

The Coaching Model: A Grounded Assessment of Expert Gymnastic Coaches' Knowledge

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An expert system approach (Buchanan et al., 1983) was used to identify and conceptualize the knowledge of 17 Canadian expert high-performance gymnastic coaches. The knowledge elicitation process consisted of open-ended questions and various questioning methods to unveil, explore, and prove important information (Patton, 1987; Spradley, 1979) about coaching. All coaches' interviews were transcribed verbatim, and the unstructured qualitative data were inductively analyzed following the procedures and techniques of grounded theory (Strauss & Corbin, 1990). The inductive analysis process allowed the meaning units of the interview transcripts to be regrouped into properties, categories, and components. The components emerging from the analysis consisted of (a) competition, (b) training, (c) organization, (d) coach's personal characteristics, (e) gymnast's personal characteristics and level of development, and (f) contextual factors. These components were further developed into a model representing coaches' knowledge.

Key words: grounded theory, mental models

Over the last 20 years there have been many publications on coaching as it relates to sport psychology or sport pedagogy. No theoretical framework, however, exists for explaining which factors are most important in the coaching process and which relationships among these factors are most significant. According to Thomas (1992), these two statements are the basis for establishing a model or a theory that would make sense of disorganized information in a specific

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domain of research. Similarly, Blumer (1969) stressed the necessity of concepts and conceptual relationships for scientific understanding. Although coaching has emerged as a scientific discipline (Woodman, 1993), there are no comprehensive frameworks that represent the complex reality within which coaches work. For example, certain authors (Lyle, 1993; Woodman, 1993) have described coaching as a dynamic and systematic process that involves various steps such as observation, assessment, development of a plan of action, implementation of the plan, and reassessment. Although this process appears to represent what coaches do to develop athletes, it does not provide information regarding the variables that need to be observed and assessed by a coach to build a "plan of action."

Because coaching is rapidly evolving as a profession (Woodman, 1993) and because coaching education programs are becoming more available around the world (Campbell, 1993), it becomes important to structure the content of the coaching domain to promote its advancement as a profession. As recently stated by Csikszentmihalyi, Rathunde, and Whalen (1993), "Whenever a domain is rationalized [structured] it becomes easier to measure performance in it and therefore to recognize promising talent" (p. 29). For instance, the domain of teaching has been rationalized (Dunkin & Biddle, 1974) and is constantly restructured by educators in the hope that learning will become more easily accessible to students. Accordingly, conceptual models of teaching have been suggested for use in coaching research (Tinning, 1982); however, the models do not adequately represent the complexity of the coaching process. For instance, competition is one of the variables that is not present in teaching but that is central in the coaching process.

Other models that have been developed for studying coaching are those describing coaches' leadership behavior (Chelladurai, 1984; Smoll & Smith, 1984). These models have been used as a framework to investigate the impact of coaches' leadership behaviors on athletes' performance and satisfaction (e.g., Smith & Smoll, 1990; Terry & Howe, 1984). Although the Chelladurai and the Smith and Smoll models provide frameworks for studying coach and athlete interactions and the coach's leadership behavior, they do not provide a conceptual framework that accounts for and works towards an understanding of all the other variables involved in coaching.

For example, research issues such as coaches' educational roles in training and competition (e.g., Horn, 1985), strategies used in coaching (e.g., Gould, Hodge, Peterson, & Giannini, 1989), coaching demands (e.g., Taylor, 1992), or gender differences in coaching (e.g., Weiss, Barber, Sisley, & Ebbeck, 1991) have been conducted without being guided by any type of conceptual framework that would provide a global and comprehensive view of the coaching process. Not surprisingly, in discussing the educational needs of 130 elite American coaches, Gould, Giannini, Krane, and Hodge (1990) stated that "one disconcerting finding was that less than half of the coaches sampled felt that there exists a well-defined set of concepts and principles for coaches" (p. 342). Without a general model on coaching, the knowledge accumulated through research remains disconnected information related to how and why coaches work as they do.

Expert System Approach

The intent of the present study was to ask high-performance expert gymnastic coaches directly about the important concepts and strategies that they use in

coaching. The idiographic approach to elicit the prerequisite knowledge of expert coaches was similar to the first two stages of knowledge acquisition—identification and conceptualization—that an engineer would go through with experts for building an expert system (Buchanan et al., 1983).

Generally, the objective of researchers interested in human expertise is to identify the content, structures, and processes responsible for skilled performance. To reach such an objective, most of the studies on expertise have examined structures and processes of individuals in different domains using the expert–novice paradigm (Campbell, Brown, & DiBello, 1992). This research approach has provided robust findings on the nature of expertise (Glaser & Chi, 1988; Starkes & Allard, 1993). However, a critical issue in the expert–novice approach is identifying standardized tasks that capture the relevant aspects of superior performance and allow an assessment of the cognitive mechanisms underlying the superior performance (Ericsson & Smith, 1991). This issue has lead researchers on expertise to focus on domains in which superior performance can be demonstrated under relatively standardized conditions, such as chess.

In more complex task domains—such as physics, medical diagnosis, music, or sport—investigators have tended to select a small number of tasks assumed to be representative of the domain (Ericsson & Smith, 1991). The tasks chosen in these complex domains usually represent well-defined activities in which the operations, objects, constraints, and goals are clear. The result of this approach for studying expertise is that the state of knowledge of complex domains of expertise is incomplete (Campbell et al., 1992; Ericsson & Smith, 1991). Coaching is an example of a domain in which the tasks and prerequisite knowledge of expertise have never been identified. In fact, despite the existence of coaching certification programs in Australia, Canada, Eastern Europe, Germany, Great Britain, and the United States (Campbell, 1993), the proven effectiveness of these coach-centered programs is not clear (Salmela, Russell, Côté, & Baria, 1994).

To obtain a conceptualization of expert gymnastic coaches' knowledge, it is crucial to choose a framework to represent the content and structure of the knowledge elicited by the coaches. Accordingly, the notion of mental models (Glaser, 1987; Holyoak, 1984; Johnson-Laird, 1983) appears to provide a flexible and suitable mode of knowledge representation for the examination of instructional issues (Glaser, 1987) such as coaching. Unlike propositional representations of knowledge, such as schemas or scripts, that consist of precompiled generic knowledge, the mental models are composed of specific knowledge structures that are constructed to represent new situations through the use of generic knowledge (Holyoak, 1984). For instance, in the course of learning, coaches might develop mental representations of their tasks based on their knowledge of certain variables; these representations can be referred to as mental models that direct their behaviors and performances.

In an ill-defined domain (such as coaching), in which many uncertainties exist concerning the given information, the operations that can be used, and the possible constraints that might be present, a great deal of time could be spent forming a mental model of a specific situation. Therefore, an assessment of the knowledge that expert coaches use to construct their mental models could provide useful guidelines for improving the coach's development and, consequently, the child's or athlete's education. As Ericsson, Krampe, and Tesch-Römer (1993) recently stated, "To better understand expert and exceptional performance, we

must require that the account specify the different environmental factors that could selectively promote and facilitate the achievement of such performance'' (p. 363). Therefore, the purpose of the present study is to rationalize the coaching domain by identifying the different variables that could affect high-performance coaches in their work and to provide a grounded heuristic model of how that knowledge is processed to solve problems and develop athletes.

Grounded theory was chosen as the research approach to investigate coaches' knowledge. Grounded theory does not test or try to prove existing theories but rather tries to develop concepts and theories that account for the behaviors of the individuals under study (Glaser & Strauss, 1967). The units of analysis are segments of text that are coded to allow the analyst to quickly find them. All segments that relate to a particular question, concept, or category are then compared, clustered, or divided, and finally related into a theory or model. In sum, grounded theorists are interested in individuals' interpretation of their experience and on the process by which meanings and knowledge are developed and used to guide actions (Tesch, 1990).

Method

Participants

The participants in this study were 17 expert high-performance Canadian gymnastic coaches. The selection of expert high-performance coaches was based on multiple criteria. First, a minimum of 10 years of coaching experience was required. Additionally, all coaches had competed as a gymnast in provincial, national, or international competitions, except for two coaches who compensate this lack of athletic performance by having 15 and 17 years of coaching experience. Second, each of the expert coaches required a performance outcome measure and, thus, needed to have developed at least one international and two national level gymnasts. These gymnasts were senior athletes who had merited a place on the team at an international competition or at the national championships by the Canadian Gymnastic Federation. Third, each expert coach had to be recognized by Canada's national coach as one of the best in Canada for developing elite gymnasts. All of the coaches initially selected to participate in the study accepted the invitation, were involved in coaching at the time of the interview, and worked with high-performance athletes who, according to Bloom's (1985) model, were in their later phase of talent development.

Because of the in-depth character of each interview, the interpretational nature of the analysis, and the limited number of high-performance gymnastics coaches in Canada, 17 coaches were considered representative and met the objectives of the study, as well as the criteria of expert selection. This number of subjects is consistent with other studies that used similar methodologies (Rose & Jevne, 1993) and that reached "theoretical saturation." Theoretical saturation is reached when data from subsequent interviews of new subjects do not contribute any new information, but fit adequately into the existing organizing system (Glaser & Strauss, 1967). Also, because of differences in age, physiological make-up, and task characteristics of male and female gymnasts, as well as the different behaviors that coaches of male and female athletes exhibit (Salmela,

Petiot, Hallé, & Régnier, 1980), 9 of the chosen coaches worked with male athletes, and 8 worked with female athletes. The two groups were analyzed separately.

Data Collection

Although many types of interviewing techniques have been defined in the literature, the major distinctions are between "structured" and "unstructured" (or "in-depth") interviews. In the structured interview, the questions are formulated ahead of time, and all informants are asked the same questions in the same order. In contrast, the unstructured interview covers broad topics that are specified in advance; the interviewer decides the sequence and the wording of questions during the course of the interview. Thus, unlike a structured interview, the unstructured or in-depth interview is concerned with unique and individual view-points. Because elite performers or experts respond well to broad areas of content and open-ended questions that allow them to use their knowledge, the in-depth interview has been suggested as the ideal type of interview for eliciting expertise from elites (Marshall & Rossman, 1989). In the present study, the in-depth interview approach consisted of asking open-ended questions to elicit relevant knowledge from expert coaches for developing elite gymnasts.

Three investigators proceeded with the interviews. Five interviews were done by the first author, and eight and four interviews were conducted by two other investigators. The three investigators received intensive methodological guidance before the beginning of the project and conducted several simulated interviews under the supervision of an experienced qualitative researcher. The three investigators acquired additional knowledge on interview techniques by reading relevant materials written by authors such as Patton (1987, 1990), Spradley (1979), and Jones (1985).

Design of the Interview Format. The same format was used for each interview. The interview format followed the guidelines for ethnographic interviews proposed by Spradley (1979). Each interview began with general information about the purpose of the project. Next, the interviewer focused on background and demographic information. Finally, the knowledge elicitation took place using Spradley's (1979) three kinds of open-ended questions for in-depth interviewing: (a) "descriptive questions" to learn about the informant's activities, (b) "structural questions" to discover how the informant organized his or her knowledge, and (c) "contrast questions" to find out what an informant meant by the various terms used" (p. 60).

The following are some examples of descriptive questions used: "Could you tell me what you do in a training session?" or "Could you describe the tasks you performed in the last competition you attended?" The descriptive questions were asked in order to identify topics and situations that the coach perceived as important. Once those specific situations had been elicited, the researcher then asked structural questions to gain as much information as possible about each issue. The following are examples of structural questions: "You mentioned before that dealing with an athlete's financial problems and family life is an important part of your job. What do you do when a gymnast has financial difficulties? What do you do when a gymnast has some family problems?" Finally, the contrast questions were employed to clarify and distinguish

between issues and situations. Typical contrast questions would be: "What are the differences between training an 8-year-old gymnast and a 15-year-old gymnast? What are the differences between dealing with the personal concerns of a gymnast on the national team and a provincial level gymnast?"

The interview schedule was designed to identify the issues most relevant to the coach and to focus on these issues in detail. By using Spradley's three kinds of open-ended questions throughout the interview process, the investigator ensured that the concepts elicited by the coaches were understood in a nonsuperficial way. The validation and credibility checks were an on-going process that consisted of continually questioning the interpretation of the coach; each coach's interpretation was verified and communicated during the interview. None of the interviews were rushed, and the coaches always had time to clarify and reformulate their thinking. Before the end of each interview, a general probe was done to ensure that coaches had discussed every issue they perceived as important for developing elite gymnasts. Each interview lasted between 1-1/2 and 3-1/2 hours and was transcribed verbatim.

Data Analyses

The objective of the analysis was to build an organizing system of categories that emerged from the unstructured data and that represented the organization and utilization of expert high-performance gymnastic coaches' knowledge (Strauss & Corbin, 1990, 1994; Tesch, 1990). Two main operations played important roles in the analysis of the interview transcripts. First, there was the detailed examination of the interview transcripts. This procedure involved dividing the text into meaningful pieces of information called "meaning units" (Tesch, 1990). The 17 interview transcripts were analyzed on a line-by-line basis by two coders who agreed on dividing the text into a total of 1,155 meaning units.

Second, common features between meaning units were identified. This procedure, referred to as "creating categories," involved comparing meaning units and grouping them into distinct categories that were referred to as "properties" (Côté, Salmela, Baria, & Russell, 1993). Thus, the 1,155 meaning units were assembled into 134 different properties. Properties were named according to the common features its meaning units shared. For instance, the following meaning unit was part of a property labeled "developing aggressiveness/intensity":

Anger is a good thing. It's okay in my mind, and it's almost encouraged to the point that it is not going to make you faster or stronger but can get you aggressive. If you're angry, that's good. Let me see that in the skill.

The following meaning unit was part of a different property labeled "developing ability to deal with stress":

Let's focus on what you're doing. Let's ignore everything else, and don't worry about it if you don't do well, just try to do your best. If you don't do well, we'll worry about it later on, but if you worry about it now, you'll screw up. We teach them to know what they can control and not to worry about things they can't control.

As the data analyses proceeded, another level of interpretation emerged that consisted of comparing properties to organize them into larger and more embracing categories. For example, all the properties that referred to the development of gymnasts' mental skills were assembled into a more inclusive category labeled "training mental skills." The two properties, "developing aggressiveness/intensity" and "developing ability to deal with stress," for which examples of meaning units were given above, were in fact included, along with five other properties, within the training mental skills category. Thus, the 134 properties were compared, and similar properties were assembled together to result in 28 different categories.

This approach to qualitative analysis is often referred to as the *constant comparative method* (Glaser & Strauss, 1967). The constant comparative method involves the process of constantly comparing and contrasting the data until saturation is reached, that is, when no more encompassing categories emerge and no new concepts can be developed from the data. Therefore, each category of coaches' knowledge was composed of several properties that were built from all the meaning units. The reliability of the decision process for creating meaning units, properties, and categories was enhanced by addressing specific questions during the coding process. Examples of questions asked throughout the analysis process were "Are all the meaning units regrouped into a property similar or different?" "What are the similarities in the content of each property? Category?" or "Is there confusion or contradiction in the content of a category?" (Côté & Salmela, 1994).

A software program, HyperQual for Macintosh users (Padilla, 1989), specifically designed for qualitative analysis, also helped in the analyses of the coaches' interviews. The electronic organization of the data facilitated the interpretation of the results by keeping a systematic classification of each meaning unit and its source. For example, all the meaning units belonging to one category were assembled in one place so that the researcher could read in a continuous fashion about every coach attitude toward each property and category. Moreover, the process of handling the data electronically, as opposed to manually, reduced the chance of error in the analysis and decreased the chance of losing the source of relevant pieces of information (Côté et al., 1993).

Conceptualization of Categories of Knowledge. The major difference between grounded theory methodology and other qualitative research approaches is its emphasis on conceptualization rather than description. Grounded theory focuses its methodology on developing theories or conceptual models through continuous interplay between data collection and data analysis. Conceptual integration of the data is done throughout the course of the research project by using strategies for linking concepts and categories (Strauss & Corbin, 1990, 1994). Therefore, following the procedures of grounded theory, the next step was to identify relationships between categories, along with their properties, in order to develop a conceptual model that would not only describe but also explain the utilization of knowledge for developing elite gymnasts. The first task involved in achieving integration was to identify the core categories and relate them to the research question or to the "central phenomenon of the study" (Strauss & Corbin, 1990). The central phenomenon of the present study was the knowledge used by expert coaches for developing elite gymnasts. Therefore, this phenomenon was chosen as the ultimate goal around which all categories of knowledge would be articulated.

The second task involved in achieving integration was to write a general descriptive story to integrate the categories and determine which ones were central to achieving the goal. Because each category seemed to describe part but not the whole phenomenon, the categories were regrouped into sufficiently broad components to encompass the main ideas of developing elite gymnasts. The resulting components were the same for coaches of males and coaches of females. This integration process consisted of comparing and relating the different categories of knowledge. Integration was not much different than the "creation of categories" (Côté et al., 1993), except that it was done at a higher and more abstract level of analysis. To include every category into the model required many versions of the story. The investigator had to arrange and rearrange the components and categories in terms of their effects on the goal. The resulting model and stories about "developing elite gymnasts" were "grounded" with interview quotations and fit the original data found in the interview transcripts of both coaches of males and coaches of females.

Credibility of the Data Interpretation

The procedure in grounded theory implies that validation is part of the research process, with continual credibility checks of the collected data. Thus, the interview guide evolved after each of the first 10 interviews were completed and analyzed. Because no new salient themes emerged from the last 7 interviews, and most of the information elicited had already been identified in the previous interviews, one can argue that "theoretical saturation" was reached (Glaser & Strauss, 1967). The interrelated process of data collection and data analysis also permitted the thorough examination of the issues perceived as important by the expert coaches. This method added credibility to the concepts elicited because these concepts were grounded in each coach's reality as opposed to the investigator's reality or to other rigid methodological procedures (Glaser & Strauss, 1967). Hence, the categories of knowledge were not imposed upon by the structure of empirical reality; rather, they represented categories by which expert coaches organize and construct their knowledge.

Another technique used to enhance the credibility of the data was to obtain feedback from the coaches interviewed (Blumer, 1969). The first task consisted of sending a copy of the model with an analytical story describing the relationship between the components of the model to all coaches who took part in the study. Of the 17 packets sent to all coaches, 9 coaches returned their assessment and generally agreed with the model and the story describing their work.

Two coaches of males and 2 coaches of females received an additional document describing the components, categories, and properties of the model in more detail. The objective was to obtain feedback from them on the more detailed aspects of the findings. Because the coaches lived all across Canada, it was not economically feasible to travel to each of their home towns for a second face-to-face interview. Thus, a tape-recorded telephone interview format was utilized with 3 coaches, and one interview was done in person. The 4 coaches interviewed to obtain feedback on the more detailed aspects of the results also indicated a general agreement with the findings.

Finally, reliability was calculated for components, categories, and properties. Two independent judges were trained to put sample meaning units into the

appropriate components, categories, and properties. The samples consisted of 60 meaning units randomly chosen from the 560 meaning units inducted from the interviews with coaches of females. After their training, the judges coded 131 randomly selected meaning units into the appropriate components, categories, and properties. The 131 meaning units used for the reliability check represented approximately 26% of the remaining meaning units not used for training the judges. The results of the reliability check for the components, categories, and properties was over 90% for each judge.

Results

The purpose of grounded theory is to develop conceptual links between concepts and not merely to describe categories (Strauss & Corbin, 1990). Consequently, it is beyond the scope of this article to provide a detailed account of the properties and categories of the coaches' knowledge. Although some examples of meaning units are provided to illustrate the type of data underlying each component, they only represent a fraction of the large set of data from which the coaches' knowledge was conceptualized. As a result, only the components of the coaching model (CM) and their dynamic relationships are identified in Figure 1.

Definition of the Components of the Coaching Model

The components of the CM have been defined to describe a coach's work from the coach's perspectives. Central to the model are the competition, training, and organization components that are also defined as the coaching process. Three variables affect the coaching process: the coach's personal characteristics, the athletes' personal characteristics and level of development, and some contextual factors. These three variables are defined as the peripheral components. Finally, the goal and coach's mental model of athletes' potential are two additional factors which complete the model.

The Goal. The goal is defined as the most obvious task of the coach: developing athletes. The word *developing* remains a flexible term that can be adapted to accommodate various levels of coaching, from youth sport participants to Olympic athletes.

The Coaching Process. The actions of the coach in the organization, training, and competition components have a direct impact on the goal, and thus are defined as the coaching process. First, the organization component involves applying one's knowledge towards establishing optimal conditions for training and competition by structuring and coordinating the tasks involved in reaching the goal. The task of organizing can take place before, during, or after training and competition, and it includes categories such as planning training, working with assistants, working with parents, and helping gymnasts with personal concerns. For example, the following meaning unit was part of the organization component:

So I came back and did some thinking, and I said, "Dammit, I'm going to start now to prepare for 1996. I'm going to find the kids, and nothing will prevent the fruition of that 1996 team to be ready on that day. We

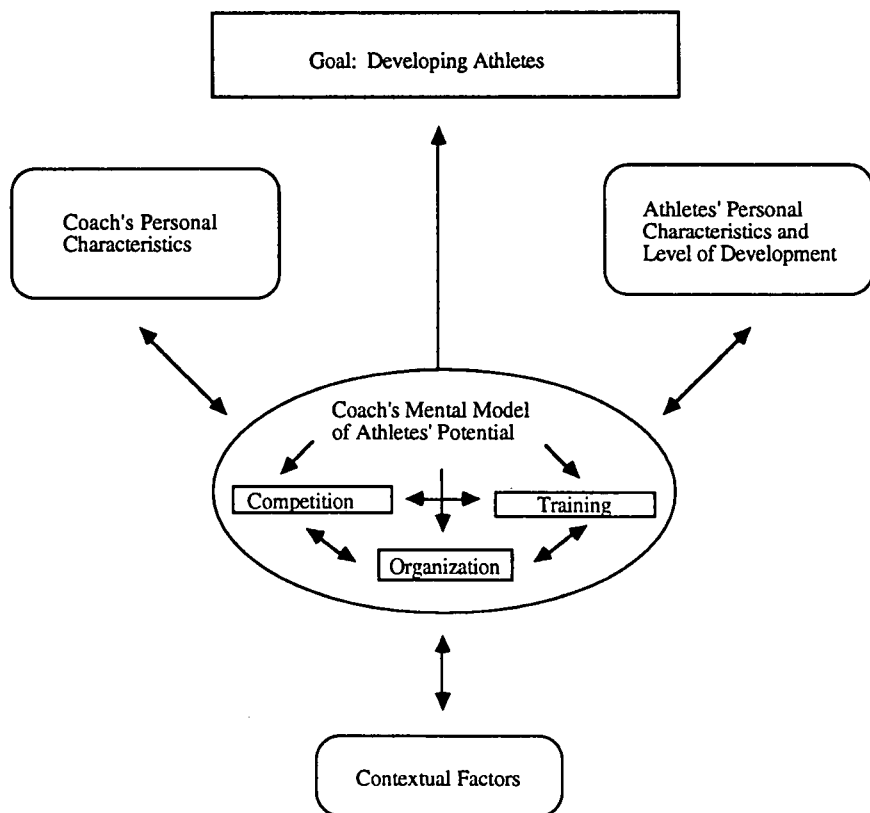


Figure 1 — The coaching model.

have dedicated coaches and programs. So we're spending between now and this summer in finding those kids." We're working and thinking ahead. There's interactive planning. We interact with the athletes. I don't sit back and just accept things. The little man inside my head says, "Come on, come on."

The second component of the coaching process was training, and this involves applying one's knowledge towards helping athletes acquire and perform different skills in training. The type of intervention style preferred, the training of technical skills and mental skills, and the use of simulation are examples of categories that characterize the training component. The following is an example of a meaning unit included in the training component:

We are big believers in progression. If they're strong enough and flexible enough, and if we've taught them the right progression, then they should be able to do it, and that's how we convince them. We go through the steps. If you do this one stage, then you can do it. You move on to the next, and you can do it. We just keep building on it.

Finally, the competition component consisted of using knowledge to help athletes perform according to their potential in competition. Included in this component were categories such as coaches' roles at the competition sites and on the competition floor. The following meaning unit characterized the competition component:

In competition, I don't try to overcoach them technically, because how much more technical information can you give them in 30 seconds that you haven't already given them in 3 months that is going to help them to be technically better? To me, it's only a waste of time. It's not going to help them anyway. It doesn't matter what you do at the competition technically; that is not going to improve it that much.

The competition, training, and organization components are constantly monitored and adjusted by the coach during the coaching process according to how these three components interact and how they are influenced by each coach's mental model of athletes' potential.

Coach's Mental Model of Athletes' Potential. The coach's mental model of athletes' potential, which is determined by a coach assessment of the peripheral components, represents the coach's mental representation of what needs to be done to reach the goal. It consists of the coach's knowledge of the actions that need to be performed in the organization, training, and competition components. It is proposed that the athletes' estimated potential can be raised or lowered, depending upon the effects of the peripheral components; however, the demands emanating from the coaching process are solved without affecting the coach's mental model of athletes' potential.

The Peripheral Components. The peripheral components can have a positive or negative impact on the goal by affecting the coach's mental model of the athlete's potential. The three peripheral components are the coach's personal characteristics, the athletes' personal characteristics and level of development, and some contextual factors. The coach's personal characteristics involve any variables that are part of the coach's philosophy, perceptions, beliefs, or personal life that could influence the organization, training or competition components. The following is an example of a meaning unit included in the coach's personal characteristics component:

My philosophy is to make them good people and good gymnasts. Like, if I had a kid who just swears and pushes everybody around, I won't accept that at all. So I'm trying to develop good people and good gymnasts.

Second, the component "athlete's personal characteristics" involves any variables dealing with the athlete's stage of learning, personal abilities, and other personal characteristics that could affect the coaching process. A meaning unit representative of this component is the following:

Some kids are really scared. There's a difference here: If they really are too scared, then they shouldn't be in the high-performance group, and we've had some kids like that. We found they were high performance, but they have lots of problems with fear, so we'd say, "I think you'd better

come back over here where you feel more successful." So, we really direct them.

Finally, the component "contextual factors" is defined as unstable factors, aside from the athletes and the coach, such as working conditions, that need to be considered when intervening in the organization, training, and competition components. Included in this component was the following meaning unit:

There's politics in gymnastics. You don't always get the score you deserve, and somebody else gets more than they deserve. You don't always win or lose when you should.

The contextual factors component, just like the athletes' and coach's personal characteristics components, can positively or negatively affect the coaching process.

Discussion

The objective of this study was to articulate a model representative of the organization and utilization of expert high-performance gymnastic coaches' knowledge. The discussion focuses on two aspects of the model. First, the discussion is centered on how the CM could be used as a conceptual framework to help organize the research on coaching. Second, the discussion deals with how expert coaches build mental models using the knowledge contained in the components of the CM to develop athletes.

The central components of the CM, including competition, training, and organization, were the main features that distinguished it from other more specific models of coaching such as leadership behavioral models (Chelladurai, 1984; Smoll & Smith, 1984) and instructional models (Tinning, 1982). The peripheral components, composed of the coach's personal characteristics, the athlete's personal characteristics, and the contextual factors, were actually somewhat similar to the other existing models.

The components of the CM and their specific relationships were described to explain how expert coaches worked towards their objectives of developing elite gymnasts by building mental models for different situations. The major components that emerged as critical aspects for coaches in gymnastics to consider appeared to be generalizable to coaching in general. Indeed, the CM has already been used successfully as a conceptual framework to investigate coaches' expertise in team sports (Salmela, 1994) and figure skating (Laplanche & Salmela, 1993), as well as serving as an organizing system to classify the existing literature on direct observation of coaches' behaviors (Trudel, Côté, & Donohue, 1993).

Other existing literature on coaching could be classified within one or several components of the CM and, accordingly, give a new perspective to the information contained in these studies. For instance, the studies that have examined the coach's educational role (e.g., Horn, 1985), coach leadership behavior (e.g., Terry & Howe, 1984), and strategies used in coaching (e.g., Gould et al., 1989) could be compared and integrated within the framework of the CM. The

results of these studies, interpreted in light of the CM, would not be separate facts, but would offer a comprehensive understanding of how coaches work in training and competition. Most of these studies focus on only one component, such as training or competition, and do not always consider how other components, such as the context or the athletes' personal characteristics, may be affecting their results. Thus, any incongruences between the results of these studies could be more easily explained by examining the interaction between the components of the CM. Similarly, when placed within the coaches' personal characteristics component of the CM, research on gender differences in coaching and coaching demands would be put within a global framework where their results would be evaluated considering other important variables such as the athletes and the context.

The relationships between the different components of the CM highlight the need to do more comprehensive studies on coaching instead of focusing on isolated variables. For example, in a given sport, the assessment of what needs to be done in training and competition at each stage of an athlete's development would be essential for truly understanding the coach's role in an athlete's career. In sum, with the absence of general models for studying coaching in various sports, the components of the model derived from the present study could serve as a system to organize the existing literature on coaching, as well as a conceptual framework for explaining which factors are most important in the coaching process and what sorts of relationships among these factors are most significant.

From a cognitive perspective, the modeling system (Figure 1), elaborated in an attempt to explain how expert coaches utilize knowledge to develop elite gymnasts, was consistent with theoretical definitions of mental models (Glaser, 1987; Holyoak, 1984; Johnson-Laird, 1983). Generally, these authors suggested that mental models are specific knowledge structures that are constructed mentally to represent various situations. Accordingly, the core of understanding for expert gymnastic coaches consisted of having a "working model" in their mind for developing elite gymnasts.

When expert coaches estimated a gymnast's potential, they considered their personal characteristics (what they could and could not do), the gymnast's personal characteristics and level of development, and any contextual factors. Using this information, the coaches constructed a mental model of what needed to be done to develop that particular gymnast. This model was then used as a basis to define which knowledge was important for use in the competition, organization, and training components. It seems far less likely that gymnastic coaches had a ready-made schema that contained the generic knowledge necessary for the development of elite gymnasts. Rather, the perception of a particular athlete or any challenging situation generated knowledge from different components that, when combined, provided a new model for each gymnast. This model, defined as the coach's estimation of a gymnast's potential, then served to establish the actions for developing that particular gymnast.

For instance, a coach's mental model could be built to develop a 12-year-old gymnast who has the physical and mental abilities to succeed at the international level, but who has difficulties at school. The given mental model would contain the appropriate knowledge to develop the gymnast, as well as to handle demands and difficulties that may be encountered in the training,

competition, and organization components. For example, to deal with the gymnast's difficulties at school, the coach may find a solution by talking to him or her about improving study habits at home or even by adjusting training and school schedules. This kind of adjustment would be made within the limits of the mental model initially built by the coach. However, if the difficulties at school are so pervasive that they become a constraint, it would be difficult to deal with the situation without changing the coach's initial mental model of the gymnast's potential. For example, if the gymnast has failed half of his or her classes because of a high level of involvement in gymnastics, then the coach would need to significantly reduce the athlete's training time or modify the competition schedule. This kind of modification would require a reevaluation of the coach's mental model of the gymnast's potential by reassessing the gymnast's personal characteristics.

Mental models of coaches are not necessarily a complete, accurate understanding of a phenomenon; rather, they are a useful representation of how concepts interact. The accuracy of the representation depends on the level of knowledge of the coach who constructs the model. For instance, a coach may estimate that two gymnasts have the potential to be on the national team. Obviously, the two gymnasts do not have the same personal characteristics, have different backgrounds, and are not affected by the same contextual factors. However, an expert coach would be able to extract the aspects that are relevant to the attainment of the goal and that need to be represented in the mental model. For example, it would not matter whether the gymnasts were born in the United States or Canada. For the purpose of developing an elite gymnast, athletes born in different countries and otherwise alike could be mapped into an identical model.

The categories of knowledge processed by a coach can be arranged and rearranged in various ways. The knowledge embodied in a specific model is maintained until there is no subsequent evidence to modify it. Coaches need to reevaluate their model and make some changes in the knowledge triggered when unexpected events arise. The large arsenal of coaches' knowledge, organized hierarchically through the different properties, categories, and components, allows expert coaches to rapidly assess situations that do not fit their mental model and, consequently, make the appropriate changes. Changes to a mental model could occur until the relationship between the model and the environment is adequate for achieving the goal.

The mental representation that expert coaches constructed allowed them to succeed in pursuing the best path for developing an elite gymnast without having to consider all the others. Because coaches' knowledge was organized into a hierarchical structure of properties, categories, and components operating in parallel, it permitted the coaches to represent a gymnast's potential in terms of a small number of patterns or "chunks." A chunk of knowledge would, therefore, correspond to tightly connected properties and categories of knowledge activated simultaneously within a component, as well as between different components. Accordingly, when coaches activated several properties of knowledge simultaneously, they mentally formed a complex and possibly unique problem situation. The nature of this organization determined the quality, completeness, and coherence of the mental model used, which in turn determined the efficiency of the knowledge applied in the organization, training, and competition components.

Conclusion

In summary, the grounded theory approach used to examine coaches' expertise lead to a conceptualization of expert gymnastic coaches' knowledge and has opened some avenues of research in coaching. In fact, by focusing on what Ericsson and Smith (1991) defined as the first research step for understanding expertise, the present study has systematized the different components and their links which appear to be central to any coaching situation.

The underlying model of the process used by expert coaches to develop athletes was an important basis for formalizing and rationalizing coaching knowledge. Indeed, the identification of relevant knowledge under each component and the assessment of the information used by coaches to build a mental model of a situation appears to be necessary for obtaining a true understanding of coaching at any level of competition. The CM renders explicit the variables that need to be observed and assessed by coaches in order to develop and implement a plan of action for developing athletes. The effort of the present study to rationalize the coaching domain could make the detection, nurturing, and support of coaching talent easier. Furthermore, since no conceptual framework has yet been proposed to represent coaches' reality, a greater comprehension of coaching could be realized by using the components of the CM as a framework to study coaches in different sports.

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