

Examining and Extending Research in Coach Development

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Research to date provides two approaches to assessing coaching expertise. The first is behavioral assessment and the second is to assess coaches' knowledge base. However, we contend that both approaches are flawed due to their inability to adequately improve coach development by failing to answer three fundamental questions: What knowledge should be taught to novice coaches? What is the optimal method for teaching this knowledge? And how should we assess to encourage learning? Cognitive psychology has demonstrated that someone with expert cognitive skill is characterized as having expert declarative and procedural knowledge. Experts are further characterized by having greater organization of this knowledge. Thus the expert is able to apply expert knowledge in a more expert manner to solve complex problems in a specific domain. Properly exploiting ideas such as these can help direct future research to provide answers to the questions posed above.

Assessment of coaching expertise has been a research focus for the past 25 years and, as the crucial role of coaching in the development of talent is confirmed (e.g., Bäckley & Stafford, 1996), the importance of this focus is increasingly recognized. Pertinent information can also be gleaned from the research of teaching expertise in physical education, as both skills contain very similar elements. This similarity is typified by Griffey (1991), who describes a teacher as someone who orchestrates learning activities and mediates social climate while diagnosing and remediating student performance—all actions that mirror the role of the coach. Within these parallel foci, the two main areas investigated have been behavioral assessment and knowledge assessment. Behavioral assessment is a quantitative tally of specified target (normally verbal) behaviors displayed by a coach. Knowledge assessment examines the knowledge base of a coach, normally through the medium of some sort of think aloud/interview method or concept mapping. The latter can be defined as "a two-dimensional diagram which illustrates relationships between ideas in a content area" (Jonassen, Beissner, & Yacci, 1993, p. 155).

Recently, however, criticisms have been aimed at these two thrusts. Behavioral assessment has been criticized for being too simplistic (Strean, 1995), while knowledge assessment has been criticized for being too ambiguous to promote its

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use (Housner & French, 1994). Furthermore, despite the considerable research base that exists, there is little or no evidence for the systematic application of this literature to the development of coaching expertise outside the rarefied atmosphere of academe. As British authors, we are unaware of any formal coach education systems that explicitly exploit the results or methodologies of either the behavioral or the expertise based literature. Enhancement of the coaching process must represent the eventual aim of this work. But how valid is it? How practical are its recommendations? And, most crucially, how can we modify our approaches as researchers to more effectively and consistently address the specific needs of coach educators?

In attempting to meet these important but challenging needs, this paper will review expertise literature from other, rather more mainstream areas of cognitive psychology that appear to offer a more promising direction. Following this, research that has taken a behavioral perspective to coaching will be reviewed. This will outline how research has progressed beyond the simplistic to far more in-depth behavioral assessment. We will go on to describe how, even though there has been improvement in measurement, there has been much less success in coach development using recommendations from this work. Next, research on knowledge assessment will be reviewed, describing the broad-ranging approach to this topic that may well have been the precursor for the ambiguous tag cited above. Finally, the consequences of presented research will be discussed, with a view to providing recommendations for both the development of coach education processes and the refocusing of research in this area in order to explicitly evaluate these recommendations.

The Nature of Expertise in a Cognitive Skill

The very labeling of coaching as a cognitive skill can produce a frosty reaction from many coaches or teachers. Typical reactions can be "coaching is an art," "it is common sense" (Griffey, 1991), or "I don't feel I make any conscious decisions when I am coaching, so how can it be cognitive?" In our experience, the first two of these statements are likely to emanate from either the truly gifted master coach who has never struggled to coach anything or anyone (and there aren't many of these!) or the coach who has coached, or been coached, this way for years and doesn't think it is possible to improve (of which there are plenty!). The short-sightedness of such statements is noted by Griffey (1991), who says, "Such perceptions are not only incorrect, they also evidence a misunderstanding about how knowledge is used in professional action" (p. 380). Thus, assuming for the moment that coaching is predominantly a cognitive skill, it would seem reasonable to review cognitive expertise literature from areas other than coaching or physical education.

Anderson's Theory of Knowledge Acquisition

Essentially, the nature of expertise in a cognitive skill is having more expert knowledge to interpret, solve, and perform solutions to problems, but what is knowledge? The most widely cited theory of knowledge content and structure was first put forth by Anderson (1982). This theory is based on the *If-Then production* theory (Anderson, 1982). Productions use knowledge of *conditions* to specify what further knowledge should be implemented to perform an *action*, so for example, if

conditions are (X) then perform action (Y). Rather than fully explaining the production theory, which is beyond the scope of this paper, examples will be given with each stage of Anderson's theory to adequately display their meaning.

Although the theory is complex, a basic understanding of it is crucial for our purposes here. Briefly, this theory discusses both the development and content of knowledge. The first, *declarative*, stage refers to the accumulation of a propositional network of facts (Anderson, 1982) that are available in any skill domain. These facts represent *declarative knowledge* content, which may best be viewed as the "why? knowledge" or the "knowledge of understanding." Others have referred to this as conceptual knowledge (e.g., Byrnes & Wasik, 1991). This declarative knowledge is developed through a process of *knowledge compilation* to a *procedural* stage. The procedural stage refers to the formation of *procedural knowledge* which is best viewed as the "doing knowledge" or the implementation of understanding.

Although we have referred to procedural knowledge as the doing knowledge, it is possible to "do," using declarative knowledge. However, due to the large amounts of facts that have to be used to solve even simple problems, a high demand is placed on working memory, which inevitably means that problem-solving is time-consuming. Thus, solving the problem of 3×9 at the declarative stage would, perhaps, involve the following set of productions.

If goal is to answer 3×9 , and 3×9 can be split into two additions of $(9 + 9) + 9$, then write $(9 + 9) + 9$. If goal is to perform first sum, and first sum is $9 + 9$, then do sum and write 18 to answer first addition. If goal is to sum 9 + answer to first sum, and first sum is complete, then sum $9 + 18$ and write 27 to finish problem.

This example has used three productions to solve what is a fairly simple problem. However, if this declarative knowledge was not known and used in the first instance, progression to the next two stages of knowledge development would be very difficult. This is certainly worthy of consideration in the design of coach education courses, and this idea will be explored in greater detail in the Recommendations section of this paper.

To overcome the drawbacks of time consumption and load on working memory, the amount of productions and declarative knowledge needed to solve a problem are reduced through *composition* and *proceduralization* of these productions. This represents the knowledge compilation stage. Composition refers to the capability for several productions to be collapsed into one macroproduction (Anderson, 1982). Proceduralization refers to the capability for declarative knowledge to be removed from the conditions of a production. These two processes can be seen by continuing with the example used earlier. The three productions having gone through composition would become:

If goal is to answer 3×9 , and 3×9 can be split into two additions of $(9 + 9) + 9$, and first sum is $9 + 9$ and second sum is first sum + 9, then write $(9 + 9) + 9$, then do first sum and write 18, then do second sum and add 9 to 18 and write 27.

The three productions seen earlier have become one composed production. Proceduralized, thus removing the declarative knowledge, this would become:

If goal is to answer 3×9 , then write $(9 + 9) + 9$, then do first sum and write 18, then do second sum and write 27.

Knowledge in the procedural stage is characterized by knowledge that has gone through the stage of knowledge compilation and has become further tuned (Anderson, 1982; Rumelhart, Norman, & Klatzky, 1978). This tuning generates either generalized, broad problem-solving procedural knowledge or discriminatory, specific problem-solving procedural knowledge. For example, the broad rule for saying the plural of a noun is to say the noun + s. However, in the case of the word "man" this rule would be wrong, and thus a more specific rule would be set up so that the plural of man is "men" (Anderson, 1982). The specific procedural production for the example used above would simply be, *if goal is to answer 3×9 , then say 27*. As procedural knowledge requires little or no declarative knowledge to be held in working memory, creating "spare capacity," this would help explain the oft-seen ability of experts to attend to more than one task. In addition, accessing procedural knowledge requires little conscious effort. This helps explain the lack of conscious decisions of the coach referred to earlier.

One final point about this theory is that productions are strengthened every time they are (perceived to be) used correctly. Consequently, if two productions approximate to solving a problem, the stronger of the two will apply. This can cause some problems, however, if the rejected production is actually more appropriate to the problem but was not selected because it hadn't been used much and therefore did not have much "strength." This has important consequences for any coach education program that is trying to teach correct knowledge to people who already have strong but incorrect procedural knowledge in that domain. These consequences will be discussed in greater depth later in this paper.

Much of this information will be familiar to researchers in the area of coach knowledge assessment, as many of the terms used can be found in the coaching/teaching literature. In such a complex area, however, the message can get lost, even though many of the terms have overlapping meanings. Consideration within a structure may help display the links between these terms and how these links can be exploited by research into coach education, a feature that is not always readily apparent from the present literature. Finally, it is important to realize that the role of knowledge in expertise would appear to be very much domain specific. That is, expertise in one domain does not normally transfer well to another. This has important consequences for why expert performers do not necessarily become expert coaches, and this observation will be explored in greater detail in the Knowledge Assessment section. In addition, the question of just how specific transfer can be, is a matter of some debate and will also be referred to later in the Recommendations section.

Outcomes of Expert Knowledge

Due to the comprehensiveness of Anderson's theory, the content can be, and has been, used to help explain findings relating to the nature of expertise. In addition, research has been guided by this theory. In his review of the nature of expertise, Anderson (1990) considers several areas that affect the approach to and solving of problems by expert and novices. First, "tactical learning," which is evidenced by the ability to recognize components of a problem where the same sequence of productions will apply. When this happens, either a specific production

can be set up to go straight to the appropriate action or, if there is no quick answer and several steps have to be carried out, a proceduralized production can be developed. An example of this could be coaching a topspin forehand in tennis. A coach would have several ways of coaching this shot to a novice player, all of which can be readily accessed depending on the problem. In this example the problem may be that a player simply needs reminding of the sequence of movements for producing a topspin forehand, hence the proceduralized production needed would be:

*If the goal is to remind players of topspin forehand sequencing, **then** ask player to take ball in front of body, **then** brush ball from low to high, **then** follow through over shoulder.*

If the same coach was working with a better player on when to hit the topspin, then the production may only be: *if goal is to hit topspin forehand, **then** tell player topspin.* In both cases the load on working memory is minimal, as the coach is able to call on his or her procedural knowledge (gained from first knowing the declarative knowledge of topspin technique and when to use limited instruction) of coaching topspin, allowing other tasks to be attended to.

According to Etringer, Hillerbrand, and Claiborn (1995), experts differ from novices in both encoding and use of information. This corresponds nicely with a further idea from Anderson (1990), that of "problem representation." Experts are able to recognize the most relevant information in, and can attach deeper meaning to, any problems that are encountered. This has been described as experts being able to attach abstract "problem schemata" (Chi, Feltovich, & Glaser, 1981) to problems rather than literal meanings. Thus "experts base their selection of appropriate principles on second order, derived cues. Novices basically use the features explicitly stated in the problem" (Chi et al., 1981, p. 123). In lay terms, the expert may be described as having a "critical eye" (Chase & Simon, 1973).

If we consider the problem schemata as being a broad problem-solving procedure, which can take in a greater and more in-depth amount of declarative knowledge or "second-order, derived cues," it is possible to display Anderson's theory in practice. An example from soccer would be that, during a game, a midfielder misses a tackle from which the opposition go on to score. A novice coach may solve this problem by practicing tackling in training. However, a more expert coach may note that the problem occurred not just because of a poor tackle, but was also probably due to a lack of cover and players being out of position. Rather than focusing on the surface feature of one bad tackle, the expert coach attempts to solve the more abstract problem of poor positional play in training.

This example leads into a further outcome of the nature of expertise, namely that experts are able to recognize patterns in environmental information. The classic example of this comes from experiments with chess masters and novices which are reviewed by Anderson (1990). The major conclusion of these studies was that experts can not only recall larger patterns of chess pieces, but also more of them, than those who are less expert (Chase & Simon, 1973; De Groot, 1966, cited in Anderson 1990). This points to highly tuned procedural knowledge of these patterns, with little or no need for recall of declarative information of why the patterns occur, which may interfere with working memory.

While this work is of interest, chess is a "highly structured" domain especially when compared to the "ill structured" domain of coaching/pedagogy (Berliner, 1991). A study of greater interest in pattern recognition was conducted by

Etringer et al. (1995) in the "ill structured" domain of counseling. The fact that the procedural/declarative distinction is observable in such similar environments evidences the promise that the approach may hold for the development of coach research and coach education.

Expertise and the Nature of Problem Solving

The expert, who has all of these advantages over the novice, also approaches problems in a more expert manner. From the literature it would appear that experts use two different approaches, depending on the type of domain. In exact sciences, such as physics, experts select a single appropriate generalized problem-solving rule (production), such as the conservation of momentum law (Anderson, 1990), to define how a problem should be tackled. This process is known as the forward reasoning approach (Chi et al., 1981). This production is then used to solve the problem in a sequential manner using the information given in the problem. In contrast, the novice will use the information given and, starting from the solution, work backward (Anderson, 1990) and hope to come across the correct rule to solve the problem.

In less exact sciences which better reflect coaching, such as computer programming (Anderson, 1990; Zeitz & Spoehr, 1989) and disease diagnosis (Johnson et al., 1981), there may not be any one decisive rule to predict the way a problem will be tackled. In fact, several broad problem-solving rules may be needed to solve the overall problem. The way in which experts use these rules is termed a breadth-first approach, that is, a Christmas-tree structure of "either-or" questions is formed. The problem is stated from the start, then all of the general rules that could affect how the problem is solved are mapped below the overall problem. These rules are then followed by anything that can affect how any of the general problem-solving rules are implemented. This process will continue until the tree is developed to such a level that an appropriate solution can emerge.

This is labeled the *breadth*-first approach, since, in contrast to the depth-first approach of exact sciences, several rules have to be considered in conjunction with each other. This is because, in such settings, the solution gained using only one rule can often have an impact on the other rules (Anderson, 1990). Indeed, it has been shown that the novices in each study of computer programming and disease diagnosis, operating a depth-first approach, who did not take into account this possibility, often produced an inaccurate solution to the given problem (Anderson, 1990; Johnson et al., 1981; Zeitz & Spoehr, 1989).

Due to the expert's problem-solving approach, it would appear that not only do experts have more and better organized procedural knowledge but also better organized declarative knowledge. This is important because, at some point, declarative knowledge must be accessed to solve a problem. Obviously if an expert's declarative knowledge is better organized, this accessing will be more efficient. Zeitz and Spoehr (1989) made the link that this may have important consequences for how declarative and procedural knowledge is taught in nonexact sciences. They demonstrated that, even if two groups are given the same declarative knowledge, the way in which this knowledge is taught can affect the ability to approach and solve problems. Their study noted that declarative knowledge, taught in a breadth-first manner rather than a depth-first, forward reasoning manner, produced subjects who performed better on troubleshooting tasks with a robot tracking system. In addition, it was shown that subjects who received the breadth-first declarative

knowledge had better proceduralization of that knowledge. Perhaps this should be the way to design coach development packages?

In summary, the nature of expertise in a cognitive skill relates to the ability of experts to build knowledge structures that contain highly organized declarative and procedural knowledge, which then enables the formation of problem representations which, in turn, facilitate the apparent effortless nature of problem solving. As stated at the beginning of this section, mainstream cognitive psychology may have a lot to offer coach education. Just how much it can offer will be discussed in more depth in the Development of Coaching Expertise section of this paper.

Assessing the Nature of Coaching Expertise: Behavioral Assessment

Most research into coaching expertise has followed a behaviorist approach rather than a cognitive line. Behavior is analyzed by the use of an assay, most commonly a tick box system. This will have certain behaviors specified, which are thought to closely mimic the action of a coach and are usually verbal and clearly defined before analysis. Perhaps the most renowned system using this approach is the Coach Behavioral Assessment System (CBAS) developed by Smith, Smoll, and Hunt (1977). This system set a precedent for others to use or adapt slightly for their own purposes. Thus, assay instruments based on behavioral analysis were developed with a view to providing intervention recommendations for basketball coaches (Lacy & Goldston, 1990; Smith, Zane, Smoll, & Coppel, 1983), football coaches (Lacy & Darst, 1985; Tharp & Gallimore, 1976), soccer coaches (Dubois, 1981; Wandzilak, Ansgorge, & Potter, 1988) or athletics coaches (Salminen & Liukkonen, 1995, 1996; Salminen, Liukkonen, & Telama, 1992).

However, there are major differences in how information gained from these studies is interpreted. It would appear that early use of the CBAS or similar tools produced recommendations that, in hindsight, may have been too absolutist for the complex coaching environment. For example, the earlier studies produced recommendations that instructional feedback, encouragement, and positive reinforcement are the most crucial techniques for coaches (e.g., Lacy & Darst, 1985; Smoll & Smith, 1980). But while there is little doubt that each tool is important, there are inconsistencies in this literature relating to recommendations for their use. Other investigations have shown that encouragement from coach to athletes, during a basketball game, could actually decrease athletes' liking for the coach. Also, reinforcement was not considered to predict, either positively or negatively, any of four attitudes: liking for basketball, team solidarity, coach evaluation, or self-esteem (Smith et al., 1983). In addition, rates of these behaviors could actually change over the course of a season (Lacy & Darst, 1985) without any reported change in coach effectiveness.

The ambiguity of such studies is highlighted by the later investigations, also using the CBAS. First, Wandzilak et al. (1988) demonstrated that behaviors of coaches changed significantly between practice and match play situation, an observation rarely taken into account in early studies. What are the implications for CBAS based advice? Could it be that optimum behavior relates more to the specific situation than to global rules?

Also, although it is recommended that instruction was a prerequisite for effective coaching (Lacy & Darst, 1985), this would represent a fairly autocratic

style of coaching. This contradicts recent work by Salminen and Liukkonen (1996), who found that athletes would actually prefer a more democratic style of coaching, which in itself represents a contradiction to the work by Terry (1984). This work demonstrated that team athletes prefer significantly more autocratic behavior. Of course, democratic and/or autocratic instruction is possible, and coaches could increase either behavior. However, if the CBAS and similar systems show a need to increase instruction, which sort should the coach now work on? In addition, just because athletes prefer one style over another, does it necessarily mean that it is the better option for the coach? The situation is therefore far from simple, and guidance to coaches must reflect this complexity.

Finally, the prescriptive nature of CBAS and similar systems has been called into question by several authors. The basis of CBAS applications are that any recommendations should emerge from data that differentiate good from bad coaches. It has been demonstrated, however, that the CBAS does not differentiate between expert and less expert coaches (e.g., Abraham, Collins, Smethurst, & Collins, 1997; Sherman & Hassan, 1984). In addition, the instructional recommendations come about predominantly because the CBAS essentially only measures direct styles of coaching (Sherman & Hassan, 1984). Thanks to criticisms such as this, there came a call to extend such overly simplistic observation systems (Sherman & Hassan, 1984; Streat, 1995).

To date this call has, unfortunately, only been heeded by a few researchers. Yet those who have followed this advice have all been able to show differences between levels of coaches. Markland and Martinek (1988) showed that players of more successful coaches received significantly more feedback. In addition, the more successful players of these coaches received more feedback than their less effective peers. This result was mirrored by Solomon et al. (1996), who, while investigating the self-fulfilling prophecy, found that head coaches and assistant coaches differed in the amount of feedback given. Head coaches would issue more feedback based on mistakes whereas assistant coaches delivered more positive feedback. Interestingly, this study used both the CBAS and an extended system, the COLE-DAS, and detected more differences with the latter.

Another study compared CBAS with an extended system in applications with expert and nonexpert tennis coaches. While only one difference was found using the CBAS (expert coaches used significantly more general communication), the extended system revealed four differences. Perhaps the most controversial finding of this study was that expert coaches would question more and instruct less than nonexpert coaches, appearing to contradict much of the earlier work on instruction (Abraham, 1997). Claxton (1988) got similar results showing that more successful tennis coaches would use more questioning.

However, although more differences are beginning to emerge from the behavioral literature, there is one remaining major criticism of the behavior tallying method. The underlying assumption of behavioral observation is that the less the coach knows about being observed, the less likely it is that bias will be introduced into the study (Dubois, 1981). But this assumption has been criticized by Franks, Johnson, and Sinclair (1988), who state, "we take the position that the observer needs to know the coach's objectives before the practice in order to determine whether or not the observed behavior is relevant to the intended task" (p. 24). In short, is what the coach doing appropriate to the aim of the session? This is a factor that has never been determined in other observation studies and yet must surely be

crucial if an evaluation of the coach's effectiveness is to be accurately completed. In addition, the nature of paper-and-pencil systems requires analysis to be carried out at a later date.

With these criticisms in mind, the same authors developed a computerized coaching analysis system, the Coach Analysis Instrument (CAI), which still produced quantitative data while also taking into account qualitative factors that can affect coaching behavior (Franks et al., 1988). However, there are two main problems with this approach. First, there is a distinct lack of studies using the system devised by Franks. Reasons for this are unclear, but it may well be that the cost of setting up the system has put off prospective researchers. Alternatively, achieving reliability using the system has produced problems (Johnson & Franks, 1991) that have only recently been addressed (More, McGarry, Partridge, & Franks, 1994). Second, the system is designed essentially for working in a one-on-one situation in providing intervention feedback to a coach. It may therefore prove difficult to gain generic recommendations using this system.

Development of Coach Expertise Using Behavioral Recommendations

The obvious proof in the pudding for the usefulness of any field of applied research is the application of findings from exploratory studies in interventional work. In a typical study of behavioral intervention, youth sport coaches were set a goal of increasing reinforcement to 25% of all behaviors (Smith, Smoll, & Curtis, 1979). This intervention was shown to increase self-esteem of young athletes. However, positive reinforcement is only one of many factors shown to affect youth participation (Boyd & Trudel, 1996). Of course, the finding is still an important one, as coaches are deemed to be significant others who will have an effect on a child's socialization process (Dubois, 1981) and participation in sport. Any improvement in either factor must be viewed in a positive light.

Unfortunately, the results are not so encouraging in settings where the philosophy of the coaching process may change, with older athletes or more competitive sports for example. Having been asked to increase her instructional behaviors from 14 to 30% of total behaviors, a high school coach found this target to be unachievable. The coach felt that the objectives of the coaching sessions used were not conducive to attaining the target (Krane, Eklund, & McDermott, 1991). Moreover, a senior swimming coach who was given a goal of increasing his reward feedback found that, on analysis of his behavior, he had achieved the goal but this had been at the expense of other behaviors. Since one of these other behaviors was instruction (Rushall & Smith, 1979), the coaching behavior described as the "prerequisite for effective coaching" (Lacy & Darst, 1985), the rationale for this change must be questioned.

As a final example, an intervention study using the CAI assessed four coaches on six behavior categories in practice settings (More & Franks, 1996). Following this assessment, interventions were set giving targets for these behaviors in future practice sessions. While all the coaches who received an intervention were meeting the targets set for them, they were not meeting them consistently and thus did not achieve "desirable changes" in the behaviors analyzed. The reasons given for this were that there may not have been enough reinforcement of the changed behaviors, a somewhat important factor in behaviorism! Also the differing aims of each follow-up session meant that certain targets were not always appropriate, a finding similar to the Krane et al. (1991) study.

Although the first study referred to here was successful to a certain extent, the success of the next three studies was questionable. Indeed, it is possible that the interventions in these studies may even have induced a performance decrement for the coaches involved. So why has there been such a lack of success? The answer may well lie in the comment made by Cratty (cited in Markland & Martinek, 1988), who stated that there is "no stereotypic coaching personality or set of behaviors which leads to success in coaching" (p. 299).

Many reasons are given in the literature as to why coaching behavior may vary. Mediating factors have included gender (coach and athlete) (Lacy & Goldston, 1990), team or individual sport (Claxton, 1988), age of athlete (Lacy & Darst, 1985; Seagrave & Ciancio, 1990; Wandzilak et al., 1988), type of sport (Claxton, 1988; Wandzilak et al., 1988), high- or low-expectancy athlete (Solomon et al., 1996), skill level of athlete (Lacy & Darst, 1985), starting or nonstarting player (Markland & Martinek, 1988), aims of the coaching session (Krane et al., 1991), level in coaching structure (Solomon et al., 1996), stage of the season (Lacy & Darst, 1985), coaching philosophy, and practice or game (Wandzilak et al., 1988). With such a huge number of degrees of freedom, a large degree of doubt must be placed on the ability to set specific targets for individual behaviors in order to improve and develop coaching expertise.

In all probability the expert coach is someone who can take account of these degrees of freedom (and any others yet to be researched), and still produce a coaching session appropriate to the player or players being coached. However, this expertise is not a function of increasing or decreasing certain behaviors. Rather it is a knowledge of making correct decisions within the constraints of the session. Thus coaching is not a behavior to be copied but a cognitive skill to be taught.

The Nature of Coaching Expertise Using Knowledge Assessment

Dissatisfaction with behavioral approaches to assessing coaches and the need to examine their knowledge led Jones, Housner, and Kornspan (1995) to state, "it is imperative that direct observation techniques be supplemented by methods for exploring the thought processes of coaches" (p. 203). However, even though this point of view is gaining credence, the research base in the area of knowledge assessment in coaching is limited at best. This limitation is partially countered when relevant research from physical education teaching is included. As with the behavioral literature, there appears to be no easy way to review the knowledge assessment literature in a systematic way. The method we have chosen here, bi-domain specificity, is not widely recognized in the literature, although some have loosely referred to it (e.g., Berliner, 1991), but it does seem to be an obvious method.

We stated earlier that expertise is very much domain specific. However, the expert coach is someone who must have expert knowledge in at least two domains. The first is a knowledge specific to coaching, that, is the knowledge required to set up optimal learning environments for their athletes. This knowledge should transfer well between sports since, in this case, the domain is always the same. The second domain is knowledge that is specific to a particular sport—the technique, tactics, mental skills, and physical attributes needed for that sport. Again some of this knowledge should transfer, to a smaller extent, between similar sports such as ball or racket sports (the full question of transfer will be discussed later).

Although domain-specific knowledge is not in question, there are to date no studies that have simultaneously assessed both sport and coaching knowledge when assessing or describing the expert coach. We would therefore offer anecdotal evidence of this bi-domain view from our conversations with coaches who often say, "I feel I could coach any sport as long as I knew enough about that sport." Further evidence relates to the large number of former professional athletes, who presumably have high sport domain knowledge (cf. McPherson, 1993) but yet fail as coaches.

Expertise literature examining coach-specific knowledge comes predominantly from a teaching background although there are a few coaching exceptions. Three areas of coaching have received attention: planning, knowledge structures, and reasoning. Jones et al. (1995) assessed the planning knowledge of novice and expert basketball coaches. They reported that expert coaches, when planning a session, would establish objectives, how they would achieve their objectives, and how they would evaluate attainment of these objectives in a far more focused way than novices. In a similar fashion, Griffey and Housner (1991) demonstrated that experienced teachers would ask many more questions before they would start planning. In addition, the experienced teachers were concerned with planning for any contingencies that may occur in a lesson.

The role of knowledge structures in physical education teachers has been examined by several authors (Ennis, 1994; Ennis & Mueller, 1991; Rink, French, Lee, Solomon, & Lynn, 1994). These studies typically assessed the knowledge structures of three levels of teaching experience, ranging from undergraduate student-teachers to full-time teachers with various years of experience. The methods used in these studies, concept maps, can provide data referring to how knowledge is stored and interconnected. Similar to the findings discussed earlier in the Nature of Expertise section of this paper, more experienced teachers store more chunks of knowledge, and these chunks contain more interconnected information. The interpretation of these results follows a developmental perspective, showing that the inexperienced teachers were in a stage of knowledge *accretion* while the experienced teachers were in the tuning or *restructuring* stage of learning, as described by Rumelhart et al. (1978). Finally, through interviews it was found that more expert tennis coaches have deeper and more complex reasoning for using various coaching tools to achieve their aim in a coaching session (Abraham et al., 1997).

The domain of sport-specific knowledge is even more sparse in the literature than that of coaching knowledge. The few studies that were completed have concentrated on assessing coaches' or teachers' knowledge of technique. A typical example is a study by Rutt-Leas and Chi (1993), who examined expert and novice swimming coaches' ability to describe a perfect technique and diagnose problems with the technique of several swimmers. The main findings were that experts had a superior "knowledge base," demonstrated as "amount of knowledge, connectedness of knowledge and depth of representation." Also, "Experts not only had more stroke findings, but these findings were embedded in more reasoning chains, longer reasoning chains, more clusters, and larger clusters thus supporting the experts' ownership of a more coherent knowledge base" (p. 90). Once again, this ties in nicely with the expertise work from nonsport areas discussed earlier. This finding is partially supported by the Block and Beckett (1990) study assessing physical education teachers specializing in throwing sports. While the specialists' verbal

descriptions were longer than those of nonspecialist teachers, the connectedness of this knowledge did not differ.

Each of these findings is confirmed in an excellent review of current research on teaching expertise (Dodds, 1994), namely that experts are able to extract more information from the environment and use this information in a more meaningful way. In addition the expert teacher's knowledge is more coherent, detailed, and organized.

Limitations of Coach Education Research

Although literature has exposed pertinent information about experts, some have expressed a few reservations. In the same review, Dodds presents a cautionary note that "Various criteria—such as years of experience; ratings by administrators, teacher colleagues, parents, or students; awards for teaching excellence; or observed process-product measures of effective teaching—have been informally triangulated to determine expertise in recent studies. Nonetheless, it is not at all clear that these measures can select expert teachers effectively, thus potentially undermining the soundness of any comparison studies, such as expert-novice contrasts" (p. 162). This sentiment is echoed by Rutt-Leas and Chi (1993), who state, "experience certainly does not always bring expertise" (p. 76).

Perhaps the most damning verdict was given by Housner and French (1994), who stated that "little attention has been directed toward generating descriptions of the substance or meaning of expert teachers knowledge, cognition or behavior" (p. 242). This statement is reinforced simply by asking ourselves, how does knowing that experts have more coherent and organized knowledge help the novice coach? Also, if the novice coach should ask more questions and plan for contingencies, what questions should be asked and what contingencies should be planned?

Apropos the present paper, if we are to present knowledge that will be useful to those who need to use it most, the coach educators, we must be able to answer three fundamental questions: What knowledge should we teach to set coaches on the path to expertise? What is the best way to teach this knowledge? And how can we assess this knowledge to encourage its development? At present, studies in the domain of coaching have consistently failed to answer any of these questions, a point reinforced, again by Housner and French (1994), who state that "debates concerning the relevance of any discipline, including pedagogy, are of little value until empirical research begins to unpack the contents of knowledge of expert physical educators and teacher educators" (p. 242). However, before pursuing these questions, perhaps we should answer the most basic one, namely, does coach education actually need help from research?

The Current Situation in Coach Education

Coaching awards, a common and now traditional feature of the British sport scene, now contain more information than ever. Not only does today's coach candidate need to know about coaching a skill but also, according to the various curricula of coaching courses, how to administrate, the political issues affecting sport, and the legal requirements of sport especially when coaching children. Obviously, however, the coaching and sporting knowledge domains should be central. Many candidates who take coaching courses will themselves have been coached. This generally means these candidates will go into a course with a set of beliefs about

coaching before they even hear the first instruction from their tutor. These beliefs can be very difficult to change, which is a problem if the beliefs are ill judged (Ennis, 1994).

Knowingly or unknowingly, this appears to have shaped the way in which coach education courses are run. Essentially, two methods of coach education have evolved. The most prevalent are courses that are run using an experiential approach; that is, candidates are put into a coaching situation wherein their approach to coaching is guided by their own beliefs. It is during this time that these beliefs are challenged and, hopefully, new ones are formed (Kolb, 1984). In other words, you learn from your mistakes.

From a cognitive viewpoint, beliefs represent very strong productions in procedural knowledge (cf. our comments made in the Theory of Knowledge section) about coaching. In the better courses, this procedural knowledge is challenged and, if found incorrect, it is weakened (Anderson, 1982). In the very best (and rare) practice, candidates are also exposed to *why* this is the case, producing new declarative knowledge. This source of declarative knowledge will help to form new, and in many cases more appropriate, procedural knowledge about how to coach. The whole process relies heavily on the novice coach having, or being taught, the ability to be critically reflective on coaching performance (Brookfield, 1995; Tripp, 1993). In addition, the process of weakening and thus forming new procedural knowledge takes a long time, a rare commodity in most basic coaching awards. So is this the optimal method for coach education?

Cross-questioning of coach educators, national governing body (NGB) directors, and other interested groups (e.g., National Coaching Foundation [NCF]; American Coach Education Program [ACEP]) reveals that the experiential process has been used because it is intuitively appealing and "obviously the right approach." After all, people learn best by doing, so get them in there doing it! There are problems, however, the main one being that intuition rarely tells the whole story. From a motor learning perspective, this is most easily seen in the case of practice. Experience would tell us that blocked, massed, or structured practice are the best forms of practice since they produce the most rapid behavioral changes. However, it has been shown (e.g., Schmidt & Bjork, 1992) that practice is somewhat paradoxical in its outcome. Blocked practice may produce large increases in skill over a short time, but these increases are usually very short lived. This is in contrast to varied and/or contextual interference practice which, in the short term, may even degrade performance but produces well-developed, transferable skills in the long term. The coach who learns experientially has therefore been let down by his or her intuition.

The alternative method used in some coach education courses has been to break sport domain knowledge, normally technique and tactics, down into very specific components. Coach candidates are then taught the "gold standard" of coaching each component. The problem with this approach is that, as noted, very rarely is there any one correct method of coaching. In addition, teaching coaches in this fashion fails to give them the ability to adapt, a crucial aspect of coaching. So which of these two aims best fits the specification for coach education? Do we need to quickly develop a large number of "method coaches" who coach by numbers? Or would NGBs prefer an adaptable, multimethod coach who is aware of the need to tune coaching style to meet the degrees of freedom inherent in the learning environment? Unfortunately, this process calls for a longer time scale because of

the amount of experience required to gain this ability. Obviously the best option is the latter, but can we cut down on the time scale?

Knowledge Content in Coach Education

When looking at what is taught in terms of declarative and procedural knowledge on coach education courses, it is likely that procedural knowledge is the aspect getting the most attention. However, it is still important to look at the coaching and sport-specific domains. The sport domain normally has a large emphasis on skill technique, closely followed by game tactics. These aspects are well covered in course handbooks and coaching literature that candidates are encouraged by the instructors to read. Indeed, in the past this would have been the full extent of many courses, a case of, "Well, now that you know about technique and tactics, go and pass that on to your athletes. You should be okay as long as you have the natural flair for the art of coaching." This approach, fortunately in decline, considers only sport related knowledge and reduces coaching prowess to a selection issue. In other words, you get effective coaches if your process selects the candidates with good natural talent.

As this becomes less the case, it is increasingly recognized that you can, indeed must, develop a candidate's coaching knowledge. However, the bulk of knowledge that is passed on to candidates is procedural which, if declarative knowledge is to be gained, must then be explicitly critiqued. Example procedural statements such as "this drill is really good for practicing this skill" are common. Unfortunately, those who critique such ready-made knowledge are few.

In addition, the process of providing procedural knowledge has also been termed dangerous (Anderson, 1982). If a snippet of procedural knowledge given to a novice coach works extremely well in one instance, for example a drill, the same coach will of course try to use this knowledge in a variety of other situations. Yet such discriminative procedural knowledge, as referred to earlier, comes about through the accretion and tuning of a great deal of declarative knowledge that has been used to clarify very specific conditions under which very specific actions take place. Therefore, unless the (conditional) declarative knowledge of the drill is known (athlete's age and skill level, the specific aims of the session, time to competition, etc.), a valued judgment cannot be made about this drill. This is almost certainly likely to initiate an inappropriate use of the drill which ends with the drill failing to do what it was intended for.

Many coaches will empathize with this occurrence. Accordingly, effective coach education must explicitly challenge candidates to rationalize, and critically reflect on, the particular blend of coaching tools that have been used. Indeed, such a rationalization should also play a central role in the evaluation process since in no other way can the educator check on the candidate's capacity to tune sessions to fit athletes' needs.

In the UK, the National Coaching Foundation plays a major role in supplying knowledge content for the education of coaches. This organization runs a series of key courses for coaches from many sports, and the courses play a key role in most sports coach education structures (Campbell, 1986). This shows an understanding that the domain of coaching knowledge is fairly generic across sports. However, the delivery of these courses may not be via the optimal method. The breadth-first delivery discussed earlier is thought to be a better method for the delivery of information where there is no easy route to solving problems, as is

certainly the case in coaching. The breadth-first method of teaching allows for a “scaffolding” to be built from which more in-depth information may be hung, thus creating a good environment for cross-referencing and linking of information between concepts (Zeitz & Spoeht, 1989). The key courses run by the NCF are taught in a depth-first approach, which *may* allow for some cross-linkage between coaching concepts but probably not to the same extent as a breadth-first approach. Certainly this cross-indexing is not a key feature of the course outcomes. The American ACBP seems to employ a similar approach.

Of course, a breadth-first approach would inevitably limit the amount of specialized knowledge that could be put across in a single sitting, which is not a cost-effective method. However, as a bare minimum, breadth-wise links should be made before delivering specialized knowledge. The disappointing influences of such courses in changing coach behavior, which are anecdotally supported (an accurate, objective evaluation is still awaited), may well be due to the adoption of the depth-first style.

So, with coach education perhaps not performing to the best of its ability, how do we produce so many world renowned coaches? Well obviously the courses must be providing a certain level of knowledge, and the experiential method of learning can be a good one. However, the coaches who make top billing are those who are truly reflective (Abraham, 1997), and this trait is an essential prerequisite for the experiential approach to be effective. A second problem is that a purely experiential approach can mean that incorrect declarative and procedural knowledge is learned, with subsequent problems and often no possibility of modification. Finally, it can take years of experience to even approach expert-coaching-domain knowledge, since it takes years for coaches to experience the variety of challenges needed to teach the necessity of varying the approach. All of these problems must be addressed if we are to improve the standard of coach education.

Recommendations for Development of Expertise

What Knowledge Should We Teach?

So what are the answers to the three fundamental questions posed earlier? The first question—what knowledge should we teach?—needs to be tackled by formulating as closely as possible the declarative and procedural knowledge of coaching. As stated earlier, coach educators need to know what knowledge to teach. If this knowledge can be found, it may be possible to knock years off the current time requirement for attaining expertise. Coaches would not need to reflect to gain declarative knowledge but rather should be able to reflect *on* declarative knowledge to improve procedural knowledge.

This process may not be as difficult as it appears. We pointed out that researchers may not be gleaming as much information from their use of concept maps and interviews as perhaps they might. Some adjustments could be made to these methods to distinguish declarative and procedural knowledge. Concept maps produce large lists of words relevant to a particular domain, and the individual draws inferences of knowledge accumulation from the relationships displayed between these words. Indeed, this method has been used to check the development of declarative knowledge (Ennis & Mueller, 1991). However, we contend that in fact these words mean little in terms of knowledge content. But if the question

were asked how these words are used in practice and how they link to other words, much declarative and procedural knowledge will be gained. In a similar fashion, if, following these “how?” questions, “why?” was also asked, further declarative knowledge (the “why?” knowledge) would also be gained. This method does need further investigation, although “think aloud thoughts” or interviews can also be useful tools for gaining declarative and procedural knowledge and has already been investigated by Ford and Wood (1992).

Perhaps the easiest source of declarative and procedural knowledge in coaching is the extensive motor learning literature that exists. It has already been shown, through the principles of blocked versus varied practice, that this literature not only complements the knowledge of coaches but in many cases can also add to it (Christina & Bjork, 1997). In our experience, this can even apply to very experienced and high level coaches. Perhaps the intuition, knowledge, and real-world experience of expert coaches, combined with motor learning literature, could produce an extensive and highly specialized declarative and procedural knowledge base. This would represent a transfer of theory into practice on two counts. In the first case there would be transfer of cognitive theory into educational practice, and in the second case there would be the transfer of skill acquisition theory into coaching knowledge practice.

How Should Knowledge be Taught?

The second question is, what is the best way to teach and implement this knowledge? There are two outcomes involved here: knowledge should be well developed and transferable. If we take the latter outcome first, there are two schools of thought about knowledge transfer. In the opinion of Anderson (1982, 1987), transfer is very specific and only occurs when proceduralized productions are shared in a skill. This is evidenced in this review by the drill that worked well for one coach but not for another, probably since this drill would have been specific only to the athletes being coached. However, another theory put forth by Pennington, Nicolich, and Rahm (1995) is that declarative knowledge is the most transferable form of knowledge. Again going back to the “borrowed” drill idea, using this theory of transfer these authors would argue that if the borrower had known the original coach’s declarative reasoning as to why the drill worked for her, this reasoning could have been exploited to enable adaptation so that the drill would transfer to the new situation.

We hypothesize further using the theory of weak-method problem solutions proposed by Anderson. This theory proposes that, when we encounter novel situations we apply weak problem-solving procedures such as “analogy, trial and error search, or means end analysis” (Anderson, 1987, p. 206). These procedures are in essence very broad transferable problem-solving procedures. We contend that such procedures are also formed in domain-specific settings. An example from coaching may be “coach for athlete understanding,” a procedure that should transfer to many coaching situations, especially in light of findings that expert players have more expert knowledge of the game being played (McPherson, 1993; Thomas & Thomas, 1994; Williams & Davids, 1995). Obviously this procedure is difficult to implement without the relevant declarative knowledge to back it up, but the reverse is probably also true.

So, it would appear that teaching broad procedural knowledge (e.g., generalized productions) and declarative knowledge would produce transferable

knowledge, but what is the best way to develop it? The most obvious way would be to take the best of both the cognitive and experiential worlds. This is essentially to teach broad problem-solving procedures along with declarative knowledge in a breadth-first fashion while combining with the important features of experiential teaching such as reasoning through decisions and critically reflecting on coaching performance (cf. our earlier comments on the need for explicit evaluation of these skills).

A further consideration is that procedural knowledge is best gained through “doing” (Anderson, 1982). In coach education, this usually means bringing in “guinea pigs” to educational courses to be coached by each candidate for a short time. There is obviously a problem with this method in that it does not allow the long-term relationship found in good coaching. This also means that coach candidates rarely come up against performance blocks, bad days, etc., which are also a feature of the normal coach/athlete relationship. This problem has been recognized in teaching. One potential solution given is that *If-then* or *What-if* scenarios can help induce the reality of problems of coaching and thus help teachers prepare for the worst using contingency plans (Tjeerdsma, 1995).

Perhaps the biggest problem facing the coach educator when developing new knowledge is that inappropriate beliefs already held by the novice coach must first be weakened. Changing inappropriate beliefs and influencing the acceptance of more correct beliefs is a problem Graber (1996) tackled when investigating a “high impact” approach to teacher education. This approach had previously been shown to produce students whose previous “incorrect” beliefs had changed dramatically, giving way to new beliefs which the students retained once they entered the workplace. The nature of this approach was for all participants of the program who would influence student learning, the instructors and the schools, to “sing from the same hymn sheet” so that the same message was consistently put across. This coherent environment was reinforced at every opportunity, not only by the instructors and schools but also within student groups working together on shared goals.

If a similar methodology of coherence is to be transferred to a coach education system using a cognitive/experiential approach, it is imperative that instructors and, where applicable, mentors know what is required of them to make the approach work. Certainly a coherent approach appears to be crucial for, and discriminatory between levels of, performance in other domains such as decision-making in team sports (Mortimer & Collins, 1997).

A final and perhaps controversial statement is that all of this should be delivered as early as possible if sturdy “scaffolding” is to be erected. However, implementing the ideas discussed here would require a significant amount of time. This would certainly contradict the pattern of coach education in the UK, that is, the lower down the coaching structure you go, the shorter the course. Rather than being the shortest course, the first basic coaching award should be one of the longest!

Assessing to Encourage Learning

At first this would appear an unusual question to ask. Yet when we consider the importance of assessment, the relevance of this question does become apparent. Assessments not only provide a measure of a candidate’s ability but also strong motivation and direction as to what should be learned to pass a course. The standard methods of assessment used in lower coaching awards at present are continual

assessment through observation, short-answer essays, and multiple-choice quizzes that are usually supplemented, in higher coaching awards, by a project and/or log books. The problem with these assessments is that they only tend to assess procedural (doing) knowledge (Abraham & Collins, 1997). They do not fully investigate a candidate's understanding of coaching (doing), that is, their declarative knowledge. Although there may be much resistance to the idea, a written assessment of some sort may provide an effective, standardized, and objective solution to this problem. While this method allows declarative and procedural knowledge to be assessed in a timely fashion, it also has the added bonus of motivating and directing candidates to learn both procedural and declarative knowledge.

Summary

Although the development plan put forth in this paper has been drawn from empirical research from various domains in cognitive and educational psychology, there is no direct evidence that the plan will transfer to the domain of coaching. For example, the breadth-first approach to teaching declarative knowledge appears to be correct, but until research looks at comparing breadth- versus depth-first approaches, a definitive statement cannot be made. However, it is hoped that, even with this cautionary note in mind, this paper will stimulate fellow coaching researchers to "grasp the nettle" and start producing findings that are of demonstrable use to, and are adopted by, those who need them most—the coach educators and coach candidates. At present this means producing findings that develop the content and process of educational experiences to help novices progress toward expertise. Following this, researchers need to produce findings that help monitor this progress and can yield guidelines that help NGBs determine which of their coaches are expert.

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Acknowledgments

We gratefully acknowledge the financial and technical support of the Lawn Tennis Association in the completion of this research.