowledge and knowledge representation of elite (athletes in the top 8 at the U.S. Senior National Diving Championships during last two years) and nonelite (randomly selected athletes who qualified for the U.S. Senior National Diving Championships, yet not placed top 8 during the last two years) divers were investigated by Huber (1997). When divers reported their thoughts during stimulated recall, elite divers would represent their dive execution in terms of scientific or higher-order concepts and nonelite divers on a superficial, naive level. Experts were more specific in the defining features of their performance and made more interrelations between the concepts of their representation. The experts possessed more procedural knowledge and had a superior ability to quickly accept and reject inapplicable rules.

A similar finding emerged when McPherson (1999) examined the problem representation of tennis players about game situations by conducting situation interviews with six expert and six novice collegiate tennis players. During the interview each participant was asked a series of six questions related to the subjects' thoughts about a particular game situation. A previously developed model for protocol structure was used to analyze the verbal data (McPherson & Thomas, 1989). The model aided in the categorization of major concepts emerging from the verbal data. For example, three major concepts were used to classify data: (a) goal concepts, (b) condition concepts, and (c) action concepts. Results indicated that the statements of the experts included tactical action plans, whereas the novices did not include any such statements in response to game situations. The responses to situations of the experts were condition-oriented in comparison to the goal-oriented responses of the novices. "Experts generated almost 80% of their conceptual knowledge as condition and action concepts, whereas novices generated 83% of their conceptual knowledge as condition and goal concepts" (McPherson, 1999, p. 376). Results suggested that the experts' schema were structured in relation to the solution or condition-oriented whereas the novices structured their representation around the goals. This indicated an interconnection of concepts within the experts' knowledge structures.

When confronted with accounting problems, some distinct differences were brought to light in regard to the way experts in accounting (faculty) and novices (underclassmen college students) identified and commented on given problems (Marshall, 1996). Again, the findings from the earlier study regarding the depth of the problem representation were confirmed by the expert accountants' more frequent use of principles to identify the problems. Additionally, it appeared that the experts displayed the ability to connect information of the problem to other information provided in the problem and make interconnections much like subjects in previous research on problem categorization had indicated.

All of the above mentioned studies investigated the experts' problem solving and in particular problem representation within their domain of expertise. In an attempt to address both problem representation and problem solving strategies outside of the expert domain Schraagen (1993) studied how experts solve a novel problem. Nine beginners (undergraduate with no experimental design experience), three intermediates (with intermediate design experience), and three expert experimental designers were instructed to think-aloud while solving the problem of designing an experiment within a domain outside of their expertise. Verbal protocols were gathered while the participants designed the experiments. Data showed that experts possess a variety of strategies that affect the form of their problem solving. Even when they are not familiar with the domain in which they design the experiment, the structured approach of the design experts was similar to that of domain experts and was schema-driven. Problems were converted into categories of problems that they were familiar with. However, they kept the global picture in mind when 'progressively deepening' or filling in the gaps and specifics.

In summary, verbal data collected from experts across various domains indicated that experts incorporated interconnections between the concepts of a problem. Apparently, experts' problem representation is constructed of concepts and their interlinking interwoven by the experts' knowledge. Smith (1992) highlighted that with the development of expertise "a person restructures his/her knowledge of the domain into a framework that is based on critical dimensions that facilitate the daily use of that knowledge" (Smith, 1992). This leads us to another important and influencing factor in expert problem representation: the knowledge base and schemata used.

Application of Knowledge

Expertise refers to 'the manifestation of skills and understanding resulting from the accumulation of a large body of knowledge' (Chi, 2006, p. 167). Prior domain-specific knowledge plays a crucial role in the problem solving performance of experts (Chi, Glaser, et al., 1988) as well as in the performance of high-achievers (Coleman, 1991). Experts possess a larger well-organized body of knowledge (Bédard & Chi, 1992). Knowledge is a key component that sets experts apart and therefore looking at the representation of the knowledge of experts and non-experts is an important step in understanding expertise (Chi, 2006). As Larkin, Dermott, Simon & Simon stated: "In every domain that has been explored, considerable knowledge has been found to be an essential prerequisite to expert skill" (1980, p. 1342).

During the third task for the physicists in Chi, Feltovich and Glaser's study (1981), the participants were asked to provide as much information about the process they employed in making decisions in sorting/grouping and then labeling the problem categories, in a three-minute period. The investigators examined how participants used their knowledge to sort, categorize and label the physics problems; which then was linked to expert and novice schema groups. Findings indicated that experts took longer to do a problem sorting task and that their established knowledge base contributed to their sorting task. Interestingly, they found that the information and actions (action schemata) necessary to solve the problems was described by the experts, but was not included in novice explanations. Results displayed the superior connections between concepts and solution methods by the experts in the study. Based on the labels and categories that emerged from sorting the problems, the researchers asked the subjects in the fourth task to tell in three minutes everything they could about the label or category of the problem and how they would solve it. Analysis of the data revealed that the keywords used by participants to describe problem solving strategies were similar across groups, yet experts had fewer keywords and the ones identified were purely a subset of the words chosen by novices. Additionally, the schema (knowledge-base to assist in problem solving) offered by the novices contained fewer explicit procedures than the experts (Chi, Feltovich, et al., 1981). Verbal data provided by experts included solution methods in their schemata (procedural knowledge) of the problem representation and indicated the importance of the experts' knowledge in representing and sorting the problems. The knowledge is essential in the problem solving process since "solvers have to rely on prior knowledge to fill in the missing data in order to understand a situation or problem" when relevant information about a problem is not present (Ge & Land, 2004, p.11).

Heller and Reif (1984) described the cognitive processes and knowledge structures inherit to good problem solving (not necessarily simulating what expert problem solvers do) in what the authors refer to as a 'prescriptive' approach. The prescriptive model of problem solving (in physics) identified three procedures used concurrent with a knowledge base. These procedures were:

> "(1) the generation of an initial problem description, and qualitative analysis, designed to facilitate the subsequent construction of a problem solution; (2) the generation of the actual solution by methods which facilitate decision making required for efficient search; (3) the assessment and improvement of this solution. The domain-specific knowledge base is designed to facilitate these general procedures. It contains declarative knowledge of concepts and principles, together with specific procedures facilitating their use, and is organized hierarchically to provide descriptions at various levels of detail" (p.181).

The existence of a solid knowledge base in experts has been demonstrated and supported by findings in research in many varying problem solving areas. DeJong & Ferguson-Hessler (1991) examined the influence of knowledge of the problem representation of twenty-three undergraduates in physics. The participants were exposed to a problem, it was removed and participants were asked to reconstruct the problem and in some cases to provide information about the solution. The memory of both the good and poor problem solvers demonstrated to contain models of problem situations in due because all participants in the study had knowledge of the subject. The good performers based their reconstruction around concepts (i.e. conductor) rather than superficial features of the problem (i.e. metal cylinder) (deJong & Ferguson-Hessler, 1991). Furthermore, the poor performers failed to provide as many solutions as the good performers did. The weaker participants' problem representation tended not to be geared toward a solution.

The effect of expertise on the problem representation of expert executives and novices in an ill-structured organizational context was examined by comparison of the data collected through a problem sorting task (Day & Lord, 1992). Results showed that the experts categorized the problems faster than the experts. The mean number of categories used by both groups to categorize was not significantly different, although there was a larger variability among the experts. A qualitative analysis of the category content indicated that the novices relied mainly on surface features, whereas the experts used both surface and meaning dimensions in their sorting of the problems. Rather than being reliant on the type of features, the experts appeared to be schemata driven and findings supported earlier findings of the use of organized schemata (Chi, Glaser & Rees, 1981).

Hardiman and colleagues (1989) reported that experts (PhD. physicists) categorized problems based on the deeper structures when deciding on the similarity of solutions for the problems. Authors also demonstrated that the use of deeper structures and principles when categorizing the problem resulted in superior problem solving compared to those who didn't rely on underlying features. Hardiman et. al. (1989) concluded that "principles play a fundamental role in the organization of conceptual and procedural knowledge for good solvers at all levels" (p. 627).

Furthermore, comparison of the knowledge structure and problem perception of novice problem solvers in math indicated that the novices relied on the superficial features in a similarity sorting task (Schoenfeld & Herrmann, 1982). However, after receiving rigorous training the increase in the novices' knowledge structure was displayed by the alteration of their sorting criteria thus emphasizing the influence of the subject's knowledge base on problem solving and problem representation in particular.

Patel, Groen and Patel (1997) studied the impact of expertise on clinical reasoning during a patient workup by endocrinologists, housestaff, and medical students. All participants were asked to develop a case based on a given patient and to offer explanations for the choices they made during the workup. Results highlighted the richness of the endocrinologists' knowledge structures in comparison the other participant groups.

In line with the findings within chess, physics, and mathematics, and medicine, the presence and use of a rich knowledge was also revealed when Wiggins, Stevens, Howard and Henley (2002) examined the decision-making of fifty pilots during simulated preflight decision-making using a computer-based process-tracing approach. Pilots were categorized as experts, intermediates or novices based on their accumulated hours of cross-country flights. Experts were found to be more effective in their determination and integrating of the appropriate information needed for the diagnosis of the presented scenarios.

When five expert botanists were asked to think aloud during a categorization of problem tasks containing unusual features, not only did their prior knowledge weigh in on their hypothesis generation and testing, but also on the revision thereof (Alberdi, Sleeman & Korpi, 2000). The use of prior and accumulated domain-specific knowledge has been found to amplify problem solving performance (Cooke, 1990). This was demonstrated by gifted physics students whose problem solving was qualitatively similar to that of experts in physics due to the use of and references to their prior knowledge while solving the problems (Coleman & Shore, 1991).

Mayfield, Kardash & Kivlighan (1999) examined four expert (advanced degree) and five novice counselors through the construction of concept maps. Although the numbers of categories between both groups was not significantly different, the depth and the links and categorization indicated a difference. Through further cluster analysis it became apparent that the novices' representation was simplistic without elaborate relationships between the categories. The experts' knowledge structures indicated the existence of complex schema.

Along with the perceptual anticipatory skills, Ste-Marie (1999) also examined the depth and breadth of gymnastic judges' declarative knowledge (defined by the author as "the knowledge about factual, rule-based information"). Twelve expert and twelve novice judges were shown twenty-four gymnastic sequences along with five questions regarding their perception, anticipation and factual knowledge of the gymnastic elements. The depth of the judges' knowledge was assessed in terms of correct identification of elements, the symbol code assigned to the element, and the level of difficulty of the element, whereas the breath of their knowledge was measured as the number of alternatives provided by the judges. Statistical analysis indicated that both the depth and breadth of the experts' declarative knowledge was superior to that of the novices.

Ten experts, ten intermediates and ten novices in the area of magnetism were confronted with unusual problems and asked to think-aloud while solving them (Stefani, 2008). Data indicated that the experts solved the problems both effectively and efficiently aided by their visualization of the field lines. The intermediate experts-in-training outperformed the novices in part because of their better recall and concrete thinking. Finally, the novices solved the problems poorly because of their reliance on their limited recollecting of previous course content (Stefani, 2008). Experts displayed the existence and use of their extensive knowledge base to enrich and form the problem representation.

When comparing the use of cues by expert and novice nurses during clinical decision-making, results indicated that the experts anticipated problems during their decision tasks (Hoffman, Aitken, & Duffield, 2009). These findings suggested that the expert nurses were able to use their knowledge and available cues effectively to formulate solutions.

Metacognition

Flavell (as cited in Feltovich, Prietula & Ericsson, 2006) defined metacognition as the "knowledge about one's own knowledge and knowledge about one's own performance" (p. 55). Numerous studies have examined and compared the metacognition of experts and novices during problem solving.

Fayena Tawil (2007) examined the thought processes of twenty-three artists and twenty-three non-artists through video analysis and think aloud protocol. An examination into the problem representation of the artists brought to light that both experts and non-artist evaluated and monitored their progress during the creation of an original artistic drawing in a similar manner. However, artists focused more on the global goals of the drawing in comparison to the localized focus on the non-artist. Secondly, artists verbalized more potential uses for objects than the non-artists, and although the frequency of metacognitive statements and monitoring of their work is similar, artists engage in more statements and monitoring later in the task's process. Again, this also supported Chi, Feltovich and Glaser's (1981) finding that the representation of novices is more naïve and superficial than that of experts.

Similar findings were reported when studying experts in genetics. When confronted with complex problems the experts showed a higher frequency of checking their problem solving (Smith & Good, 1984). An increased presence of metastatements was also found by Coleman and Shore (1991) whose investigation on the problem solving protocols of twenty-one expert and high achieving physics students found that both expert and high-achievers outperformed the average students in terms of metacognition. The thinking of the participants who were gifted seemed to mirror that of experts, characterized by accurate metastatements and the frequent use of references to prior knowledge.

Summary on Expert Problem Representation

Think-aloud protocol has been a prominent data gathering technique in research on problem representation. In numerous studies, participants were given scenarios or hypothetical problems to categorize, sort or solve while thinking aloud. Verbal protocols captured the qualitative differences between the expert and novice participants in the majority of reviewed research on expert problem representation.

Expert problem representation research in a variety of domains has brought forth common differences in the qualitative problem representation of that of experts and novices. First, experts defined and represented a problem based on the conceptual or structured principles behind the problem. On the other hand, novices represented a problem based on the features embedded in the problem or the superficial characteristics of the problem. Second, experts' problem representation is characterized by interconnections or linking between the different concepts underlying the problem. Third, the problem representation of experts is an application of their large knowledge base. Experts will incorporate procedural knowledge geared towards solutions in their problem representation. Lastly, experts distinguish themselves by the use and incorporation of metastatements into their problem solving. Although research findings among all the domains have established common differences, there is an apparent lack of continuance of this line of research in the area that pertains to athletics, and in particular that of expert coaching.

Expert Problem Solutions

This section will examine the differences between experts and novices regarding the strategies used in the problem solution phase of problem solving. First a definition will be provided. Next, evidence from literature will highlight: (a) the effectiveness of experts' problem solving and (b) the strategies used to arrive at a solution. Finally, a summary of findings on expert problem solutions will be offered.

Definition

A strategy is "a coherent set of steps for solving a problem" (Schunn, McGregor, & Saner, 2005, p. 1377), which involves a plan of action necessary to accomplish a task. This implies that multiple strategies may accomplish solving the problem. According to Chi and Glaser (1985) "The process of finding a solution to a problem can be visualized as a search through the paths in the problem space until one that leads to a goal is found" (p. 234).

Problem solving strategies often used are: random search ('coming upon the goal by randomly trying paths), depth-first (systematically searching the tree of possible solutions by exhaustively exploring each particular path), generate-test (generate possible solutions and test them), and means-end analysis ('by analyzing problems into goals and sub-goals by working out which moves (means) will attain the end-goal (means-end analysis", Kahney, 1993, p. 48). Chi and Glaser (1985) defined means-end analysis as:

> The general idea is to discover what differences there are between the current state and the goal state, and then find the operators that will reduce them. If there is more than

> one such operator, the one that reduces the largest difference is applied first. In other words, find the best means to achieve the desired end (p. 235).

In means-end analysis the problem is typically solved in a backward working manner (from goal state to initial state) in contrast to a forward working approach where the problem solvers works from the initial state toward the goal state or solution.

Effectiveness

One of the widely excepted areas in which experts set themselves apart from the novices is the accuracy and speed with which they can generate the best solution (Chi, 2006). Even though experts are faster at arriving at a solution, the time spent on the problem representation tends to be longer.

Both well-defined and ill-defined problem solving has been examined among a variety of disciplines and yielded common findings. In contrary to a well-defined problem, an ill-defined problem is ‘one in which little or no information is provided on the initial stage, the goal state, the operators, or some combination of these…the solver has to help to define the problem’ (Kahney, 1993, p. 20). In light of seeing organization design as an ill-defined problem solving process, Sánchez-Manzanares, Rico and Gil (2008) examined the role of expertise in the problem solving patterns of expert and novice organization designers. Participants were provided with a simulated problem and asked to think-aloud through the problem solving. Data analysis revealed the experts’ time spent on the problem representation was significant longer, although their time in the solution phase was shorter (Sánchez-Manzanares, et al., 2008). Finally, the amount and type of justifications and difficulties reported were analyzed. Justifications were classified as: (a) specialist justifications (based on domain-specific knowledge), or (b) realistic justifications (knowledge on how the organization works), or (c) psychological justifications (based on intuition), or (d) logical justifications (based on sequencing and order), or (e) value-based justifications (based on values). In this study, the experts in organization design voiced more specialist justifications than the other participants. The experts also verbalized more difficulties throughout the process, in particular strategic difficulties. All difficulties reported were categorized as: (a) declarative ('the what of the problem'), or (b) technical ('the how to go about'), or (c) strategic (regarding the model to create or the why).

The qualitative differences in the problem solving of twenty-four expert (mentors) and twenty-four preservice novice teachers were examined by gathering think-aloud data while presenting the participants with hypothetical scenarios (Swanson, O'Connor & Cooney, 1990). Furthermore, two different conditions of providing instructions were used. One group was given nondirective instructions, whereas the other group was asked to focus on specifics (such as their educational beliefs influencing the situation and alternatives to their decision). Through the coding of the responses data analysis revealed that the expert teachers who were given nondirective instructions used more heuristics (definition of problem, data acquisition and interpretation) and strategies than the novices. Experts, regardless of the instructions, focused on the definition of the problem and the evaluation of the strategies, in contrast to the novices who represented the problem mainly related to possible solutions (Swanson, et al., 1990).

Strategies

Experts also stand out by the strategies used to come to a solution (Chi, 2006). Fourteen math education students were presented with a total of twenty-five problems displayed to them on a computer-controlled screen. Several of the problems were similar and were repeated throughout the task. When comparing the problem solving strategies, Sweller, Mawer & Ward (1983) found that with the increase of expertise the strategy switched from a means-end approach to a forward-working approach. Furthermore, lesser moves were needed to arrive at a solution, hence becoming more efficiently in their problem solving.

Similar findings have been found in other fields. While thinking-aloud through the process, experts in genetics approached the complex problems analytically and used a forward-working (knowledge development) approach that set them apart from the unsuccessful participants (Smith & Good, 1984). Similarly, when confronted with real-life simulated problem experts engineers used forward or top-down strategies whereas the backward or bottom-up approach was preferred by the novice engineers (Elson, 2003).

Although previous research on expert engineers had revealed that experts under certain circumstances or with difficult situations deviated from a top-down approach and relied on their strategic knowledge to solve the problem (Ball, Evans, Dennis & Ormerod, 1997). This was also shown when experts and novices in chemistry were given six problems and asked to talk aloud during the solving of them (Engemann, 2000). Analyses of the verbal protocol data indicated that the successful problem solvers favored a forward strategy for problems with a moderate difficulty (or routine problems) and a means-end strategy for the difficult problems. A backwards strategy was a rarely used approach by the experts in this study.

When expert organization designers were confronted with ill-defined, complex problem, they used - much like the novices in the study - general strategies to come to a solution (Sánchez-Manzanares, et al., 2008). This might be contributed to the nature of the problem, which was not a structured problem with one solution, but a complex open-ended problem. Though the strategies used were similar, a significant difference was observed in the length of and the depth of the representation phase of the problem solving process.

In an attempt to address both problem representation and problem solving strategies Schraagen (1993) studied how experts solved a novel problem. Participants were instructed to think-aloud when solving the problem (designing an experiment). Verbal protocols were gathered while the participants designed experiments. Data showed that experts possessed a variety of strategies that affected the form of their problem solving. The structured approach was similar to that of domain experts which is schema-driven: problems were being converted into categories of problems that they were familiar with. However, the content or solutions of the non-domain experts were not better than those of beginners when confronted with a novel problem.

Summary of Expert Problem Solutions

Research findings confirmed that experts tended to use more time to represent the problem, although contradictory findings can be found regarding the amount of information gathered. This review of literature showed that experts seemed to excel by the effective use of information to solve problems, faster time to come to a solution, and better selection of the type of strategies used to solve a problem. Experts preferred to use a forward working strategy to come to a problem solution, whereas novices used a backward strategy. Depending on the familiarity or difficulty of the presented problems, experts might also rely on means-end analysis to solve complex problems, but rarely a backward working approach. As summarized by Horn and Masunaga (2006): "Expert reasoning proceeds from the general – comprehension of essential relations, knowledge of relevant principles – to develop specific alternative courses of action, whereas novice reasoning is stimulated by the salient attributes of a presented situation or problem" (p. 599). A variety of domains studied how experts and novices differed in their problem solving solutions; however, little remained known about the problem solving of expert coaches.

Summary of Expert Problem Solving Research

Whereas the initial research on problem solving was concentrated in the area of chess (deGroot, 1978; Chase and Simon, 1973), the research on problem solving broadened and expanded in the following decades in a variety of areas such as physics, (Chi, Feltovich, et al., 1981), medicine (Hardiman, et al., 1989), computer programming (Adelson, 1984), aviation (Wiggins, et al., 2002), athletics (Huber, 1997), the arts (Fayena Tawil, 2007), and statistics (Rabinowitz & Hogan, 2008). The problem solving research is no longer focused its scope on well-defined problems but also on the problem solving of ill-structured problems (Fayena Tawil, 2007, Schunn, et al., 2005). Although the larger amount of research on expert problem solving uses the expert-novice paradigm and labels the participants us such (Chi, Feltovich, et al., 1981; Schraagen, 1993; Fayena Tawil, 2007), numerous studies use alternate groupings and labeling for their participants related to their performance such as experts and novices, high performing and average performing (Coleman, 1991), effective problem solvers (Auclair, 2007), and successful and unsuccessful students (Gulacar, 2007).

Most expert problem solving research aimed to understand the cognitive processes in depth (and not merely describe quantitatively) as illustrated by qualitative studies with a relative small number of subjects (between three and thirty-two per compared group). The prevailing data collection method used among expert problem solving research is the think-aloud method to obtain verbal data. Researchers used think-aloud to 'understand thought processes' (Fayena Tawil, 2007), and to 'explore the differences in knowledge structures and behaviors' (Gulacar, 2007) during the problem solving process. The protocol was used while solving the problem (Coleman & Shore, 1991; Schraagen, 1993) or in five minute intervals during the problem solving process (Fayena Tawil, 2007).

Among the various areas, disciplines and domains, the differences between experts and lesser performing peers were significant. Those with expertise represent problems based on the deeper, underlying principles of the problem rather than the surface characteristics of the problem. (Chi, Feltovich, et al., 1981; Hardiman, et al., 1989; Auclair, 2007; Rabinowitz & Hogan, 2008). Furthermore, expert problem solving was characterized by the presence and use of conceptual knowledge and the display of linking of concepts and the occurrence of interconnection among the concepts (Chi, Feltovich, et al., 1981; Gulacar, 2007; Hardiman, et al., 1989: Auclair, 2007). The performance of those at a superior level was set apart by the frequency and use of metastatements and monitoring of one's own performance (Coleman & Shore, 1991; Fayena Tawil, 2007). Experts were more effective in solving problems (Azevedo, 1998; Thompson, 1997), although they might spend more time on the problem representation (Sánchez-Manzanares, et al., 2008). The experts preferred a forward-working strategy over the backward or means-end approach preferred by novices (Sweller, et al., 1983; Elson, 2003).

Related Coaching Research

According to Gilbert's document of an analysis of coaching science research between 1970-2001 (2002), there were five distinct areas of coaching research: "(a) behavior (what the coaches do or are expected to do) , (b) cognition (what coaches think), (c) demographics, (d) development (who coaches are), and e) measurement (how we study coaches)" (p. 14). Although the majority of research focused on behavior (average of 69%), there has been an increase in the research on coaching cognition (from 31% to 41%) and development or a shift "from what people do to why they do it" (Gilbert, 2002, p. 22).

Besides broad examinations of coaches' behavior, the most examined specific areas within coaching behavior research were coach-athlete relationships, effectiveness and leadership styles. Within coach cognition research, the emphases were on perception, knowledge and attitudes (Gilbert, 2002). Coaches' decision making only accounted for an average of 8% of the coach cognition research. While quantitative inquiries declined during the thirty year period, qualitative approaches increased (although they still account for the lesser amount). Between 2000 and 2001 however, one third of the coaching science research used interviews as a data collection method. Only ten percent of the studies examining coaches used a measure for expertise. Of those who established criteria for inclusion, win-loss percentage and coaching awards were most frequently used. The following sections will focus expert coaching research as it related to (a) coaching behaviors, and (b) coaching cognition. It will be concluded with a summary of expert coaching research.

Coaching Behavior

Expert coaches have set themselves apart by the importance they place on planning and preparation. When examining an elite handball coach it became obvious how important the pre-game planning and preparation was to the coach in regard to an upcoming competition (Debanne & Fontayne, 2009). The coach used various routines in getting his players ready during the period leading up to the competition. Routines have shown to be very deliberate and important to expert coaches (Baker, Schempp, Hardin, & Clark, 1998). Although, expert coaches used structured routines, their behavior, responses to situations and approaches have often become automated and intuitive in nature (Bloom, 1986). Nevertheless, coaches who strived to excel and to continually become better, not only sought out resources to broaden their knowledge (Ericsson and Charness, 1994), they also continued to self-monitor their performance to ensure continued improvement (Schempp, McCullick, Busch, Webster & Sannen Mason, 2006).

Numerous studies investigating coaching behaviors used systematic observation to study coach behaviors in sports as basketball (Bloom, Crompton & Anderson, 1999), football (Segrave & Ciancio, 1990) and soccer (Potrac, Jones & Armour, 2002). Using the Arizona State University Observation Instrument (A.S.U.O.I.), Claxton (1988) examined the behaviors of more and less successful tennis coaches during practice on three occasions throughout the season. Coaches were categorized in their respective groups based on their win-loss record. Analysis of data indicated that all coaches displayed the different types of behaviors recorded with the observation instrument (such as praise, first name use, questioning); however, the less successful coaches used more praise than the successful tennis coaches and the more experienced coaches asked more questions during practice than less successful coaches (Claxton, 1988).

Smith and Cushion (2006) also used the A.S.U.O.I. to analyze the behavior of eight professional youth soccer coaches. All participants had at least 10 years of experience, held a coaching license and coached either in the premier league or nationwide league. Results from this study highlighted the importance of instruction by the high frequency displayed on all instruction-related categories among all coaches. It also showed that the top-level soccer coaches utilized praise and silence as second and third most frequent behaviors.

A systematic observation of one successful youth football coach during his practices using the Coaching Behavior Recording Form (CBRF) indicated that he spent the majority of his time providing his young athletes with instructions (Segrave & Ciancio, 1990). Instructions included all “verbal statements about what to do or how to do it” (p. 297). Two other frequently shown behaviors were the interaction with his coaches, and praise.

Elaborate information about a coach’s type of instruction was provided when one division I basketball coach’s teaching behaviors during practice were systematically observed. Bloom and colleagues (1999) found that the nearly one-third of the basketball coach’s behavior was related to providing tactical instructions, followed by giving hustles to his athletes. The selected participant in this study had 26 years of basketball coaching experience and a win-loss record of 667 wins and 145 losses at that time. Additionally, the coach had the second highest number of career wins when the study was conducted.

Given Coach Tarkianian's success, including an NCAA Championship, arguably, this coach could have been considered an expert coach although he was not labeled as such in the study.

In summary, although experts performed some of their behaviors seemingly automatic (Bloom, 1986); they also deliberately had routines in place that facilitate both planning and practice (Debanne & Fontayne, 2009; Baker, et.al., 1998). The majority of research using systematic observation of coaching behaviors indicated that the successful and less successful coaches qualitatively differ in the frequency and length of behaviors displayed. More successful coaches and high level coaches incorporated a large amount of instructional behaviors (task-related instructions or tactical instructions) in their practices, as well as positive behaviors such as praise (Segrave & Ciancio, 1990; Claxton, 1988; Bloom et al., 1999; Smith & Cushion, 2006). While numerous studies have focused on the behaviors of expert coaches during both practice and competition (Trudel, Cote & Bernard, 1996; Potrac et al., 2002; Cote & Sedgwick, 2003), their focus has been on the observable behaviors, and not the cognitive processes of the coaches. The following section will review research on coaches' thinking.

Coaching Cognition

Coaching cognition, or 'what coaches know, what they think and how they think' is a vital component of understanding the observable behavior coaches display. As Jones, Housner & Kornspan (1995) noted that it is "imperative that direct observation techniques be supplemented by methods for exploring the thought processes of coaches" (p. 203). The thought processes of the coaches are a crucial part in examining the decisions of coaches. Therefore, the following section will highlight the research regarding expert coaches' knowledge, and decision making.

Knowledge. The importance of acquiring and using knowledge in the process of becoming an expert has been researched in the arena of expert coaching. Research on the sources of experts' knowledge found that the primary source of knowledge for the experts is often through personal contact and relationships with peers. Various methods have been used to examined where an expert gets their well-established and highly organized knowledge base.

Eleven expert golf instructors were presented with a Q-sort task and asked to rank the knowledge sources according to their importance. Schempp and colleagues (1998) found that the primary source of knowledge were other teachers as well as the coaches' experiences. The secondary sources of knowledge indicated by the experts included books, students, and workshops (Schempp et al., 1998).

In an examination of the technical knowledge of seven expert sprinting coaches', the coaches were interviewed and asked what they considered the needed technical characteristics for sprinting at a high level (Thompson, Bezodis and Jones, 2009). Results revealed specific technical aspects of sprinting identified by the coaches as instrumental. Furthermore, data indicated that conversations with peers were the primary knowledge sources for the seven expert coaches who participated in the study (Thompson, et al., 2009).

A case study on the practical knowledge of an expert strength coach used observations, interviews and document analysis revealed that the expert coach had an elaborate and structured knowledge base (Dorgo, Newton & Schempp, 2009). Practical knowledge in this study was defined as coaches' knowledge that is used in practice or "knowing-how". The expert strength and conditioning coach obtained his practical knowledge mainly through experience, real-life practices or other professionals with only a part of their practical knowledge constructed through formal education (Dorgo et al., 2009).

Expert coaches' knowledge is flexible, yet very organized and elaborate. A coaching model of expert gymnastics coaches' knowledge was established through the in-depth interviews of seventeen elite coaches. The constructed conceptual coaching model incorporated various components such as the coaching process (training and competition and the organization of those), characteristics of both the athlete and the coach and contextual factors that were instrumental to the coach in developing their athletes (Cote, Samela, Trudel, Baria & Russell, 1995). This study highlighted the importance of expert coaches' knowledge as well as its complexity.

Studies on the recall ability of expert coaches have shed light on the well-organized knowledge structure and memory of experts. Expert golf and tennis instructors were shown ten photographic slides for five seconds each (McCullick, et al., 2006). After every slide, the participants were asked to "recall as much as they could". Not only did the expert coaches give a large quantity of information, it also appeared to be provided in a similar order. The experts gave lots of detailed skill analysis information embedded with specific feedback and speculations. When comparing expert tennis instructors and novice tennis instructors on their ability to recall information, Woorons (2001) found that the experts recalled more relevant information in regard to tennis and tennis instruction

(Woorons, 2001) than the novices. However, the differences were most striking only when the participants were shown familiar situations.

In summary, the primary source of knowledge for expert coaches' knowledge, whether general, technical or practical in nature was through interaction with others and through their experiences (Thompson, et al., 2009; Dorgo, et al., 2009). Similar to the knowledge structure of experts in areas outside of coaching, the structure of the expert coaches' knowledge base was elaborate, well-organized and complex (Cote et al., 1995). Furthermore, expert coaches excelled in how they organized and used their knowledge as highlighted by their superior ability to recall information in depth and in a seemingly ordered manner (McCullick, et al., 2006). Although the knowledge base plays an important role in making decisions and solving problems, the thought processes involved demand further examination to better understand the process.

Decision making/problem solving. The decision making of basketball coaches during the game, and in particular preceding a timeout has been investigated previously (Duke and Corlett, 1992). However, this inquiry only consisted of a questionnaire. Participants were asked to indicate on a Likert scale how likely they would call a timeout given the question. Questions were constructed based on six predetermined reasons for the coaches' decision making. These predetermined responses were: (a) offensive games events, (b) defensive game events, (c) attentional state of players, (d) emotional state of players, (e) physical state of players, and (f) strategy. Results indicated significant differences among coaches. Specifically, the focus of successful coaches was more often of the offensive events during a game for calling a timeout.

Gilbert, Trudel, and Haughian (1999) however, examined the interactive decision making of youth ice hockey coaches qualitatively through a multi-case study design. Five coaches underwent a background interview, pre-game interviews, and video-taping of their games, were asked post-game questions and participated in stimulated recall interviews the day after the games. The coaches in the study identified the decisions they made during the game. Those situations were included in the stimulated recall as were decisions identified by the researchers. Most identified decisions by coaches were: (a) talking to players and (b) players substitutions. Data analysis categorized the goals for the decisions into five groups: (a) discipline, (b) provide feedback or information, (c) motivate, (d) observe, and (e) organize (Gilbert and colleagues, 1999). The types of factors influencing the decision making process were broken down in two main groups: (a) the field information (attend to during game) and (b) the coach's knowledge. Within the field information, the subcategories of (a) objective information (such as game score, location of face-off, injury) and (b) subjective information (such as team performance, player performance, coach's previous action) were established by the researchers. When comparing the five participating coaches in the study, it became apparent that more than half of the factors provided by the coaches were based on field information, specifically from the subjective subcategory.

Using computer-simulated scenarios, Hagamann, Strauss and Busch (2008) investigated the problem-solving of top- and lower-league team handball and basketball coaches, in particular as it related to their domain-unspecific problem solving strategies (wide range of strategies). Results showed that the top-league coaches were better problem-solvers than the lower-league coaches when confronted with the domain-unspecific computer-stimulated problems. Furthermore, the top-level coaches provided more criticism and motivation during competition than the lower-league coaches.

Jones, Housner, and Kornspan (1995; 1997) investigated the decision making of experienced and inexperienced high school basketball coaches during the planning of a practice session and observed the conduct of the practice. The planning of the experienced coaches was qualitatively different than that of the lesser experienced coaches, although both had the same amount of planning decisions. All coaches implemented their practice plan into the practice consistently; however the more experienced coaches used more technical instruction. Through a questionnaire the responses of 80 head high school basketball coaches were gathered, examined and ranked according to their experience. Experience or expertise was measured based on five criteria: (a) extensive coaching experience, (b) prolonged coaching success, (c) peer recognition, (d) professional involvement, and (e) teaching certification (Jones, et.al., 1997). Ten coaches were selected to serve as the experienced coaches for this study and ten coaches were identified as the inexperienced coaches for this study on decision making and behavior. The researchers used the same protocol as a previous study (Jones et al., 1995) to guide the think aloud of the coaches during an individual planning of the practice. Following the planning, the coach conducted a thirty minute practice with four middle school students. The practice session was videotaped. At the conclusion of the practice session, various predetermined two-minute sessions from the practice were shown to the coach and a series of ten questions were asked. Data analysis of the frequency with which the coaches followed a certain decision pathway indicated that the experienced and inexperienced coaches displayed many similarities. Path 1 indicated that the coaches coached as they planned. Path 5 referred to in-flight adjustments made by the coaches in an attempt to bring student behavior within the limits of expectations. Both coach groups used path 1 the most, followed in frequency by path 5. The only significant differences between the experienced and inexperienced coaches were found in relation to perceived problem situations. Experts made no changes when the problems were not serious. Experienced coaches also provided more skill-related information and feedback.

Through telephone interviews using a questionnaire constructed around hypothetical scenarios, the relationship between gymnastics coaches' experience and decision-making was examined (Vergeer and Lyle, 2009). From an expert-novice paradigm perspective, the sixty-four coaches were classified as least, intermediate or most experienced. Mixed methods were used to analyze the numerical and verbal data obtained. Quantitative data analysis indicated that more factors were taken in account by the most experienced coaches when weighing a decision. However, the more experienced coaches did not significantly use more statements. Vergeer and Lyle (2009) highlighted in their analysis of verbal data that the most experienced coaches emphasized managerial aspects of the decision (for example, sharing information with those involved, finding alternative to competing, seeking medical advice) when asked to explaining their reasons behind the decision. In contrast, the least experienced coaches focused mainly on more obvious features and information related to the problem (for example, amount of pain by the athlete). The authors hypothesized that the use of decision rules (for example, 'making that decision earlier than the night before competition') narrowed the options of the decision of the more experienced coaches (Vergeer and Lyle, 2009) resulting in the absences of more statements. Although the coaches in this study were not categorized by their level of coaching expertise, results indicated the importance of experience and its influence on how coaches make decisions.

In summary, research on decision making of coaches has revealed some of the main reasons for calling a timeout in basketball (Duke & Corlett, 1992), the types of decisions made during the game by ice hockey coaches and the factors influencing those decisions (Gilbert, et al., 1999). When comparing coaches according to their level of experience, research revealed that experienced and lesser experienced basketball coaches differed in their planning of practices (Jones, et al., 1997) and more experienced gymnastics coaches' included managerial aspects in their decision making, whereas the lesser experienced coaches represented the problem in a more superficial manner (Vergeer & Lyle, 2009).

Summary of Related Coaching Research

The leading paradigm used to conduct expert coaching research was the expert-novice paradigm (Hagemann, et al., 2008; Jones et al., 1997). Research on expert coaching linked to expertise characteristics has provided useful and important differences in various characteristics and skills that separate the novices from the experts. Expert coaches have found to be better at self-monitoring their performance, have a large well-organized knowledge base, superior memory and distinguish themselves in their behavior, and decision making. However, the existing research conducted on coaches problem solving and decision making focused on the coaching conduct during practices (Jones et al. 1995; 1997), hypothetical scenarios (Duke & Corlett, 1992; Hagemann, et al., 2005), or in games (Gilbert, et al, 1999). In very limited amount was an expert-novice paradigm used to investigate expert and novice coaches problem solving during the game situations.

Despite the known characteristics of expert coaches and the insight in the decision making of coaches in general, little remained known about the problem representation and problem solving phases of expert and novice coaches’ problem solving during competition. The research on areas outside of coaching however, suggests perhaps that effective problem solving during games is a distinct characteristic of expert coaches. This study aided to close the gap between the existing expert problem solving research and existing coaches’ decision making research.

CHAPTER 3

METHOD AND PROCEDURES

This study examined the decision making of expert and beginning coaches. Specifically, the purpose of this study was to analyze and compare how expert and beginning coaches represent problem solving situations and solve problems during games. The following research questions guided this study:

1. How do expert and beginning coaches represent a problem situation? What characterizes expert and beginning coaches' problem representation?
2. How do the expert and beginning coaches' problem solving strategies differ?

In the first section of this chapter, the selection criteria and recruitment procedures for the expert and beginning coaches will be described. Through two separate tasks, participants were presented with video segments of games. Section two, will elaborate on the techniques employed to gather data from the participants while presenting them with video segments of games. The selection process for the video game segments is also described. An overview of the data collection procedures from pilot testing and from the testing of the study's participants are presented in section three. The procedures for data analysis and ensuring trustworthiness are offered in the final sections.

Participants

Number of Participants

For this study, four expert and four beginning coaches were interviewed to gain access to their knowledge of how they represent and solve problems during games. Various studies using the expert-novice paradigm and/or think-aloud procedures for obtaining data have been successful in obtaining useful and rich qualitative data through interviews with a comparable relatively small sample sizes (McPherson, 1999; Alberdi, et al., 2000; Mayfield, et al., 1999; Woorons, 2001).

Choice of Sport

Given the high occurrence of 'problem situations' and decision-making actions by basketball coaches during games and the researcher's familiarity with and training as a player and coach in basketball, basketball coaches were chosen as the preferred participant group for this study. Furthermore, given the researcher's location in the Southeastern United States, the selection of participating coaches for this study was limited to coaches located and actively coaching in the Southeast. The pool of active high school coaches in the researcher's region was larger than the potential collegiate coaches meeting the selection criteria. Therefore, high school coaches were targeted in the identification and selection of participants for this study.

Selection Criteria for Expert Coaches

Selection criteria for the expert basketball coaches in this study followed previously established selection measures for expert coaches as found throughout coaching expertise literature (Gilbert, 2002; Ericsson & Smith, 1991; Vallee & Bloom, 2005).

Primary selection criteria. Expert coaches met three primary selection criteria. First, the expert coaches had at least ten years of experience. Ten years, or 10,000 hours is the critical amount of experience needed to become an expert (Ericsson & Smith, 1991). The average number of years of basketball coaching experience in this study was 28.25 years and far exceeded the ten-year mark. As noted, experience is a requirement for expertise and of importance to become the very best. It is also a better distinguishing factor then age or intelligence (Yarlas and Sloutsky, 2000). Experience is a crucial part of expertise; however it is not the sole criteria or requirement to become an expert. As a second criterion, the coaches in this study obtained a consistent and sustained level of success (Jones, et al., 1997; Schempp et al., 2006). The expert coaches' sustained level of success was supported by having won at least two State Championship titles at the highest level (i.e. as a varsity high school coach). The expert coaches in this study each had won an average of 3.75 varsity basketball State titles. Third, the expert coaches were all current head varsity high school coaches (Vallee & Bloom, 1999).

Secondary selection criteria. The coaches who met the three primary selection criteria also met at least one of the following secondary selection criteria: (1) peer recognition, (2) outstanding win-loss percentage, (3) additional honors, or (4) collegiate scholarship athletes produced. Peer recognition included awards such as 'coach of the year' voted on by other coaches. Peer-recognized accomplishments have been used frequently as selection criteria in expert-related research (Jones, et al., 1997; Baker, Schempp, Hardin & Clark, 1998). Outstanding win-loss percentage included a winning percentage above .650 as a high school basketball coach. Additional honors included honors or recognitions by sports writers. Lastly, the coaches produced at least one athlete who upon high school graduation received an athletic scholarship to play basketball at the collegiate level (Nash & Sproule, 2009).

Selection Criteria for Beginning Coaches

The beginning coaches in this study met two primary selection criteria and no more than one of the secondary selection criteria set forth.

Primary selection criteria. The beginning coaches selected for this study were characterized by two primary criteria: (a) the lack of coaching experience and (b) the lack of consistent level of success at the highest level. The beginning coaches had 2 years or less of coaching experience, with an average of 1.75 years of basketball coaching each. Further, none of the beginning coaches had won a State championship title.

Secondary selection criteria. The coaches who met the two primary selection criteria could not meet more than one of the following criteria: (a) current head varsity high school basketball coach, (b) peer recognition, (c) outstanding win-loss percentage, or (d) additional honors. A junior varsity coach and middle school coaches were included as beginning coaches in this study. A head varsity high school coach was also selected, since none of the other secondary selection criteria were met. None of the coaches had received peer recognition, demonstrated an outstanding win-loss percentage (all below .650 as a basketball coach), nor had received any other additional honors (honor or recognition by sports writers).

Recruitment of Coaches

The following section will describe how the participants for this study - specifically the coaches for the pilot study, the expert coaches and beginning coaches - were recruited.

Coaches for pilot study. Given that the purpose of the pilot study was the refinement of testing procedures and protocols and the familiarity of the researcher with the data collection process, the two participating coaches were high school coaches who did not meet the primary selection criteria for expert or beginning coaches in this study and who were in close proximity to the researcher. Coaches were contacted through personal contacts at their local schools. The purpose of the pilot study was explained to them and their participation in the pilot study elicited.

Expert coaches. Records posted on the Georgia Athletic High School Association's website were used to identify teams who won at least two state basketball championship titles over the last ten years. Next, internet sources and other resources were used to identify the coaches of the selected state-winning teams and checked the criteria that (dis)qualify them as an expert coach according to the primary selection criteria. Using online resources, other basketball coaches with multiple high school State titles were identified, checked and included in a potential expert coaches' participant list.

All the coaches who met the primary selection criteria, were sorted by approachability (shorter length of the process to obtain county, school or district permission were associated with a higher ranking), latest title won (later was associated with higher rank) and the distance to the researcher (closer was associated with higher rank). The highest ranked coaches were selected for initial contact. Upon approval from the Internal Review Board (IRB) at the University of Georgia, the coaches were called and explained the study. Furthermore, coaches were asked for permission to video-tape their game and to consider their participation in the study. During the phone call, any questions that arose were answered.

Beginning coaches. The internet and other available resources were used to identify beginning coaches according to the primary selection criteria. Coaches who met the primary selection criteria, were sorted by approachability (shorter length of the process to obtain county, school or district permission were associated with higher rank), latest title won (later was associated with higher rank) and the distance to the researcher (closer was associated with higher rank). The highest ranked coaches were selected for initial contact. In a phone-call with the identified beginning coaches, the purpose of the study was explained (Appendix A). Furthermore, coaches were asked for permission to video-tape their game and to consider their participation in the study. During the phone call, questions that arose where answered by the researcher.

Data Collection Techniques

The participants in this study were given two tasks. The selection of the data collection techniques was in accordance with methodological trends found in similar studies on problem solving as reported in the literature review and was in alignment with Mayer's (1992) conceptualization of the problem representation phase within the problem solving process. According to Mayer (1992), different types of knowledge inform the phases within one's problem representation. The problem translation, or "converting each sentence or major clause into an internal representation" (Mayer, 1992, p.459) depends on one's linguistic and semantic knowledge. The author defines semantic knowledge as "knowledge of the facts" (p.458) or "knowledge of concepts underlying a given situation" (p.396). As a method to assess this type of knowledge he suggested to "give a sort of comprehension test, that is, to ask novices and experts to describe what a …problem means" (Mayer, 1992, p.396). This supports the findings from a literature review on expert problem solving research where verbal reporting is the most commonly used method to study expertise (Ericsson, et al, 2006) and think-aloud is one of the techniques to capture the data and found to be an effective tool in recording the subjects' cognitive processes (Ericsson and Simon, 1993). Therefore, verbal reports were recorded during both tasks to gather the semantic knowledge of the participants in this study.

In the first task, participants were shown video segments from other coaches' team, while in the second task they did a think aloud during a video segment of their own team's game through stimulated recall. Stimulated recall has been shown to be an appropriate method to get to a coach's decision making (Debanne & Fontayne, 2009). A detailed description of both tasks and the criteria for selecting the video-taped game segments is provided in the following sections.

Task One

To initiate task one, the researcher read the instructions for task one (Appendix B). During the first task, the participants were shown four video segments of a collegiate basketball game. They were instructed to think-aloud while they observed the video and to verbalize their representation of the problem. Coaches were prompted or encouraged to "keep talking" when silences of more than ten seconds occurred. Research had shown that such reminders would not affect the subjects' processing (Ericsson and Simon, 1993). A second viewing of the video took place, except for when the coach explicitly indicated that one viewing was sufficient (Gilbert, 2002). Instructions read by the researcher lead the participant through the viewing of four video segments while asked to think-aloud. The verbal responses of the participants were audio-taped while a video-camera simultaneously captured the video watched by the coaches (Debanne & Fontayne, 2009).

Video segment selection. The same four segments of a basketball game were shown to all the participants. Therefore, one game was selected from which the segments were chosen as the data collection instrument. Given the accessibility of game tape on a local collegiate team, one game from a team with an expert basketball coach was selected.

Women's Basketball Coach Andy Landers from the University of Georgia met the expertise criteria set forth in the literature. He had more than ten years of experience (Coach Landers has currently more than 30 years of experience), and has displayed a consistent level of success as highlighted by his 800+ career wins. Furthermore, Coach Landers has been widely recognized for his achievements through his induction into the Women's basketball Hall of Fame and numerous Coach of the Year awards. Additionally, several internationally recognized athletes have been produced in his program. A copy of a video-taped game of a Lady Bulldogs basketball game against Iowa was obtained through the Lady Bulldogs' office.

The criteria for selecting the video segments used in this study were: (a) segments prior to a time-out, (b) all time-outs following the segment were called by coach Landers, and (c) the length of the segments were determined by the previous break in the game (i.e. TV time-out, half time) until the time-out was called.

The researcher watched the game, identified, selected and edited four segments that met the criteria. Consequently, the segments were stripped, edited, muted and video segments were uploaded to a laptop, which was used to present the video segments to the participants.

Task Two

To initiate task two, the coaches were read the instructions for task two (Appendix B). During the second task, the participants were shown one (or more) game segment(s) from their own team's game. Through stimulated recall they were instructed to think-aloud while they observed the video to verbalize how they represented the problem and solved it. Supplementing think-aloud with stimulated recall of the coaches' videotaped game had been shown to be an effective tool in capturing the cognitive processes occurring during the competition (Lyle, 2003). Coaches were prompted or encouraged to "keep talking" when silences of more than ten seconds occurred. A second viewing of the video took place when desired by the coach.

Video segment selection. During the initial phone call, a game day and time were selected to video-tape one of the coach's games. The video-taping took place prior to the data collection.

The criteria for selecting the video segment from the game to use in this study were: (a) segments prior to the first time-out called by the coach, (b) all time-outs following the segment were called by the coach, and (c) the length of the segment was determined by the previous break in the game (i.e. begin of game, other coach's time-out) until the time-out was called.

The researcher watched the game, identified, selected and edited the game segments that met the criteria. Consequently, the segment was edited with i-movie software and video segments were uploaded to a laptop, which was used to present the video segments to the participants. Each coach observed one (or more) video segment(s) of their own team's game during task two.

Data Collection Procedure

Pilot Test

A pilot study was conducted for the purpose of: (a) refinement of the testing protocols, (b) timing of the data collection process, (c) clarity of the instruction, (d) testing of the interview protocol and (e) experience for the researcher with the procedures of this study. Two high school basketball coaches conducted task one and two, and were timed. Notes were taken regarding questions asked by the participants related to the testing protocols and procedures. Changes to the protocol were implemented as needed prior to proceeding with the data collection on the selected expert and beginning coaches.

Study's Procedures

In follow-up of the initial phone call, the coaches were asked to read and sign two copies of the *informed consent form* (Appendix C). The researcher answered any questions the participant had regarding the study and the video-taping was scheduled.

After the video-taping of the games, the participating coaches were contacted and asked to schedule their interview. The interviews were scheduled at a convenient time for the participant and took place the University of Georgia's Sport Instruction Lab, at the participant's school office or another alternative location. Research on stimulated recall has shown that to increase validity, the time delay must be minimized between the event and recall (Lyle, 2003). The researcher scheduled the interview after the video-taping of the game as soon as conveniently possible for the coaches. The time between the videotaping of the game and the interview - in terms of the number of other games played in between - varied from none to five.

Task one. Prior to starting and recording the first task during the interview, the researcher explained the procedure of the think-aloud protocol. The coaches were asked to observe four short video segments of a basketball game preceding a time-out. The participant was informed that the researcher would show the first segment during which the participant was asked to think-aloud about the problem that might have led to the time-out being called by the Georgia coach. The segment was shown a second time and the coach asked to verify the comments, as an one-the-spot member check of the coaches' responses (Gilbert, et al, 1999). The data collected through the think-aloud protocol and clarifying follow-up questions produced verbal data about the coach's problem representation or specifically the coach's semantic knowledge that informed their problem translation (Mayer, 1992). Ericsson and Simon (1993) demonstrated that verbal data can be a very useful and effective tool to gather data about cognitive processes. The researchers instructed the participants to describe their thoughts, and feelings as a concurrent verbal report. Participants were told that the videotape could be stopped at any time. Additionally, the participants were encouraged to take as much time as needed, to rewind or review the tape if needed. When silences of more than ten seconds appeared, the researcher reminded the coach to "keep talking". Meanwhile, the participants' verbalizations were audio taped while the laptop screen was video-taped. Follow-up questions were asked when needed to clarify the participants' responses and to elaborate on the coaches' thoughts.

The sequence of observing the segment while thinking aloud was repeated for all of the four video segments of task one. Each sequence took approximately five minutes to complete. The total interview for task one was completed within approximately 30 minutes (Table 3.1).

Task Two. Prior to starting the second task, the researcher repeated the procedure of the think-aloud protocol. The coaches were asked to observe a video segment of their basketball team preceding the first time-out called by the participant. The participants were informed that the researcher would show the first segment during which the participant was asked to think-aloud about the problem that might have led to the time-out being called. The segment was shown a second time if asked for or desired by the participant. The data collected through the think-aloud protocol and clarifying follow-up questions produced verbal data about the coach's problem representation as well as the problem solution phase of the coach's problem solving. The researchers instructed the participants to describe their thoughts, and feelings as a concurrent verbal report. Participants were told that the videotape could be stopped at any time. Additionally, the participants were encouraged to take as much time as needed, to rewind or review the tape if needed, and when silences of more than ten seconds appeared, the researcher reminded the coaches to "keep talking". Meanwhile the participants' verbalizations were audio taped and the laptop screen with the video segments was video-taped. Follow-up questions to clarify the participants' responses and to elaborate on the thought process were asked when needed. Task two took approximately twenty minutes. The total time for task one and two was approximately fifty minutes.

Table 3.1:

Data Collection Procedure and Schedule

Procedure	Estimated Time to Complete
Initial phone call, answering questions, informed consent, scheduling of video-taping	10 minutes
Video-taping of game	60 – 90 minutes *

Interview	
Task One	
Instructions	5 minutes
Presentation of video segment # 1 and think aloud	5 minutes
Presentation of video segment # 2 and think aloud	5 minutes
Presentation of video segment # 3 and think aloud	5 minutes
Presentation of video segment # 4 and think aloud	5 minutes
Task Two	
Instructions	5 minutes
Watching segment(s) and think aloud	15 minutes
TOTAL TIME for each participant	120 minutes: 60 minutes engaged (and 60 - 90 minutes *)

Note. * required no active participation or interaction from the participant

The verbal responses of the coaches were audio taped throughout both tasks. Follow-up, probing questions and additional questions were asked to clarify the participants' responses and to ensure that the answers were understood correctly by the researcher.

Data Analysis

Data collected from both tasks were analyzed independently. An inductive analytic approach was used to gather data and search for emerging patterns and categories of basketball coaches' problem solving. After transcriptions, the initial part of the analysis was inductive in finding themes and categories in the data. An important step was the sorting and management of all data (Patton, 2002). A color-coding book was used to record categories as they emerge. The researcher used a constant comparative method when analyzing the data to capture the data in their totality. Verbal data were clustered in 'meaning units', compared, grouped, categorized and emerging themes were coded and color-coded. Modifications were made to the categories and various incidents were compared to identify the properties of the categories broadly. Categories in the coding book and the data were color-coded correspondingly. Using copy and paste functionalities and multiple copies of the data, data were sorted in folders according to their categories and thus colors. Throughout the coding process, comparison of incidents and data was crucial.

Trustworthiness and Credibility

Familiarity with the data collection technique and protocol and refinement of the data collection procedures were obtained through the pilot study. Data were triangulated through the use of different data sources; think-aloud data while participants observed video segments from another coach's game, verbal data from think-aloud by stimulated recall of the participants' teams; and the data obtained through the questions during the interview. Furthermore, a member-check was conducted throughout the data collection by asking the participants to watch video segments twice to verify of their comments from the initial think-aloud (Gilbert, et al., 1999).

A current educator, with Master-level educational background, was included and briefed in the data analysis and interpretation process as a 'disinterested peer' with the purpose to uncover the researcher's assumptions and perspectives (Lincoln & Guba, 1985). Additionally, credibility of the interpretation and analysis of the data was sought by conducting continuous peer checks with a researcher in the University of Georgia's Sport Instruction Lab throughout the data analysis process.

CHAPTER 4

PROBLEM REPRESENTATION

The purpose of this study was to analyze and compare how expert and beginning coaches represent problem solving situations and solve problems during games. The following research questions guided this study:

1. How do expert and beginning coaches represent a problem situation? What characterizes expert and beginning coaches' problem representation?
2. How do the expert and beginning coaches' problem solutions differ?

This chapter addresses the problem representation phase of the problem solving process and presents how the coaches' problem representation is formed. In the problem representation phase of the problem solving process an individual develops a "cognitive structure corresponding to a problem, constructed by the solver on the basis of his domain-related knowledge and its organization" (Chi, Feltovich, and Glaser, 1981, p.122). The quality of one's problem representation plays an important role in one's ability to solve a problem since "one of the most important determinants of the ease with which a problem can be solved, or whether it can be solved at all, is the way the solver constructs a mental representation of the problem" (Kahney, 1993, p.34).

Analysis and interpretation of verbal data obtained through a think-aloud protocol brought forth five main mechanisms used by basketball coaches to construct a problem representation. Both expert and beginning high school basketball coaches used these particular mechanisms or 'building blocks' to understand the situations and problems they were confronted with during games and to construct their representation of the problem. For each of the building blocks presented in this chapter, a definition derived from the researcher's interpretation and analysis of the verbal data, and exemplary quotes will be provided. Furthermore, an analysis of the use of each building block and a comparison between the expert and beginning coaches will be presented. The five building blocks identified in this study were: descriptions, analytics, connections, solution-oriented statements and anticipation/prediction/speculation (APS) statements.

Descriptions

One of the most often used building blocks in the representation of problems during a game was descriptive verbalizations of the observed events. The descriptions were a verbal, and often literal identification, provided by the coaches of what they saw happening during the game. The descriptions appeared to fall into one of three types of statements: (a) strategic formations descriptions, (b) general movement descriptions, and (c) score and time references.

Strategic Formations Descriptions

Definition. Coaches described the strategic (mainly) defensive and (some) offensive formations of how the observed teams were setting up. For example, one beginning coach said while watching a segment in task one "looks like they are in man, but they are…yes, in a 2-3, looks like a man, but it's actually a 2-3" (Interview, BB). An expert coach commented "I also see an odd offensive alignment set going on against an even defensive set…it appears to be sort of a 1-2 offensive alignment against a 2-3 defensive alignment" while watching a game segment in task one (Interview, JE). While watching their own game's segment a beginning coach noted "we're still in our man to man press"

(Interview, BB), while an expert coach described the opposing team's formation "they go to a 3-2 zone on the out of bounds play" (Interview, ME).

Analysis of the use of strategic formation descriptions. The strategic descriptions provided by all the coaches were mainly focused on defensive formations and very sparingly on offensive formations (see table 4.1). Specifically, out of 120 utterances made by the coaches, 101 were made about defensive formations, whereas only 19 of them referred to offensive formations. In task one, of all the strategic descriptions that provided specific information about which team was being described, slightly more than half of the defensive strategic formation descriptions were describing Georgia's defensive formations and the other half focused on the Iowa team's defensive formations.

Furthermore, when comparing the strategic description given by coaches when watching someone else's game (task one) versus the segments of their own coached game (task two), it appeared that more than twice as many strategic formation descriptions were provided in task one than in task two (84 in task one versus 36 in task two). Given the unfamiliarity of the segments observed in task one, the coached focused some of their attention to describing the strategic formations of the team's being observed, whereas they were already familiar with the strategic formations of their own and the opposing team; thus not merely describing them as frequently while representing the problem situation in task two. The amount of strategic descriptions provided by expert and beginning coaches between both tasks and the ratios of defensive versus offensive formation descriptions remained similar between the experts and the beginning coaches. The main difference between the expert and beginning coaches was the amount of offensive strategic formation descriptions given during their own game (task two). All expert coaches provided multiple offensive formation descriptions (nine) whereas only one beginning coach made one verbal reference to an offensive formation in his description. Apparently, the expert coaches' focus was wider than merely on the defensive formations highlighted by the offensive formation references by the experts and lack thereof by the beginning coaches. When examining reasons for calling a timeout, Duke and Corlett (1992) found that successful coaches often focused on the offensive events during the game, thus possibly explaining some of the focused attention of the experts on the offensive events during their game. Although in the time leading up to a timeout the majority of all coaches' attention in this study was geared on the defensive formations.

Table 4.1

Overview of the Frequency of Defensive and Offensive Strategic Formation Descriptions in Task One and Task Two by Expert and Beginning Coaches (Descriptions about the Opponent in Parentheses)

Strategic Formation Descriptions (n=110)	Experts	Beginners
	Task One	
Defensive (n=65)	30 (18)	35 (16)
Offensive (n=9)	6 (1)	3 (0)
	Task Two	

Defensive (n=26)	16 (4)	10 (4)
Offensive (n=10)	9 (0)	1 (0)
Total Defensive + Offensive (n=36)	25 (4)	11 (4)

It should be noted that the strategic descriptions often included subtle references to previous events by noting re-occurrences or changes of the strategic formations related to earlier events in the game being observed demonstrated by the frequent usage of words such as 'again' or 'they are back in a…' or 'they are still in a…'. More on the connection with previous events can be found in the 'connections' section later in this chapter.

Besides strategic formation descriptions, the coaches also used general movement descriptions when describing the situations observed throughout the game.

General Movement Descriptions

Definition. The coaches gave descriptions of what was going on visibly on the screen related to the players' or team's movements. These descriptions were literal verbalizations of the skills and movements performed by the players or team, and these included specific language and basketball-specific terminology. For example, one expert described while watching a game segment in task one "denial on the wings, okay…screen and roll…help…double screen…bam" (Interview, DE). Another expert described while watching a segment in task one that "Georgia breaks the press, she starts to attack the rim, sees that she's getting cut off…they give it to her, she goes in" (Interview, ME). A beginning coach in this study noted "Iowa is switching all the screens" (Interview, BB).

While observing their own team, a beginning coach described the players “getting it out and taking it to the hole” (Interview, BB). While another expert described the movement of one of the players “she went behind her, she sealed her up, lay-up” (Interview, DE).

Analysis of the use of general movement descriptions. Both expert and beginning coaches used this type of description in similar amounts. However, all coaches added more general movement description when watching another team’s game segments (task one) versus their own team’s performance (task two). Similar to the strategic formation statements, coaches offered more descriptive statements when watching unfamiliar game segments than when they observed their own team’s game. The familiarity of their game allowed the coaches to focus their attention beyond the description of the situations.

Furthermore, the movement descriptions of the experts appeared richer by adding additional, yet subtle, background information or descriptors on the players or situation observed. For example, an expert described a missed lay-up situation by including additional information on the player executing the lay-up by saying “best player, lay-up …and miss” (Interview, DE), whereas a beginning coach described a similar situation in their game by just describing it as “a missed lay-up”. Resemblances in the problem representation of expert physics problem solvers and good novices were also reported by de Jong and Ferguson-Hessler (1986), although the authors found clear distinctions in the richness of the problem representation of the experts and novices, much like the differences in richness of the general movement statements in this study indicated.

A third type of description - besides strategic formation and general movement descriptions - was the inclusion of score and time references as a description throughout the think aloud protocol.

Score and time references

Definition. The coaches in this study made numerous references to the score of the game and/or the time left on the play clock. For example, some expert coaches made score references such as "it's 57-57" (Interview, DE), or "we're down 11 points here" (Interview, VE), or "now instead of it being a 2 point game with the ball, you're down 5" (Interview, DE). A beginning coach alluded to the score by saying "at this point we're up by a good bit" (Interview, BB). In reference to the time, an expert coach added, "with 1:20 left" while watching his team's segment (Interview, ME), while a beginning coach noted the time by saying "with about a minute left" (Interview, BB).

Analysis of the use of score and time references. The expert coaches appeared to be more likely to make references to the score and time left in the game than beginners did in both other game (task one) and their own game segments (task two). The few references to score made by the beginning coaches while watching their own game were more general estimations, versus the more exact checking points from the experts. For example, beginning coaches used words as 'about' or vague terms; whereas the experts used the exact point differential or time.

According to the expert coaches, the score and time appeared to be important factors in representing a problem situation in basketball. As an expert coach explained while watching video segments, "…I'm noticing down there, what the score is, cause that dictates a lot of what is going on" (interview, DE). The coach reiterated this later in the interview, "the score dictates a lot, and really a lot of how you play". Another coach highlighted the importance of the time, "possession has become the critical part in this with a minute and 40 something seconds to go…" (Interview, JE). By utilizing the time and score references, the experts in this study made more connections to underlying principles related to the problem as has been shown in studies on expert problem representation in other fields. These findings support earlier studies on problem representation, where Chi, Feltovich, et al. (1981) found that the expert physicist represented problems in terms of the underlying concepts inherent to the problems, rather than superficial features. Those findings have been consistently found across the problem representation of different populations such as genetics (Smith, 1992), mathematics (Schoenfeld & Herrmann, 1992) and statistics (Rabinowitz & Hogan, 2008).

The beginning coaches, however, did not completely lack an understanding of the importance of the time and score factors in regard to the timing of a timeout as demonstrated by this beginning coach's quote when asked about the importance of time and score,

> "timeout wise I do think that it plays a huge role….for both the time and the score…..you're gonna do all you can do to try to keep possession of the ball…whether you're two points ahead or two point behind…so if you can't get the ball in, then I'd definitely call a timeout at this point, especially this situation of the score as well as 45 seconds left to go in the game" (Interview, GB).

Nevertheless, the beginning coaches did not use the score and time references frequently as descriptions statement while watching the segments. This supports findings from Yarlas and Sloutsky (2000) who investigated the problem representation of experts and novices when matching arithmetic equations based on similarity. By manipulating the problem features of presented problems and unmasking the deeper principles (removing surface features) they illustrated that the novices did not lack an understanding of those principles although the use of those principles during the problem representation phase differed between experts and novices.

Besides providing descriptions of events happening in the game, coaches also analyzed the events that were seen. The coaches used – along with descriptions – analytics very often in their problem representation.

Analytics

When analyzing what is happening on the court during the basketball game, coaches used four categories to evaluate or judge what they saw. These categories in the order of their frequency of use were: (a) judgments and evaluations of player or team, (b) causal statements, (c) intent statements, and (d) interpretation of another coach. First, the judgments and evaluations of a player or the team will be discussed.

Judgments and Evaluations of Player or Team

Definition. Coaches made one of four type of judgments and corresponding evaluative statements of skills and actions by either a player(s) or team: general, positive, negative or inconclusive. First, these judgments and evaluations of player or team were a general opinion and evaluation of what was observed, recognized and interpreted by the coaches. None of these judgments were expressing a positive or approving nor negative or disapproving remark toward the player or team, but appeared neutral in nature. However in contrast with the descriptions, the statements reflected a judgment or evaluation by the coach. For example, during task one an expert coach judged a player's shot by noting, "That was a tough shot, that was a money play" (Interview, VE). Another expert coach evaluated both teams by saying "Both of these teams are really methodical in the way that they kind of run their sets" (Interview, DE). While watching their players, a beginning coached said “We started to get away from the play…” (Interview, FB), while another coach commented, “It is taking us a little while to adjust” (JE).

Second, the judgments and evaluations of player and team were positive, specific, expressing approval, and a liking by coaches. An example of an approving statement by an expert coach was “a great slip off a back screen of the point guard…she did a good job of getting on the inside” (Interview, JE), while another expert said “he did a good job of getting down for the loose ball and getting the ball back up top” (Interview, JE). A beginning coach evaluated a players’ action by commenting, “Nice fake up and then going back down to the basket for that pass…that was a good job driving to the goal” (Interview, BB). Another beginning coach noted, “She did a good job of getting in front of the ball and stopping it” (Interview, BB).

Third, the judgments and evaluations of player and team were negative, expressing disapproval or disliking by coaches. An expert coach voiced his disapproval by stating “I thought that was poor defense…on the ball and help side too, that was poor defense” (Interview, ME), while another evaluated a player’s performance by stating, “She never gets control of it, she doesn’t make a play…that’s a bad decision” (Interview, DE). Two beginning coaches expressed their disliking in their statements: “they are getting a little lost in defense getting screened off” (Interview, BB) and “he screens the completely wrong person” (Interview, HB).

Fourth, while analyzing what they were watching, the coaches used, yet very sparingly, and inconclusive judgment statement. In the midst of analyzing, coaches verbalized the unknowns of what they were watching, posed questions or made inconclusive judgmental or evaluative statements related to the viewed events. For example, an expert coach wondered, “I don’t know if this is pre-planned or at the spur of the moment” (Interview, JE), while another coach stated, “and I don’t know if there was contact or not” (Interview, VE).

Analysis of the use of judgments and evaluations statements. The amount of judgment and evaluation statements given by the coaches was largest by the experts (both task about the same amount) followed by the amount of statements made by the beginning coaches during task one and the least judgment statements were made by the beginning coaches while watching their own games (task two). Overall among both tasks, the expert coaches in this study utilized slightly more judgment statements than the beginning coaches. This indicated that although all coaches gave similar amounts of descriptive statements, the expert coaches provided more analytical, evaluative and judgmental statements when watching the segments. These findings were in line with results from a study by Hagamann and colleagues (2007) who showed that top-level basketball and team handball coaches, in comparison to lower-level coaches, criticized and motivated their players more frequently during play.

These findings also indicated a deeper level of analysis or representation of the problems supporting existing research findings regarding the deeper and richer problem representation of experts in physics (Chi, Feltovich, et.al, 1981), mathematics (Schoenfeld & Herrmann, 1982), statistics (Rabinowitz & Hogan, 2008), and teaching (Hogan, 2004).

During task one, the watching of the Georgia game, all coaches used mainly positive judgments or statements verbalizing things they liked, followed by neutral statements and thirdly negative or disapproving statements. However, during the second task, while watching their own game segments, the coaches uttered mostly negative or statements voicing their disapproval of things seen, followed by both neutral and positive judgments, providing a more balanced variety of judgment statements. It appeared that all coaches were more critical of their own players by the amount of negative or disapproving statements made, whereas the focus on the other segments appeared to be on positive or approving actions. Although used very infrequently, at least every coach used at least one inconclusive judgment statement during task one or two.

A second type of analytic statement included statements that were causal in nature.

Causal statements

Definition. Coaches provided a cause for what they saw or didn't see happening (illustrated by the use of the word 'because'). They elaborated on what was allowing the events observed to happen and the basis for them taking place or not. The coaches also verbalized the causal relationship within what they are watching. For example, an expert coach explained, "… because there was no contact it opened up the backdoor for her to get the offensive rebound" (Interview, VE). Another expert coach concluded while watching his player that "because the guy went away from the basket, we had a wide angle" (Interview, JE). Similar examples of cause and explanation statements were provided by beginning coaches: "cause she was in no position to be help side whatsoever' (Interview, GB) and "she wasn't moving her feet well on defense, so she got around her" (Interview, BB).

Analysis of the use of causal statements. Overall, both expert and beginning coaches provided slightly more possible causes or explanatory statements during their own games (task two) than while watching the Georgia game (task one). Experts used more explicit cause-and-effect statements to explain the why events (both positive and negative) were happening. For example this quote from an expert coach, "…the defensive player for Georgia did not jump the pass immediately, which allowed the offensive player to slice her face and even seal her, which is what caused a breakdown in defense, and after that the help side decided to come over and trap" (Interview, JE). The cause-and-effect statements by the expert coaches indicated a forward-thinking strategy as has often been reported in expert problem solving research. Smith and Good (1984) found that a forward-working approach set experts in genetics apart from the unsuccessful participants when solving complex problems. Similarly, when confronted with real-life simulated problem expert engineers used forward or top-down strategies whereas the backward or bottom-up approach was preferred by the novice engineers (Elson, 2003). Rather than using explicit cause-and-effect statements, the beginning coaches in this study offered more explanatory statements without the explicit indication or verbalization of the causal relationship with other related events. Often the explanation by the beginning coaches followed a solution-oriented statement (see in later section). For example, after suggesting that the player should have given the ball inside the paint, a beginning coach justified the solution: "because that girl did a good job of posting up her defender" (Interview, GB) indicating more of a backward approach to the problem.

A third type of analytics used in the problem representation phase, were statements related to the intent of the events being observed. These statements were used less frequently than the judgments and evaluations or the causal statements previously presented.

Intent

Definition. While talking aloud, coaches indicated and elaborated (briefly) on the purpose or goal for events viewed, the players' actions or referred to the game plan. Coaches gave (often a one-sentence) an answer as to why a player or a team might be doing something and what the intention behind the action was exemplified by the frequent use of the words 'trying to'. For example, an expert coach elaborated on the intent of Iowa's actions by stating, "looks like they are obviously trying to get the ball to Tasha" (Interview, VE), while a beginning coach commented while watching the Georgia game segments, "with a double team on the post trying to get the ball out of the best players hands, trying to make someone else beat them" (Interview, HB). An expert coached clarified his team's intent in defense, "we were trying to be really conscious of where number 5 was" (Interview, VE).

Furthermore, some verbal statements made revealed that the intent was accomplished. These statements often included the words "what we wanted". For example, "they got her where they wanted her" (Interview, DE), or "which is what we were looking to do" (Interview, VE).

Analysis of the use of intent statements. Although not done very frequently, all expert coaches offered various intent statements during both tasks. The intent statements were often accompanied or following a judgment or description statement. Only one beginning coach (who worked with a collegiate team as a manager and was in close communication and observation of a collegiate coach prior to his coaching career) often used intent statements similar in frequency to most or even more than some expert coaches. Again, the presence of intent statements indicated that the experts made a connection between what was seen (and described or judged) and with the concepts or intentions behind the problem, much like findings from Chi and colleagues (1981) suggested. When examining the problem representation of tennis players about game situations, McPherson (1999) found that the statements of the experts included tactical action plans, whereas the novices in her study did not include any such statements in response to game situations. In comparison, the intent statements in this study can be seen as action plan to reveal the purpose or plan behind what is seen and were used by the experts as a plan.

Furthermore during task two, only the expert coaches made a verbal connection between what was observed and the accomplishment of the intent. When expert coaches made a connection with their plan, they apparently matched the information observed with their efficiently stored plans or schemas.

Besides analytics related to judgment, causal and intent statements, coaches also analyzed and interpreted another coach, coach Landers, during task one.

Interpretation of another coach

Definition. While watching coach Landers and his team's game (only in task 1), coaches interpreted and/or speculated on coach Landers' thoughts, actions or communications. One coach commented related to coach Landers, "and buddy he is going to be ripping somebody's butt" (Interview, DE), while another expert coach said, "I'm sure the coach had a great plan for why he decided to do that" (Interview, JE). Another statement made by a third expert coach while watching the Georgia game segments, "which I'm sure the Iowa coach didn't like, and probably Andy Landers is very happy about" (Interview, ME). One beginning coach noted, "Coach calls his bread and butter plays right now" (Interview, HB).

Analysis of the use of interpretation of another coach. During task one, only the four expert coaches and one beginning coach (who worked with collegiate team as manager in close communication and observation of a collegiate coach prior to his coaching career) verbalized statements that provided an interpretation of Coach Landers' actions or thoughts. The expert coaches in this study appeared to have more understanding and familiarity with the situations seen in task one and seemed to identify with coach Landers who was more similar to them in experience and expertise. Whereas the beginning coaches' awareness of the great discrepancy in experience between the experienced and expert collegiate coach and themselves might have contributed to the lack of connection with or interpretation of coach Landers. Both intent and interpretation of coach Landers mechanisms were almost exclusively used by the expert coaches.

Although the building blocks of descriptions and analytics were most commonly used, the third building block was connections.

Connections

The coaches in this study made connections between what they were seeing and other moments or experiences. The connections made by the coaches were related to themselves, to previous same-game events, to prior events/experiences, to their coaching approach or philosophy or to their general coaching knowledge. The following section will interpretatively define and discuss each of the different types of connections. First, the coaches' connection to themselves or their personal experiences and self-awareness will be explored.

Personal Experiences and Self-Awareness

Definition. The coaches connected what was viewed with their own personal experiences while demonstrating a sense of self-awareness of their actions and emotions. The coaches related current game events with what they had personally experienced, related it to what they would do, or they recalled what they were experiencing, feelings or communicating during the moments observed. For example, coaches commented while watching the Georgia game segments, "I would have wanted the same thing" (Interview, ME) and "If you're the coach, I would be unhappy with that effort right there" (Interview, HB). Eluding to his communication with his assistant coaches during the game an expert coach said, "That's where I am telling my assistant coaches: [the coach quoted himself *italicized*] *this is not a great start, we've missed, we've got what we wanted twice and we haven't done what we needed to do defensively*" (Interview, DE). Another expert coach provided insight into his emotional state, "this right here is where I go about…go upset…and see that's where now I'm really frustrated" (Interview, DE). Furthermore, the self-awareness of the coaches was not only focused on their actions and emotions, but also on their decisions as demonstrated by an expert coach's reflection: "I called it one play too late. That was a definite call, but I probably went one play too late" (Interview, DE).

Analysis of the use of personal experience and self-awareness. During task one, all four expert coaches incorporated statements related to their actions, communication or personal feelings while watching the game segments, while only one beginning coach (who worked with a collegiate team as a manager) uttered a few personal experience statements. The lack of familiarity and inability to recognize the situation observed, contributed to the beginners' lack of connection to their personal experiences and self-awareness during task one. As a beginning coach explained, "…the other game I am still watching on the outside you know. It wasn't my team I guess, I don't know…It's kind of hard to know what other people are thinking" (Interview, FB). An examination on experts in physics by Coleman and Shore (1991) revealed that the experts' problem representation was characterized by the use of accurate metastatements, which is comparable to the expert coaches' use of self-awareness connections in this study. In a study on the problem representation of artists, Fayena Tawil (2007) found that both artists and non-artists monitored their progress during the drawing in a similar matter. Although the verbalization and self-awareness of the coaches' communication during the game in this study is not the exact same as the monitoring of the drawing process of artists, it does resemble the act of reflecting on their actions. In this study, the reflection and self-awareness of the expert and beginning coaches during their own game were very similar.

During task two, all expert and beginning coaches verbalized more personal experience or self-awareness statements. The majority of personal experience statements during task two incorporated a recall of the communications that took place between the coach or players, assistant coaches or referees. Vergeer and Lyle (2009) highlighted in the analysis of verbal data of their study that the most experienced coaches emphasized managerial aspects of the decision making (for example, sharing information with those involved, finding alternatives to competing, seeking medical advice) when asked to explain their reasons behind the decision. The emphasis of the coaches in this study on communicating with others during the problem representation phase can potentially be seen as a managerial task.

More frequently than making connections with themselves, the coaches connected events from the observed game with events that happened earlier in the game.

Previous same-game events

Definition. Coaches connected the current events in the game with previous events from the same game they were watching, or they recalled a sequence of previous events from the game (almost like they were keeping a tally). Same-game connection statements can be exemplified by the following quotes made by expert coaches while observing segments in task one: "got basically the same shot they got earlier" (Interview, VE), and "same play that we've seen several times before" (Interview, GB). An expert coach highlighted the sequencing of events when commenting, "so far we've gotten 5 to 6 shots, 4 of them have been jump shots, 2 of them have been lay-ups" (Interview, DE). Subtle references to earlier same game events (characterized by words such as 'again' or 'we're back in a …' or 'we are still in a…') were also found throughout the strategic formation descriptions presented earlier in this chapter in the 'descriptions' section.

Analysis of the use of previous same-game events. During task one, the beginning coaches in this study rarely made references to previous events from the game they were watching while all of the expert coaches recalled earlier events or sequences from the game multiple times. In an examination of teachers' problem representation, Hogan (2004) found that the expert teachers were more effective in their perception of relevant information in the classroom much like the expert coaches' ability to make connections between what they are watching and information gathered leading up to that moment. Furthermore, previous research on expertise in accounting demonstrated that experts and novices differed in how they connected several parts of information within the problem to each other (Marshall, 1996). In this study, the experts also demonstrated their superior ability to relate what was observed with previous events within the game.

During task two, the amount of connections to previous events was similar between the expert and beginning coaches. However, the expert coaches appeared to use more sequencing events in their recall of the previous same-game events whereas the beginning coaches used singular previous events. This finding resembled findings from research on the problem categorization of expert and novice counselors conducted by Mayfield (1999). The author concluded that although all participant categories problem similarly, the depth and links indicated a difference among both group of participants. The relations between concepts of a problem were also highlighted in a study of medical students' problem formulation (Auclair, 2007). An accurate diagnosis was characterized by the use of higher-order concepts and relations between the concepts.

It should be noted that two coaches mentioned throughout the interview that they had already observed at least once the game tape of their own game. Those two coaches provided more statements regarding previous same-game events during task two than the other coaches in this study.

Although in lesser amount than the same-game references, the coaches also made connections with other basketball-related events and experiences.

Other basketball-related events and experiences

Definition. The coaches in this study occasionally connected the current observed events with situations from previous games, practices, other events, or players'/coaches' background. Related to one of the players observed, a coach noted, "I coached her mom" (Interview, VE). Discussing a specific player, a beginning coach explained, "this is his first year even playing basketball, he's a senior, he has never played basketball before in his life" (Interview, HB). Several other comments connected with content from previous team practices and team communications. One expert said, "that is something we coach, that is something we talk about" (Interview, DE), while another expert coach elaborated "that is stuff that you drill to them in practice. It is not something they just pick up on. You've got to drill that into them at practice" (Interview, ME).

Analysis of the use of other basketball-related events and experiences. During both tasks, both expert and beginning coaches verbalized connections between what they were watching and the background information about players or content from previous practices. When examining expert and high achieving physics students, Coleman and Shore (1991) found that both the experts and high achieving participants made frequent references to their prior knowledge, much like the experts in this study displayed.

Fourthly, connections were made with the coaches' personal coaching approach or philosophy.

Personal Coaching Approach

Definition. The coaches in this study also made connection between the current game events observed and their coaching approach for the game, team or their philosophy. As one expert coach alluded to their philosophy, "again, that is just my philosophy: we try to run more man-to-man stuff to create more movement out of our offense" (Interview, ME). Another expert coach explained, "and that is one thing that we really emphasize: is trying to make people drive baseline and we have help defense come across" (Interview, VE). Specific ways of playing for the team were revealed by various coaches when they said, "That is the tempo we like to play" (Interview, BB) or "We're an up and down team" (Interview, JE). One coach explained his approach when the opposing team calls a timeout, "our rule of thumb anytime an opposing coach calls a timeout for us, we change defenses, just because I don't want them to get a feel for what we are doing" (Interview, JE).

Analysis of the use of personal coaching approach. While watching coach Landers' game (task one), two of the expert coaches made multiple connections between what they saw and what their approach or philosophy in certain situations, while only one beginning coach verbalized once while watching "our team, we would front the post (Interview, HB). However, during task two, all the expert coaches and three of the four beginning coaches made connections between while they observed their team with what their preferred approach for the team was. The experts' ability to connect the problem situation observed in the game segments with their own knowledge and approach to coaching their team resembled the physics experts' ability to rely on underlying concepts or principles to represent a problem (Chi, Feltovich, et al., 1981). Moreover, expert accountant were also found to rely more frequently on the use of principles to identify problems (Marshall, 1996). Moreover, research on expert and novices' problem solving outside their domain showed that experts converted the unfamiliar problems into problem they were familiar with (Schraagen, 1993).

Lastly, the coaches connected problems with their general coaching knowledge during the problem representation.

General Coaching Statements

Definition. The coaches in this study made general statements related to their knowledge of coaching basketball; general coaching knowledge, or a general adopted and commonly accepted coaching philosophy. An expert coach said, “Theoretically, I think most coaches want, going against a zone, I think most coaches want each perimeter player to be able to absorb at least two defender perimeter players, which in theory frees up at least one guy on each ball rotation” (Interview, JE). A beginning coach elaborated on offense against a zone defense when he said, “Those are the plays that are open against zone defenses: the skips across court and the dunk-downs toward the basket, when the ball is on the opposite side of the floor” (Interview, HB). Another expert coach made a generalized statement about inbounds under the basket, “you never, ever throw it back in under your basket” (Interview, DE), while a beginning coach verbalized a general statement about end of game situations, “when it’s late in a game like this, you’ve got nothing to lose anyway” (Interview, HB).

Analysis of the use of general coaching statements. General coaching statements were offered more frequently by the expert coaches than by the beginning coaches. All expert coaches offered multiple statements related to general coaching knowledge during task one, whereas only one beginning coach (who worked with a collegiate team as a manager) provided multiple general coaching statements and two other beginning coaches each made one utterance related to their general coaching knowledge. During task one, the general coaching statements voiced by the expert coaches appeared to be related and specific basketball coaching strategies and approaches versus the broader coaching statements by the beginning coaches. The problems seen by the experts appeared to be connected to the coaches’ familiar or commonly accepted knowledge base on coaching and seen in terms of one’s beliefs on coaching. A similar finding was reported by Schraagen (1993) who examined the problem solving of experts confronted with novel problems. The author found that the experts converted a novel problem into categories that were familiar with and resembled their stored schemas. Research on experts in magnetism also showed the experts' ability to use their extensive knowledge base to enrich and form their problem representation (Stefani, 2008). Similarly, an examination of expert endocrinologists displayed the richness of the experts' knowledge structures (Patel, Groen and Patel, 1997).

During task two, the beginning coaches verbalized more general coaching statements in connections to what they were watching than they did during task one due to their increase familiarity with the situation. One beginning coach explained the increased level of familiarity while watching their own team, "because I know what is going on, I know my girls". The familiarities with the game made it easier for the beginning coaches to see the connections with their general coaching beliefs. The importance of knowledge - in particular when relevant information was not present - is critical since "solvers have to rely on prior knowledge to fill in the missing data in order to understand a situation or problem" (Ge & Land, 2004, p.11). However, the lack of familiarity might have contributed to their inability to connect the problem with their existing knowledge base. While solving a problem, experts also display more frequently the use of metastatements regarding the problem solving process and references to prior knowledge (Coleman & Shore, 1991).

The three most often used building blocks by all coaches in this study to represent problems were descriptions, analytics and connections. A fourth building block - used much less frequently - entailed statements geared towards a specific solution to the perceived problem.

Solutions-Oriented statements

Definition

Coaches provided suggestions and solutions to improve or solve perceived problems happening during the game or specifics of what players should have done. Furthermore, many of the solution-oriented statements were characterized by wording such as ‘should’, ‘could’ or ‘got to’. An expert coach offered the following solution-oriented statement while watching a segment during task one: ‘she probably could have faked her and got her off her feet and drew a foul’ (Interview, DE). While a beginning coach verbalized that the coach “got to have all five girls stopping the ball” (Interview, HB). Another beginning coach suggested that the player “should have drove to the basket” (Interview, FB), while an expert coach suggested that “defensively we’ve got to do a better job of communicating” (Interview, DE).

Some of the solution-oriented statements provided by the coaches were alternatives and preferred scenarios contrasted and compared to what they saw happening in the game or was done by a player (by using words as ‘instead’). For example, a beginning coach stated “instead of that little fade, maybe she wanted to take it a little stronger to the rim…see if she can draw a foul” (Interview, HB). An expert coach commented while watching one of his players pass the ball: “that was a situation where I probably would have liked my 21 to score there rather than always looking to pass” (Interview, VE).

Analysis of the use of solution-oriented statements

Although during task one all expert and beginning coaches provided statements that involved a solution, suggestion or preferred scenario, the beginning coaches provided more such statements than the expert coaches in this study. The solution-oriented statements appeared to be based on the coaches' specific solution steps that should be followed to solve the problem. A study on the problem solving of novices and expert teachers on hypothetical scenarios showed that, regardless of the specific instructions provided, the novices primarily represented the problem mainly related to possible solutions (Swanson, et al., 1990).

During task two, only three of the four expert coaches mentioned at least one solution-oriented statement, whereas all the beginning coaches provided multiple solution-oriented statements while watching their own team's game segments. The beginning coaches appeared more eager to offer a specific solution, indicating a backward-thinking approach to the problem. The beginners focused on an immediate solution for the problem, a preferred problem solving strategy for beginners (Elson, 2003).

Finally, although used very sparingly, statements related to anticipation, predictions or speculation were used to represent problem during the game and will be discussed in the next section.

Anticipation/Prediction/Speculation

Anticipation and Prediction

Definition. The coaches in this study offered a few statements in which they anticipated or predicted future actions or events happening in the game. An expert coach indicated his anticipation of events when saying: "obviously they're gonna go inside" (Interview, ME), while a beginning coach said: "I would think you're looking to again, set something up and take your time and run off clock" (Interview, HB). A prediction was illustrated in the following quote: "We're thinking our opponent is going to run a triangle and two on our two best scorers" (Interview, DE).

Analysis of the use of anticipation and prediction statements. Although offered very infrequently compared to other 'building blocks', all expert coaches provided multiple anticipation/predication statements during task one or two. For example, an expert coach anticipated, "because we know the big girl is gonna come after that". This supports findings from Hoffman and colleagues (2009) who found that expert nurses would anticipate problems during their clinical decision-making process in contrast to the novices nurses in the study.

The majority of anticipation and prediction statements from the beginning coaches where made by one coach (the collegiate basketball team manager). While watching he said, "Let's see if we can get something in the middle". Furthermore, two other beginning coaches made only two anticipation/prediction comments (one each). McPherson (1999) found that the problem representation of expert tennis players was generated based on their conceptual knowledge in terms of condition and action statements; whereas the beginners relied on condition and goal statements. Mostly all statements were anticipating events happening in the next possession and very immediately thereafter.

Next, statements related to speculation will be discussed.

Speculation

Definition. Coaches also very occasionally, speculated on the outcome or process under hypothetical or alternative scenarios or displayed the use of 'if…then'... thinking. For example, an expert coach expressed his disapproval in a speculated scenario, "if they had not fouled him that would have just been a dumb shot" (Interview, JE). A beginning coach speculated that "if you give her, if she's going at it, but you don't make her use it, and she goes back the other way, there is all that open space like there was, and she got an open shot jump shot from it" (Interview, HB). The use of word 'maybe…' also suggested some speculation although mainly used in combination with other building blocks. An expert coach tried to explain the defense he observed by speculating, "Maybe that's the philosophy of the program, maybe there is some logic behind what they are trying to do defensively" (Interview, JE).

Analysis of the use of speculation statements. Three of the expert coaches provided some speculative statements during both task one and task two, whereas one beginning coach (collegiate team manager) speculated while watching the segments in task one. When confronted with unfamiliar problems, experts will try to fill in the specifics and gaps of the problem, while keeping the global picture in mind according to Schraagen (1993), who examined experts' novel problem solving. However, during task two, all beginning coaches offered speculative statements while watching their team's game segments. All APS statements were almost exclusively used by the expert coaches.

Summary

The basketball coaches in this study used various mechanisms or building blocks to construct a representation or cognitive structure of the problems encountered throughout a game. Five building blocks were identified and defined based on the verbalizations of the coaches while watching video segments: (a) descriptions, (b) analytics, (c) connections, (d) solution-oriented statements and (e) anticipation/prediction/speculation (APS) statements.

The first building block, descriptions, revealed statements that were one of three types: (a) strategic formations descriptions, (b) general movement or (c) score and time references. The descriptive statements referred to strategic formations descriptions (formation used in offensive of defense), general movement descriptions (movements and skills players or team were performing) or were references made to the score or time at that point in the game. All the coaches described twice as many strategic formation descriptions when watching another coach's game (task one) than their own; although the experts provided more descriptive information than the beginning coaches throughout all the watched segments. Clear distinctions between the coaches were displayed by the lack of offensive formation information provided by the beginning coaches while watching their own team; and the richness or use of adjectives and additional information by the experts when describing general player movements. Furthermore, the expert coaches made references to the score and time throughout the games more frequently than the beginning coaches.

Within the second building block, analytics, four differentiations were made: (a) judgments/evaluations of player or coach, (b) causal statements, (c) intent statements, or (d) interpretation of another coach. Analytical statements were frequently used while representing problems during the game. This included judgment and evaluative statements (to judge and express approval, disapproval or merely a neutral evaluative statement), causal statements (to explain the cause-effect or the why of a situation), intent statements (to elaborate on the goal or purpose behind an action or game event) and interpretations of coach Landers' actions, intentions and thoughts (watched in task one).

Analysis of the data indicated that the expert coaches used more judgment statements than the beginning coaches, indicating the deeper level of analysis when presenting a problem in line with findings in other areas of expertise (Chi, Feltovich, et al., 1981;

Schoenfeld & Herrmann, 1982; Rabinowitz & Hogan, 2008). Furthermore, all coaches used more negative judgment statements while watching their own team's game segments versus the mainly positive or approval statements during the game segments of another team (task one). In an attempt to explain the why of what they were watching, the expert coaches used mainly cause-effect statements and elaborated on the intent behind the events; whereas the beginning coaches used simple explanatory statements. Only the expert coaches elaborated and interpreted coach Landers' actions, intentions and thoughts while watching the game segments (task one).

Connections were a third mechanism or building block employed by the coaches in this study during their problem representation. Connections were subcategorized in five groups: (a) personal experiences and self-awareness, (b) previous same-game events, (c) other basketball-related events and experiences, (d) personal coaching approach, or (e) general coaching statements. The coaches made connection statements referring to themselves, previous same-game events, previous basketball-related events/experiences, previous events/experiences, their personal coaching approach or made general coaching statements.

During task one (watching another coach's game), the beginning coaches lacked the ability to make the connection between that game and what they would think or do in a similar situation or to events that happened earlier in the game watched. The experts were able to connect more often what they watched in task one (another coach's team) to themselves, their experiences, and previous events from the same game and their own coaching approach.

In lesser amounts, solution-oriented statements were a fourth building block in the problem representation of the basketball coaches. Solutions, suggestions, alternatives or preferred scenarios were provided while watching the game segments to improve or solve a current game situation. The beginning coaches provided more solution-oriented statements than the experts in both task one and two and appeared more eager than the expert coaches to offer a specific solution to what was being watched. As final and infrequently used building block, APS statements were uttered while watching the game segments.

Last, some coaches' statements indicated either anticipation or prediction of future events or a speculation on the process or outcome of hypothetical or alternative scenarios. Expert coaches were more likely to provide anticipatory or predictive statements during the game than the beginning coaches. Beginning coaches were unlikely to provide speculation during the game segments of another team; however, all beginning coaches made this type of speculative statements while watching their own team's game.

This chapter reported the findings from the analysis of the problem representation data. In the next chapter, the analysis of data pertinent to problem solution will be presented to answer to following research question: How do expert and beginning coaches' problem solution phase differ?

CHAPTER 5

PROBLEM SOLUTION

The purpose of this study was to analyze and compare how expert and beginning coaches represent problem solving situations and solve problems during games. The following research questions guided this study:

1. How do expert and beginning coaches represent a problem situation? What characterizes expert and beginning coaches' problem representation?
2. How do the expert and beginning coaches' problem solution phase differ?

While chapter four presented the mechanics or building blocks of the problem representation phase, this chapter will address findings related to the differences in the problem solution phase of problem solving between the expert and beginning coaches.

The problem solution phase of problem solving referred to the part of the problem solving process when an individual constructs and implements a solution to the particular problem (Gick, 1986). Analysis of the interview data revealed three differences or themes related to the problem solution phase of the basketball coaches in this study: (a) plan flexibility, (b) strategy choice, and (c) solution scope. Plan flexibility referred to the coaches' ability to make adjustments to the game plan. Secondly, strategy choice related to the way coaches go about selecting and communicating a solution to their players throughout the game. Thirdly, solution scope was described in terms of the foresight for a bigger picture or immediacy in the solution approach.

The distinguishing themes differentiating the expert and beginning coaches' problem solutions are discussed by offering a definition for each theme based on the researcher's interpretation of the verbal data. Furthermore, an analysis and comparison of the specific differences between the coaches were provided and supported by quotes from the participants.

Plan Flexibility

Definition

In preparation for a game, coaches prepared a 'game plan' or scheme on how to approach the game and the opposing team strategically. The plan addressed specific tactics and strategies necessary to be most successful against that specific opponent and these were developed by the coach based on their existing or gathered knowledge of the opponent. A game plan contained specific guidance for a team regarding the offensive and defensive game strategy and game pacing as it related to the opposing players' or team's perceived strengths or weaknesses.

Plan flexibility referred to the coaches' willingness and ability to - when confronted with a problem during the game and while constructing the problem representation - make adjustments to the game plan according to the particular game circumstances and context and to provide an effective solution.

Analysis of the verbal data indicated similarities between the expert and beginning coaches regarding the construction of the game plan and the contextual coaching adjustments made during the game. However, clear differences were found regarding the coaches willingness to modify or abandon--in part or whole--the plan. The section on plan flexibility discusses and compares (a) the construction of the game plan, (b) flexibility within the plan, and (c) willingness to abandon part or the entire plan.

Construction of the game plan

Prior to the start of a basketball game, all coaches prepared and thought out a particular game plan or approach for a particular opponent as shown by an expert coach's quote: "…we always game plan a scheme for different people, our opponents" (Interview, DE). As voiced by a beginning coach, "that's all game planning in my opinion…all these coaches, we all exchange game tape and this and that, so we know the teams really well as well as we can before we go into it" (Interview, HB).

This game plan often was created based on prior information obtained or known about the opponent, whether that was a scouting report, video footage of the other team, or a remembrance from playing that team earlier in the season. It should be noted that although most coaches in this study alluded to the importance of gathering information on the opposing team, an expert admitted his reliance on scouting, "I am obsessed about scouting teams" (Interview, JE). However, this expert continued about the focus of his scouting, "I scout movement, and more than that anything I scout tendencies; because sets change and if they are a really good team they even evolve in between the set, but tendencies rarely ever change" (Interview JE).

It is the information gathered and knowledge obtained by the coaches that is used to establish a specific plan for the game. An expert coach pointed out particular strengths of the opposing team gathered through his prior experiences and scouting, "….is a very talented team, they are well coached, and they are very hard to beat in their gym. They play extremely well there. They have good size, they are very athletic. One thing we were trying to do was try not to give up any breakaway lay-ups, because they have a tendency, number 30 really runs a lot, trying to get the ball down the floor quickly" (Interview, VE). Therefore, this coach's game plan encompassed playing more zone than usual in an attempt to take away some of the opponent's number 30's fast break opportunities.

A beginning coach referenced to the prior knowledge of the opponent to establish the game plan, "I looked back on what happened previously, plays they had run, defenses they have played, we actually played them two times prior before that game that we played them, I believe it was…I anticipated that things were going to be very similar" (Interview, GB). As a result this coach implemented a different type of defense for this game.

The game plan for the coaches was tailored specifically to their specific knowledge of the opponent and the game plan was specifically linked to the opponent's strengths or weaknesses as indicated by a quote from an expert coach, "on the defensive end, we wanted to initiate some pressure. I felt like they only had one major ball handler and that was he …kid" (Interview, JE). A beginning coach expressed the reason for planning to play a different defense based on knowledge gained from a game earlier in the season: "Our plan was to be in a 1-3-1 in the first half ….the game we played them before hand, we got beat by 20 something points….this team just destroyed us, we couldn't stop them, they had two girls who could just score every time. We put the 1-3-1 in" (Interview, FB).

Expertise literature had revealed that experts formed and stored specific schemas based on their knowledge (Chi, Feltovich, et al., 1981). In a similar manner, all basketball coaches in this study constructed a specific plan based on the knowledge inherent and related to the problem (their opponent) and used it as a blueprint to approach the game.

Flexibility within the plan

Although a scheme or game plan was in place, the coaches in this study made changes, adjustments or decisions throughout the game due to the circumstances and context of the game. These circumstances were recognized throughout the game and often verbalized in the think aloud of the problem representation phase. For example, as a player committed a foul, an expert coach analyzed the particular instance by elaborating on the cause and effect of that situation by saying, "because of that play we did not box out and one of our better offensive players we pick up a foul". This circumstance, the foul, recognized in the problem representation phase contributed to the coach's decision to make changes to the game plan. The expert coach elaborated, "we got in some foul trouble with a couple of our players, that kind of messes our rotation up a little bit" (Interview, DE). The experts appeared to have kept their specific plan in mind and made rather small changes in line with their strategic game plan and overall approach for the game. These changes were merely adjustments to personnel and the execution of the plan.

As a beginning coach watched this team perform inaptly against a press, the coach verbalized the problem as he observed it; using mainly disapproval judgment statements and solution-oriented statements. The coach said, "press break, she should be out wide, not a good pass and you also have to stop the pass…didn't do a good job of getting back when we turned the ball over" (Interview, BB). Consequently, the coach called a timeout to address the specific press break as indicated by this quote, "I probably just drew it out on the board and we went over where they were supposed to be" (Interview, BB). Another beginning coach indicated that adjustments were needed during the game due to a personnel issue, "I am pretty sure that one of my main starters got hurt, so that messes up our press so we had to put a few players in different spots" (Interview, FB).

When needed, all coaches in this study made adjustments based on what they were seeing and were needed. Although a specific plan was in place, it gave room to some flexibility to make small adjustments in response to the contextual factors of the game.

Willingness to modify or abandon--in part or whole--the game plan

All coaches indicated that they made changes throughout the game warranted by circumstances and context. However, some changes, adjustments and decisions sparked by circumstances and the game context indicated by the expert coaches in this study were no longer clearly linked to their game plan or the strategic approach to the game, but an attempt to choose the contextual demands over the game plan; whereas the changes, adjustments or decisions sparked by circumstances and game context made by the beginners appeared to remain linked with the strategic plan or schema for the game.

These findings extended the work by Jones, Housner and Kornspan (1997) who found that coaches were likely to follow their plan during practice, yet the second most frequent decision during practice by all the coaches in this study was a willingness to change their plan when serious problems arose. This study revealed that the expert coaches appeared willing to – according to what was developing in the game and continuing unfavorable circumstances– adjust part of their strategic game plan when circumstances continued to require changes or previous adjustments were inefficient. To quote an expert coach, "I didn't change my offensive game plan, not at all…but we did have to change some things defensively' (Interview, JE). This expert coach, while watching his team in defense, constructed his problem representation by connecting his general coaching knowledge (on how a lack of communication in defense can lead to unnecessary fouling) with what his players were doing. The coach continued, "Which pretty much nullifies anything you tried to do good. We are fouling entirely too much. Just if my memory serves me correctly, we foul four times in the last five possessions" (Interview, JE). The coach recognized the fouling and this coach indicated that against his game plan and coaching philosophy for his team, he had to change his press defense because of those circumstances. The expert explained:

> Then at one point, because of so many fouls, we completely came off the press and went to half court man-to-man defense, and they kept calling fouls, and then had to change again by the fourth quarter, we are literally in a match up zone, which is probably our least likely defense to run, but you know, when in Rome do as the Romans, I mean, you've got to do whatever it takes (Interview, JE).

One expert coach highlighted the need for change over sticking to the initial game plan, "I had to, I had to change. Anytime as a coach you've got a game plan, but you've got to be flexible, and you've got to have other options. No matter what you do" (Interview, DE). Another expert coach used an analogy to express the need to change and adjust, "look at this as an amoeba; we should be able to change shapes, based on whatever the situation is" (Interview, JE).

Although personnel changes and other subtle changes were made by the beginning coaches during the game, none of the beginning coaches expressed a willingness or need to drastically change their plan or forgo their strategic approach due to the context of the game. The beginning coaches offered frequent solution-oriented statements during their problem representation while watching the game segments. The majority of these statements appeared to be geared toward the skills and execution therefore within a specific offensive or defensive strategy (or how to execute *better* within a certain defensive scheme), but they rarely focused on a change of the strategic offensive or defensive scheme. For example, a beginning coach addressed the need for a player who "should be behind them" or "got to stay in front of her" in the particular defense (Interview, BB). Nevertheless, two of the beginning coaches indicated clearly that their strategic game plan didn't undergo any adjustments throughout the game, "during this game, the game plan didn't change that much" (Interview, GB). The game plan of the beginning coaches appeared to be holding on to the principles of their game plan no matter what the circumstances. They appeared to gear their attention to improve the execution of the plan; whereas the experts were able to let go or change up their strategically prepared game plan according to the arisen circumstances and context of the game. There is a lack of expert research in other areas to explain the contributing factors to the experts' willingness to abandon the plan.

Connection with problem representation

Experts verbalized more frequently while watching their team's game, the intent or purpose behind the actions and events of the game. Additionally and unlike their beginning counterparts, the experts made verbal connections between events during the game and the accomplishment of the intent as indicated by such statements.

The use of the 'intent' building blocks during the problem representation indicated that the expert coaches made a strong and conscious connection with the plan and the intent behind the events while watching them develop during the game. The experts verbalized the connection between current events and the intention behind the event during the problem representation phase as demonstrated by the use of the intent building block. The beginning coaches lacked a connection between what they were seeing during the game and their game plan. Research in various areas indicated that experts will represent problems in terms of the underlying deeper structure or principles behind the problem rather than the inherent superficial feature of the problems they encounter (Chi, Felotvich, et. al., 1981; Schoenfeld & Herrmann, 1982; Rabinowitz & Hogan, 2008)

It was only in continuing serious circumstances and after trying various other subtle adjustments that the experts abandoned the strategic plan; whereas the beginning coaches continued to remain within the realms of the general game plan. Nevertheless, the expert coaches in this study were very aware of their deviance from their plan and they verbalized it clearly. Deviations by the experts seemed to be a well-contemplated decision, yet necessary towards success.

During the problem representation phase, the expert coaches more often verbalized their feelings and actions related to the game segments as highlighted by the more frequent use of self-awareness statements. Throughout the problem solving, the expert coaches displayed more metacognitive skills than the beginning coaches. This supported findings from Fayena Tawil (2007) who reported that expert artists monitored their own work more and uttered more metastatements throughout their work than the beginning artists.

A second theme found in the comparison of beginning and expert coaches' problem solution phase related to the choice of a problem solving strategy.

Strategy Choice

Definition

According to Schunn, McGregor, & Saner (2005) a problem strategy is “a coherent set of steps for solving a problem” (p. 1377). Analysis into strategy choice of the coaches in this study indicated that they took various steps to construct, implement or provide a solution to the perceived problems during the game. More specifically, the theme of strategy choice was defined as the way coaches went about selecting and communicating a solution throughout the game. It appeared the expert and beginning coaches preferred a different approach toward a solution.

Analysis of the strategy choice

When addressing problem situations that arose during the basketball game, the expert coaches tended to address the process inherent to problem solving and focused on the steps and options to get to a favorable outcome. As summarized by Horn and Masunaga (2006): “Expert reasoning proceeds from the general – comprehension of essential relations, knowledge of relevant principles – to develop specific alternative courses of action, whereas novice reasoning is stimulated by the salient attributes of a presented situation or problem” (p. 599). One expert coach elaborated on how he approached a timeout with limited time left in the game. The coaches highlighted the alternatives and multiple options as discussed during the timeout in the following quote:

> We discuss what we’re gonna do right now. Are we gonna run a set play, are we gonna spread the floor and hold the basketball, are we shooting free throws or not, how many timeouts we have left in case we need to use one on a situation? We try to

cover the whole gammet of things as quick as we possibly can on this thing (Interview, ME).

A forward thinking approach is a problem solving strategy that works from the initial state (or the problem) toward the solution and is a preferred strategy used by experts (Smith & Good, 1984; Elson, 2003; Engemann, 2000). The experts in this study appeared to prefer a forward-thinking approach characterized by thorough analysis of the situation before jumping to a solution. Although the expert coach highlighted in the section on 'willingness to let go of (part of) the plan', decided to forgo the game planned press due to the excessive fouling, this expert coach did not do so before exploring and implementing various alternatives. The coach explained in the following quote:

"during the third quarter we had a series of fouls, and I had to go to a, even though we still pressed somewhat, it was more of a match up than a man (press), which one of the reasons I did that was because in a match up you're less likely to foul than if you'd be playing an aggressive man-to-man. Then at one point, because of so many fouls, we completely came off the press and went to half court man-to-man, and they kept calling fouls, and then had to change again by the fourth quarter, we are literally in a (half court) match up zone" (Interview, JE).

The beginning coaches appeared to focus on the product, outcome or one solution without a focus on the process towards a solution. As one coach's quote illustrated: "for like 5 minutes I was yelling 'side', but they never set up" (Interview, FB). The beginning coaches in this study appeared very eager to offer solution-statements as a solution for the problem during the game with a seemingly 'there is only one solution' mentality. The strategy choice of the beginning coaches in this study involved working from the solution toward the problem situation. Research in other areas has previously demonstrated that the experts preferred a forward-working strategy over the backward or means-end approach preferred by novices (Sweller, Mawer & Ward, 1983; Elson, 2003).

The preference for a backward approach was also apparent in the frequent use of solution-based statements throughout the problem representation with a lack of accompanying analysis or descriptive statements such as “should have been in front of the high post” (Interview, FB), or “I tell her to push the ball, tell her to drive” (Interview, BB). During the timeouts, the beginning coaches focused on what was done negatively first, and then secondly provided the solution. A beginning coach shared his timeout communication towards his players, “with the defense spreading out on you, it’s because you’re not being a tread, because you’re not attacking the gap…you’ve got to attack those gaps, converge the defensive players and then you can pass this” (Interview, HB). Another beginning coach elaborated on the timeout communication, “they were rushing the ball, they weren’t looking before they were passing it, and they weren’t running it right. One of the girls is supposed to be out to the side and she wasn’t getting there in time. I probably just drew it out on the board and we went over where they were supposed to go and what they were supposed to be doing” (Interview, BB).

In summary, the expert coaches appeared to focus on the process of continuously improving and taking steps towards a favorable solution outcome; whereas the beginning coaches started from the preferred (and often seemingly only) solution and offered ways to get to that desired solution. This resembled findings from McPherson (1999) who indicated that the statements of the experts in response to game situations included tactical action plans, whereas the novices did not include any such statements. The responses to situations of the experts were condition-oriented in comparison to the goal-oriented responses of the novices.

Connection with problem representation

Throughout the problem representation phase, the expert coaches verbalized cause statements more frequently in terms of cause-and-effect than the beginning coaches did. The beginning coaches preferred explanatory statements to elaborate on events and additionally used more solution-oriented statements while watching their team. This particular use of statements suggested that the expert coaches in this study were more focused on the process towards the solution in contrast to the beginning coaches' attention to the solution in addressing situations. This supports findings from previous research on expert problem solving that indicated the experts' use of forward-thinking strategies versus beginners' backward approach to problem solving (Elson, 2003). The focus of the beginning coaches on the outcome or solution was prevalent throughout the problem representation phase by their verbalizations of solution-oriented statements while watching the game segments.

Besides the plan flexibility and strategy choice, differences were found regarding the scope of the solution phase. These findings will be addressed in the following section.

Solution Scope

Definition

The scope of the solution phase represented what the coaches focused on while communicating or implementing a solution to a problem situation. The extent of the coaches' solution scope can be described in terms of the foresight for a bigger picture or the immediacy for the current situation. Interpretation and analysis of the data from the coaches in this study indicated distinct difference between the expert and beginning coaches regarding the scope of their solution phase.

Analysis of the solution scope

Expert coaches in this study made decisions during the game more frequently with a bigger picture in mind; that is, future games, development of players, or potential situations later in the same-game. As shown by an expert coach's quote, "I am always thinking about what we need to do" (Interview, DE), the bigger picture was continually in the back of the expert coaches' mind and they demonstrated continuous foresight regarding potential later game implications. While watching and analyzing his players' lack of boxing out, an expert coach called a timeout to address that issues with his players. In the following quote, the coach explained the scope of his solution in terms of foresight for potential end-of-the game situations:

> I try to call a timeout early on to send a statement to my players, and it can be the smallest detail, but if I think it is something that is going to be magnified later on (in the game)….I may call a timeout and exaggerate that point. I think players think I am crazy for that sometimes, but, especially if it is a big game, because of those plays, even though if they have not been executed well, can end up being game losing plays, if you don't address it (Interview, JE).

Another expert coach revealed how even during the warm-up he observed his team in light of the upcoming game. The coach explained how, even though he intervened, the warm-up still influenced the game: "You didn't notice this probably, but I stopped them in warm-ups because our warm-ups were not where they needed to be. I'm really big on warming up right because it leads to the first part of the game…so we have an absolute awful, awful start of the game" (Interview, DE).

A game is often seen by experts as part of the bigger picture in terms of the entire season, or as part of the development and preparation of the players for the post-season. An expert coach's quote highlighted this: "we're at that point in the season, right now where, late January, you're getting closer to post-season play, and you hope you're execution is starting to come in a whole lot better, and you hope your half-court defense is coming in a lot better" (Interview, ME). Schraagen (1993) emphasized in his research on expert problem solving of a novel problem that experts kept the global picture in mind when 'progressively deepening' or filling in the gaps and specifics, much like the experts in this study did.

In contrast, the beginning coaches appeared to focus on the immediacy of the solution, or how it solved this particular problem right now, in the next possession or in the moment of the game. For example, a beginning coach indicated, "I called a timeout to address the press breaker" (Interview, FB), while another beginning coach called a timeout "because …we threw the ball away twice in a row. Just to calm them down, get their head on…" (Interview, FB). Hardly ever was the bigger picture in terms of later in the game, or implications for later in the season brought up by the beginning coaches. Although one beginning coach (collegiate team manager) indicated that, in the latter part of the game while his team was trailing, his focus was on future games and player development,

> In these situations…it's just a chance for us to work on possible late game situations. Some of these are plays and some of these are stuff that I just made up on the spot, just

> to kind of test our guys. I am trying to keep their focus. The game is out of hand, we are losing the game, we are probably not going to win…get them used to that because if that happens in a tournament game or something where we find something we can take advantage of….giving them a chance to work on seeing it on the board and then seeing if they are where they are supposed to be (Interview, HB).

Connection to problem representation

As stated previously, experts have the bigger picture in mind while watching a game; whereas beginning coaches focused on the immediate events. This was evident during the problem representation by the more frequent use of certain building blocks by the experts in comparison to the beginning coaches. The experts referred to the score and time more frequently throughout the game and thus looked and remained aware of the context of the events and situations they watched. They would also keep up with the sequencing of events instead of just one single possession as illustrated by the use and type of previous same-game statements. Furthermore, the expert coaches made more references during the game to previous events and saw the current problem in terms of other experiences and events, thus hinting at their concentration and awareness of the big picture.

The foresight of experts during the solution phase was an extension of their broad focus during the problem representation phase. They used connections between their coaching approach and general coaching knowledge more frequently than the novice coaches. When the coaches observed certain unfamiliar game situations, the expert coaches made a verbal connection between the observed events and their general coaching knowledge more frequently than the beginning coaches. This finding illustrated that the experts' focus was geared toward a bigger picture and that they possessed a vast amount of related experiences and coaching knowledge. An expert coach described how different aspects from the problem representation all worked together, "it is all intertwined. There is thousands and thousands of decisions. I think that is what makes basketball a great game…As a coach, you're doing the same thing, you're looking and seeing to the flow of the game, you're looking and see the scoring runs, you're looking at possessions in each game, it is all intertwined within itself" (Interview, DE).

A similar finding has been reported by Woorons (2001) in the examination of the recall of expert tennis instructors when confronted with situational pictures. When confronted with a familiar situation, the experts' focused on information that was relevant to the situation, much like the experts in this study's focus on the bigger, team performance-related picture.

Summary

When examining the problem solution phase of basketball coaches during the game, three differences between the expert and beginning coaches were found. These themes were (a) game flexibility, (b) strategy choice, and (c) score of solution phase. First, all coaches in this study prepared a game plan for the game against the opposing team. All coaches indicated that they made changes throughout the game warranted by circumstances and the contextual factors of the game. Throughout the problem representation phase, experts included intent statements and statements to indicate that the intent was accomplished and were very aware of changes needed during the game. The experts had the goal or purpose in mind and checked events against that goal or purpose. The beginning coaches also made adjustments based on the circumstances, but didn't verbalize a clear link between their adjustments and their plan, rather they offered various solution-oriented statements. The beginning coaches did not provide intent statements while observing their team during the game.

Some strategic changes, adjustments and decisions sparked by circumstances and game context indicated by the expert coaches in this study were no longer clearly linked to their original game plan or strategic approach for this game. In these situations they chose a context-dependent solution over the game plan. When circumstances continued to prevent improvements, the expert coaches were willing to abandon all or part of the plan. Whereas the changes, adjustments or decisions sparked by circumstances and game context made by the beginners appeared to remain linked with the plan or strategy for the game and focused on a better execution of the proper solution.

Second, the experts preferred a forward-thinking approach characterized by a thorough analysis of the situation before selecting a solution. These selections were characterized by a focus on the continuous process to reach a favorable outcome. The experts verbalized cause-and-effect relations in the observed events throughout the game as indicated by such statements during the problem representation phase. In contrast, the beginning coaches used a backward decision making approach that focused on the product, outcome or one solution illustrated by various such solution-oriented statements during the problem representation.

Third, conditions and outcomes beyond the immediate series of game events remained in the back of the expert coaches' mind as they sought solutions to the perceived problems. They demonstrated foresight regarding potential later game or season implications. During the problem representation phase, experts made connections with previous events from the game, the context of the game in terms of score and time, and with their knowledge of coaching in general. The beginning coaches used a different strategy. They appeared to focus on the immediacy of the solution, or how it would solve this particular problem right now or in the next possession.

In summary, all basketball coaches displayed the ability to use various mechanisms or building blocks to construct a problem representation during the game. However, the expert and beginning coaches used different ‘blocks’ more often and focused on varying elements during the competition. It appeared that the use of score and time references, intent statements, cause-and-effect statements, and all the connections blocks during the problem representation phase contributed to the differences in the problem solution phase and allowed experts to act according to the way the problem representation was constructed.

CHAPTER 6

DISCUSSION, RECOMMENDATIONS AND CONCLUSIONS

The purpose of this study was to analyze and compare how expert and beginning coaches represent problem solving situations and solve problems during games. The following research questions guided this study:

1. How do expert and beginning coaches represent a problem situation? What characterizes expert and beginning coaches' problem representation?
2. How do the expert and beginning coaches' problem solutions differ?

As this study sought to understand the problem solving of coaches during competition, findings from this study began to reveal commonalities among the coaches in their problem representation during competition. Furthermore, specific differences between the expert and beginning coaches in regard to their problem representation and problem solution phases were exposed. Through analysis and interpretation of the verbal data provided by the coaches while observing game segments, several distinguishing themes emerged. Besides revealing procedural differences between the experts' and novices' problem representation, this study provided insight into the specifics of the problem representation phase by displaying the building blocks used in the thought process of coaches during competition. Furthermore, differences in how the basketball coaches approached the problem solving phase during competition were brought to light.

This chapter will provide a discussion of the findings as they relate to expert and beginning coaches' problem representation and problem solving. Furthermore, recommendations for coaches and future research are offered.

Discussion of Findings

A think aloud protocol was conducted while the coaches observed segments from another game (task one) and from their own game (task two). The collected verbal data were analyzed to construct themes and categories related to the coaches' problem representation and problem solving during competition. First, findings regarding the problem representation phase of the coaches during competition will be discussed.

Problem Representation

A problem representation according to Chi, Feltovich, and Glaser (1981) is a "cognitive structure corresponding to a problem, constructed by the solver on the basis of his domain-related knowledge and its organization" (p. 122). Through a comprehensive analysis of the verbal data of all the coaches, the emerging themes or building blocks from the problem representation were established and defined. Both expert and beginning high school basketball coaches used particular mechanisms or building blocks to understand the situations and problems they were confronted with during games and to construct their representation of the problem. The five distinct building blocks identified in this study were: (a) descriptions, (b) analytics, (c) connections, (d) solution-oriented statements, and (e) anticipation, prediction and speculation (APS) statements. Results from this study indicated that the process of problem representation of basketball coaches displayed a common approach to construct a problem representation by using the five defined building blocks and their subcategories. The presence of these five building blocks among all the coaches in this study, illustrated that all the coaches, regardless of their level of expertise, constructed their problem representation in a similar manner and based it on their existing knowledge as Chi and colleagues (1981) defined. The specific wording and quotes for all coaches were different within each building block, but showed enough similarity that allowed the researcher to recognize and construct a definition for the specific block. Each expert differed from the other experts, each beginning coach differed from the other beginning coaches, and each expert differed from each beginning coach in the way that specific words and phrases were used to verbalize what was observed.

The use-or the amount and frequency-of the building blocks during the problem representation differentiated the expert and beginning coaches in this study. However, the changes were overall fairly slight and subtle. Differences between the expert and beginning coaches' problem representation have been highlighted previously (chapter four). The expert coaches utilized and focused their attention on different aspects of the problem (i.e. making connection to previous events); whereas the beginning coaches employed other building blocks more often (i.e. solution-oriented statements). The experts in this study were able to construct their representation of the game situation at a deeper level than the experts as shown by the more frequent use of certain building blocks (intent, time and score references, and connections between what was seen and what they know).

The expert coaches' superior ability to construct problems in terms of underlying principles and structures supported previous studies on expert problem representation in other areas (i.e. connections). The experts' ability, especially during task one, to connect with coach Landers could be explained by their recognition of coach Landers' practices and the experts' familiarity with similar game situations due to their rich arsenal of experiences and large basketball and coaching knowledge base. The characteristics of the experts' problem representation and the perceived importance experts placed on analysis of the problem situation supports McCullick and colleagues' (2006) findings regarding experts' working memory. Furthermore, the superior ability of experts to anticipate has previously been illustrated in expert nurses and physicians' problem solving (Hoffman et al., 2009; Aucliar, 2007).

Problem Solution

The differences in the use of the problem representation blocks manifested itself into the problem solution phase of the basketball coaches' problem solving. The manner in which the blocks were use differed slightly between the expert and beginning coaches in the problem representation phase. This led to distinct differences within the problem solution phase between experts and novices. Using certain building blocks more frequently contributed to a different action during the problem solution stage of the problem solving.

When comparing how expert and beginning coaches developed and communicated solutions with their players during the game, analysis of the data indicated three main themes related to the problem solution phase: (a) plan flexibility, (b) strategy choice and (c) the scope of the solution approach. First, although a scheme or game plan was in place, the coaches in this study made small changes, adjustments or decisions throughout the game due to the circumstances and context of the game. These circumstances were recognized throughout the game and often verbalized in the think aloud as mechanisms in the problem representation in terms of intent or causal statement. All coaches indicated that they made changes throughout the game warranted by circumstances and context. However, the expert coaches in this study expressed a willingness to adjust (part of) their strategy when circumstances continued to require change or previous small adjustments were inefficient. The beginning coaches' focus remained on personnel changes or an emphasis on better execution within the predetermined strategic game plan.

Second, when addressing a problem situation that arose during the basketball game, the expert coaches tended to address the process and focused on the steps and options to get to a favorable outcome. The experts preferred a forward-thinking approach characterized by a thorough analysis of the situation before deriving to a solution. The beginning coaches appeared to focus on the product, outcome or one solution. The backward approach was also was indicated by the frequent use of solution-based statements throughout the problem representation with a lack of accompanying analyzing or descriptive statements.

Third, the extent of the coaches' solution scope in solving problems can be seen in terms of foresight for a bigger picture or immediacy for the current situation or possession or rather in the moment. The bigger picture was continually in the back of the expert coaches' mind and they demonstrated foresight regarding potential later game implications. The frequency of solution-oriented statements during the problem representation highlighted the focus on the immediacy of the solution by beginning coaches, or an attention on how to solve a particular problem right now, in the next possession or in the moment of the game.

These main differences between beginning coaches and experts in the problem solution phase support what is known about coaches decision making during practice (Jones et al., 1997) and the prevalence of forward thinking strategies used by experts in other areas (Elsen, 2003).

In summary, all basketball coaches displayed the ability to use various mechanisms or building blocks to construct a problem representation during the game. However, the expert and beginning coaches used different 'blocks' more often and focused on varying elements during the competition. It appeared that the use of the blocks in the problem representation phase contributed to the differences in the problem solution phase and allowed experts to act according to the way the problem representation was constructed. The expert coaches in this study displayed a willingness to forgo their strategic plan when warranted by contextual game factors; they favored a forward-working approach or solution strategy and focused on the bigger picture of their team, season and player development rather than the immediate impact on the next possession.

Findings from this study illustrated the importance of problem representation during competition in terms of the consequent problem solution phase. Differences in the construction of the problem representation were directly linked to differences in the problem solutions of the coaches in this study. As highlighted by Kahney (1993): "one of the most important determinants of the ease with which a problem can be solved, or whether it can be solved at all, is the way the solver constructs a mental representation of the problem" (p. 34).

The following section discusses specific recommendations for coaches based on the findings from this study.

Recommendations for Coaches

Three practical recommendations and implications from this study's findings will be offered and discussed next: (a) observe analytically and focus on the process, (b) be mindful of the bigger picture, and (c) gain and value experience.

Observe analytically and focus on the process

Findings of this study indicated the need for coaches to be analytically-minded while observing a game in their quest towards expertise. Rather than describing what is seen and offering a solution, coaches should analyze the events during the game in clear causal relationship to their sources and evaluated them as being positive or negative toward the accomplishment of their intent or the overall execution of the strategic game plan. To develop expertise in problem solving, the coaches' should approach the events with attention to the process and seek to understand the situation. Coaches should be reluctant to provide immediate solution-oriented statements while events are unraveling during the competition, yet focus on the analysis of the particular situation and the anticipation of future events prior to constructing a solution.

Be mindful of the bigger picture – Don't get caught up

This study's findings indicated that coaches should be mindful of the bigger picture while observing a game. That is, to be more expert coaches need to make connections between what they know and what they see. Their level of analysis in representing problem must include: thinking beyond what is obvious during the observation and extend to potential outcomes and intended goals. An expert coach's quote confirmed this:

> Rarely even will I do anything without a purpose, I have a reason for it….it's like playing checkers and playing chest…you may be happy about a move, but it doesn't behoove you to be so emotional that you forget what you're doing…but I try to always think clearly when making a decision and not get caught up in what is going on (Interview, JE).

During competition, coaches should look for and consciously consider contextual factors such as the score and time, previous events in the game, and check the observed events against their general coaching knowledge, as these pieces will help guide coaches in the process of finding an appropriate solution while continually keeping a perspective in mind that goes beyond the immediate and considers future consequences and results.

Gain and value experience

Coaches seek out knowledge from various sources. However, putting knowledge in practice and moving from 'knowing' to 'applying' comes with experience. One of the expert coaches shared the following about his development as a coach:

> I was more of a scientist than I was a coach when I first started coaching, because I did was experiment on my players...I wasn't too much of a coach. I've always been hungry to learn. But the problem with that has been that I'll learn all this stuff, going to clinics, sitting down with coaches, and then I try to implement everything all at one time and everybody was confused, including me (Interview, JE).

Expertise literature has highlighted the critical role of experience in the development of any performer. A large part of coaching expertise is built through an extensive period of deliberate practice and experience; as a minimum of 10,000 hours or 10 years of deliberate practice is essential (Ericsson & Smith, 1991).

An expert coach in this study underscored the importance of experience in the development of good in-game decision making through the following quote:

> …as you experience all these things, you understand situations a lot more, you understand what your players are going through a lot more, you're understanding which players you can get on to harder, which players need that pat of encouragement. I'm telling you, there is no substitution for experience in coaching and even as a veteran coach…I'm learning things every game, every game! I'm very critical of myself. I'll go back and basically say: I should have done this….You're always gonna look back at a thousand things that you could have done better, but I think that's what helps me as a coach (Interview, DE).

Going deliberately through game experiences--whether by watching game taping, or by scouting other teams--will help coaches become more familiar with particular basketball situations and help to make connections with those experiences when observing their own team in a similar event. This also might facilitate the coaches' utilization of self-awareness connections and recognition of links with one's general coaching knowledge during competition which in term will assistant in the problem solution.

Recommendations for Future Research

In reflecting upon this study, there are three methodological additions the researcher would make if the study were to be repeated. First, the researcher would seek input from coaches during the interpretation of problem representation data and use a member check once the categories were found and defined. These procedures would help ensure that the categories represented the meaning of the verbal data by coaches and would strengthen the trustworthiness of the findings.

Second, if possible the coaches' would be asked to assist in the selection of segments from the game to represent and capture the problems and solving during competition rather than the selection of segments by the researcher. Data seemed to indicate that sequential events can be an integral part the coach's problem representation and solution. Thus, input from the coaches in the selection of important and contributing segments of the game to be included in the think aloud should be gathered. This might lead to a more comprehensive and richer set of data regarding the structure of the problem representation and the solution approach. Furthermore, it might help to analyze and compare the coaches' perception of the importance of events during competition. The coaches know the problems they most often need to solve during a game.

Third, in ideal circumstances, the coaches would undergo an immediate post-game interview to recap the main problems and solutions experienced by the coach. This could avoid a time lapse as well as focus on the coaches' perception of the importance of problems and decisions.

In extension of this study, future research should further examine the experts' willingness to abandon a plan if warranted by circumstances. More light should be shed on what the determining factors or thresholds are for experts to modify of forgo their strategic plan.

In light of the findings regarding the 'bigger picture' and interconnections of different events beyond the game, future research on problem solving in coaches should be geared towards examining a coach for a longer and extended period of time (i.e. a season) to analyze how the components of practice, knowledge, players and circumstances shape the coaches problem solving behaviors during competition and throughout the season.

To further the research of problem solving of coaches, additional settings should be explored and coaches within various sports compared. For example, does the problem solving of basketball coaches during practice resemble that of the problem solving during competition? How do expert and beginning coaches in one sport solve problems in a different sport? How does the problem solving of basketball and football coaches during practice or competition differ? Additionally, the problem representation of coaches and players during the game should be explored within a variety of team and individual sports.

Conclusions

The purpose of this study was to analyze and compare how expert and beginning coaches represent problem solving situations and solve problems during games. The research questions that guided this study were:

1. How do expert and beginning coaches represent a problem situation? What characterizes expert and beginning coaches' problem representation?
2. How do the expert and beginning coaches' problem solutions differ?

Findings from this study provided answers to these guiding research questions. First, data show that both expert and beginning coaches represent a problem situation during competition by using five building blocks in the construction of a cognitive structure of what they observe. The building blocks include: (a) descriptions, (b) analytics, (c) connection, (d) solution-oriented statements and (e) anticipation, prediction and speculation statements. When comparing the coaches, the problem representation of the experts is characterized by the frequent use of analytics and connections; whereas the beginners rely on descriptions, and solution-oriented statements to form a problem representation during competition. In particular, experts will consciously note the intent of events, time and score references, cause-and-effect relationships of events, and make connections with previous events or their available knowledge.

Second, differences in the problem solution of the coaches were found to be rooted in the different use of the building blocks during the problem representation phase. Expert coaches display a greater willingness to do whatever it takes to win, even if this means foregoing their strategic game plan due to continuous contextual factors. Furthermore, expert coaches work forward from a problem situation toward a solution, in contrast to beginning coaches' eagerness to provide an immediate solution. Lastly, expert coaches' evaluate situations and pursue solutions with future outcomes in mind and are always thinking of future implications.

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APPENDIX A

Phone Script

Hello, my name is Ilse Mason and I am doing a research study under the direction of Dr. Schempp, in the Department of Kinesiology at the University of Georgia. This research study is about the decision making of expert and beginning coaches during competition. Findings of this study might help you understand how you and other coaches represent problems situations during the games. Furthermore, I hope to learn more about the development of expertise as well as coaches' problem solving during games.

I have obtained your name/contact information through public records. I would like to ask you some questions to determine if you might qualify for this study. This should only take 5 minutes of your time. You do not have to answer any questions you do not want to answer. You may stop this interview at any time.
If you qualify for this study, you will be asked participate in the study by granting permission to video-tape one of your team's games, and to participate in an approximately 45 minute interview. If you do not qualify for this study, the information you give me today will be destroyed immediately. Do I have your permission to proceed?

- How many years have you been coaching, how many of those years have you been a head Coach?
- Have you won any State titles?
- Could you tell me what your current win-loss percentage as a head coach is?
- Have you won any awards or peer recognitions as a Head coach?
- Have you received any additional honors (such as through newspaper)?

Thank you for answering my question(s) today. You do/do not qualify to participate in this research study. [If qualified to participate] I would like to arrange a convenient place/time to meet to discuss the study and obtain your consent to participate. Are you interested in participating in this study?

If you have any questions regarding this study, please email me at isannen@uga.edu or call me at 706-542-4456.

If you have any questions or problems about your rights as a research participant, please call The Chairperson, Institutional Review Board, University of Georgia at 706-542-3199.

APPENDIX B

Task One Procedures

I have four video segments for you to watch. These segments are portions of a lady bulldogs game and will show a few minutes of game prior to a time out called by coach Landers.

I would like for you to watch this segment and while watching tell me out loud what you see happening that might have led to the time out called by coach Landers. I will be audio taping your response. We will watch the segment once, and if you would like to go back and watch it again or parts of it we can do that as well. Do you have any questions? I will turn the first segment on now.

Would you like to watch this again or is there anything you would like to add to what you said during the segment?

Let's watch the second segment. Again, I will show you the segment and would like for you to talk aloud about what you see happening that might have led to the time out called by coach Landers.

Would you like to watch this again or is there anything you would like to add to what you said during the segment?

Let's watch the third segment. Again, I will show you the segment and would like for you to talk aloud about what you see happening that might have led to the time out called by coach Landers.

Would you like to watch this again or is there anything you would like to add to what you said during the segment?

Let's watch the last segment. Again, I will show you the segment and would like for you to talk aloud about what you see happening that might have led to the time out called by coach Landers.

Would you like to watch this again or is there anything you would like to add to what you said during the segment?

Let's move to task two.

Task Two Procedures

I have a segment of one of your games on [insert date that game was video taped] against [insert opponent]. I will show you the few minutes preceding the first time out you called in the game. When I turn this on, could you please take me through what you were thinking and seeing leading up to the time out you called. Just say anything aloud as you recall it.

Would you like to watch this again or is there anything you would like to add to what you said during the segment?

Example follow-up questions asked during or after the think aloud protocol

Thinking back about the game…

- What important decisions did you make during the game?
  What prompted you to make those decisions? Was the outcome what you anticipated? If not, did you make adjustments? How?
- Did you have a specific plan going into the game? Did you change that? When?
- Do you recall what you told your players during half time?
- How did you solve this situation during the time-out?
- Do you think consciously about your decision making during the game?
- Does your knowledge of the other team and a game plan play a role in your decision making during the game? How?

Thank you very much for your participation.

APPENDIX C

Informed Consent Form

I, ________________________________, agree to participate in a research study titled "A study of problem representation by expert and beginning coaches during competition" conducted by Ilse Mason from the Sport Instruction Research Lab in the Department of Kinesiology at the University of Georgia (542-4456) under the direction of Dr. Paul G. Schempp, Department of Kinesiology, University of Georgia (542-4379). I understand that my participation is voluntary. I can refuse to participate or stop taking part at anytime without giving any reason, and without penalty or loss of benefits to which I am otherwise entitled. I can ask to have all of the information about me returned to me, removed from the research records, or destroyed.

The reason for this study is to examine coaches' decision making during competition. More specifically, the purpose is to examine and compare how expert coaches and beginning coaches represent and solve problems during games.
If I volunteer to take part in this study, I will be asked to do the following things:

1) **Give permission to video-tape one of my team's games**
2) **Schedule an interview with the researcher**
3) **During the interview, watch four video-taped game segments and provide the researcher with my thoughts; which will last 25 minutes**
4) **During the interview, watch a segment of my team's video-taped game and provide the researcher with my thoughts; which will last about 15 minutes**
5) **Someone from the study may call me to clarify my information**

The benefit for me is that the findings may help me understand how I and other coaches represent problem situations during games. The researcher also hopes to learn more about the development of expertise as well as coaches' problem solving during games.

No risk or discomforts are associated with this study.

I understand that information will be confidential when published, presented or made available to the public. Transcripts of interviews will be coded by date of the interview. The participant and institution will be given pseudonyms. The video-tape, and audio-recordings will be destroyed upon completion of the study. Transcripts will be stored in a secure place in the researcher's locked office for 3 years after completion of the study. The only people having access to these documents will be the principal investigators.

The investigator will answer any further questions about the research, now or during the course of the project.

I understand that I am agreeing by my signature on this form to take part in this research project and understand that I will receive a signed copy of this consent form for my records.

Ilse S. Mason____________________ ________________________ __________
Name of Researcher **Signature** **Date**
Telephone: 706-542-4456
Email: isannen@uga.edu

__________________________ ________________________ __________
Name of Participant **Signature** **Date**

Please sign both copies, keep one and return one to the researcher.

Additional questions or problems regarding your rights as a research participant should be addressed to The Chairperson, Institutional Review Board, University of Georgia, 629 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; E-Mail Address IRB@uga.edu