

**How could process-oriented research approaches capture the interplay between training and competition in athlete performance preparation? The contribution of ecological dynamics**

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1 **Abstract**

2 Analyses of training or competition environments traditionally tend to adopt a product-oriented  
3 perspective through the recording and statistical analysis of performance outcomes.  
4 Consequently, most investigations continue to ignore the *processes* underpinning functional  
5 achievement of outcomes, therefore, failing to examine contextual effects of how and why  
6 performance evolves. This critical research note highlights the need for sport psychologists,  
7 pedagogues, and other applied scientists to consider a range of alternative methodological  
8 designs for research to monitor and explain processes inherent to performance preparation and  
9 athlete development. These process-oriented designs require the continuous flow and exchange  
10 of performance data between training and competition, mediated by practitioners' experiential  
11 knowledge. We endorse a triangulation of information defined as a 'competition-coach-  
12 training' triad which needs to be better acknowledged. Redirecting the focus of practice and  
13 research away from a product-oriented (driven by broad statistical data patterns), towards a  
14 process-oriented perspective (examined through in-depth contextual analyses) may re-calibrate  
15 the theory-practice alignment.

16

17 **Keywords:** process-oriented approach, athlete development, contextual analysis, performance  
18 analytics, mixed-methods research, ecological dynamics

1 **Highlights**

- 2       • Performance analysts could adopt a process-oriented approach to athlete development
- 3       • Advances in mix-methodological designs could contribute to research innovations
- 4       • Athlete-environment interactions during performance must be better acknowledged
- 5       • Coaches' experiential knowledge can mediate practice designs using competitive data

6

7

## 1 **Introduction**

2           In seeking a better understanding of how to develop and prepare athletes and teams for  
3 competitive sport, applied scientists typically acknowledge the importance of integrating  
4 information between performance in training and competition. For example, a key issue  
5 concerns the implementation of the longstanding principle of practice specificity (Henry, 1968)  
6 related to the importance of designing practice tasks aligned with competition demands.  
7 Specifically, the training specificity hypothesis proposes that, as the constraints of learning  
8 designs approximate those of competition, there are greater opportunities for a positive transfer  
9 of learning (Tremblay, 2010). Without neglecting the contribution of other psychological  
10 approaches, which have sought to enhance knowledge in sport performance research, the  
11 concepts of ecological psychology, by considering the mutuality of the of individual-  
12 environment relationship, have enhanced understanding of practice and training processes  
13 underlying performance outcomes. For example, associated with practice specificity, the  
14 ecological concept of *representative design* (Brunswik, 1956) has gained prominence in  
15 protocols for competitive sport performance preparation. Representative learning design  
16 suggests the inclusion, in task designs, of similar informational constraints characteristic of  
17 competitive environments (Pinder et al., 2011). Here, *constraints* refer to information that  
18 shapes the emergence of athletes' performance behaviours , providing them with opportunities  
19 for action (i.e., affordances (Gibson, 1979). Information from rules, equipment, surfaces,  
20 objects, events and other athletes are examples of constraints that may induce different action  
21 opportunities.

22           The building of representative designs challenge practitioners to sample the most  
23 relevant information sources from competition considering the age, maturation, sex, and skill  
24 levels of athletes (Woods et al., 2019). Through their experiential knowledge, based on learning  
25 over years of practical experience and reflection (Nash & Collins, 2006), practitioners may

1 record, retrieve and interpret competitive performance data, distilling it to guide athlete(s)-  
2 environment interactions in representative designs. An ecological dynamics framework  
3 proposes that practitioners can achieve this aim by helping athletes to perceive and utilise  
4 relevant affordances in the environment (Greenwood et al., 2013). From this rationale, a major  
5 task for applied scientists is to develop evidence-based methodological designs which enhance  
6 understanding of the *training processes* underlying the achievement of *outcomes* in  
7 competition. Here, we advocate and conceptualise a *process-oriented approach*  
8 for performance preparation interventions to design representative practice programmes  
9 adjusted to individual athlete needs. In these process-oriented practice designs, individualised  
10 opportunities for action may be embedded in preparatory performer-environment interactions  
11 prior to competition. From an ecological conceptualisation, processes refer to *why* and *how* a  
12 set of task constraints may be manipulated during practice by sport practitioners, supporting the  
13 emergence of intended technical, tactical, physical and/or emotional outcomes.

14 Elsewhere, we have argued that a process-oriented approach to designing athlete  
15 interactions is fundamentally based on *knowledge of* the performance environment (Ramos et  
16 al., 2020), which Gibson (1966) distinguished from *knowledge about* the environment. He  
17 clarified that “...a distinction [can] be made between *perceptual cognition, or knowledge of the*  
18 *environment, and symbolic cognition, or knowledge about the environment. The former is a*  
19 *direct response to things based on stimulus information; the latter is an indirect response to*  
20 *things based on stimulus sources produced by another human individual. The information in*  
21 *the latter case is coded; in the former case it cannot properly be called that.*” (Gibson, 1966,  
22 p. 91).

23 In sport, *knowledge of* the performance environment helps support athletes’ learning and  
24 performance by facilitating the construction of individualised relationships between  
25 knowledge, perception, and action to facilitate their ongoing interactions in competition (Araújo

1 et al., 2019). In turn, *knowledge about* the environment may be provided by an external agent  
2 to describe the environment. This type of knowledge helps support verbalised responses in  
3 problem-solving and decision-making through mediation of language, abstract symbols, and  
4 instructions (Gibson, 1966). Specifically, Ramos et al. (2020) highlighted how *knowledge of*  
5 the performance environment is continuously needed in preparation, used by athletes to regulate  
6 their interactions with its problems, events, tasks and challenges during competition. In  
7 contrast, *knowledge about* the environment is more abstract, descriptive, and can be more easily  
8 symbolically coded, underpinning the capacity to describe or verbally respond to questions  
9 about tactics and strategies. This type of information is over-relied upon by sport commentators,  
10 traditional instructors, coaches and data analysts. The clear implication of Gibson's (1966)  
11 distinction for sport science is that performance analytics data should be interpreted and used  
12 to develop players' *knowledge of* the environment in a process-oriented way. Doing so,  
13 practitioners could enrich their monitoring and evaluation of continuous athlete-environment  
14 interactions in performance preparation.

15 For instance, in a volleyball training application, if notational data from performance  
16 patterns in competition reveal low values of blocking success percentages for a team,  
17 subsequent training sessions could address this issue in diverse and gradual ways, providing  
18 affordances for: (i) players to individually coordinate their block actions as a function of  
19 different attacking tempos (constraint of time); (ii) players' blocking actions to emerge as  
20 function of the opposition setter's tactical decisions, integrating the block action into tactical  
21 game scenarios (constraints of time and space); and (iii) designing full team practices in which  
22 successful block actions are double-scored (narrowing applications of time-space blocking  
23 actions into game contexts representative of competition). Here, the richness in analysing the  
24 performance preparation and development *process* requires an in-depth examination of *how*  
25 sport practitioners use statistical competitive performance data to support their practice designs.

1 Thereby, research needs to explore why coaches design specific types of performance  
2 preparation tasks, and how their interventions could be adapted as the needs of athletes and  
3 demands of competition change. Notwithstanding its relevance, there are several barriers  
4 inhibiting the progress of this *process-oriented approach* to applied sport science research.

5 First, despite the need for a clear association between training and competition data,  
6 applied scientists have tended to investigate these contexts independently (Ribeiro et al., 2020).  
7 This de-compartmentalisation of research on practice and competition contradicts the  
8 assumptions behind the aim to enhance competitive performance. Furthermore, it also refutes  
9 spractitioners' use of data from competitive performance to improve training designs, to satisfy  
10 athletes' needs, and to potentiate further performance outcomes. Also, such a separation  
11 provides a lack of clarity on how performance and practice contexts mutually shape each other,  
12 raising important questions, like: Is the way a team trains closely aligned with how it competes?  
13 During training sessions, are competitive constraints faithfully represented in practice tasks? A  
14 broader question is posed over whether performance during practice may, or not, be a valid  
15 indicator of athlete learning. Indeed, Whiting (1975) proposed a long time ago that *learning* is  
16 difficult to directly observe, evaluate and confirm, whereas *performance* is much easier to  
17 observe, although the latter may or may not be indicative of the former. Moreover, he  
18 highlighted that, at the heart of the confusion between performance and learning, lies the need  
19 to distinguish between performance *outcomes* and *processes* when investigating whether  
20 learning has emerged as a result of practice and experience (Whiting, 1975). These words of  
21 caution signify the need to carefully interpret data from both, competitive performance and  
22 observations during practice, when seeking to understand the effectiveness of learning designs  
23 on athlete preparation and development.

24 Second, constraints on competitive performance have increasingly been investigated  
25 using notational methods (Lord et al., 2020). This method documents action frequencies in a



1 'what-where-when-who' sequence of analysis, for instance indicating that one football player  
2 has successfully completed fifteen out of twenty passes attempted during offensive transition-  
3 phases in a match. Despite its relevance, this *data-driven*, statistically-oriented approach runs  
4 the risk of falling into a reductionist and linear cause-effect vision of competitive performance  
5 (Araújo et al., 2021). Over-relying on statistical outcomes, the emergent nature of continuous  
6 performer-environment interactions with competitive surroundings is often disregarded. An  
7 implication of these ideas is that a powerful theoretical framework is needed to support the  
8 utilisation and interpretation of performance data for the design of pedagogical practice (Araújo  
9 et al., 2021). Because team sports may be viewed as complex dynamical systems (those formed  
10 of multiple elements (athletes), whose interactive relations evolve over different timescales),  
11 performers' interactions in competition are emergent, leading to adaptive transitions in system  
12 states. The dynamical property of *emergence* helps teams to rapidly co-adapt to dynamics of  
13 the competitive environment, facilitating achievement of intended performance goals  
14 (Travassos et al., 2013). Although these team properties are challenging to measure using  
15 traditional analytic methods, they can be captured and analysed through nonlinear measures.  
16 Particularly, nonlinear metrics quantify the relationship, or dependency, of data in a time series,  
17 describing their patterns or structures (Harbourne & Stergiou, 2009). In this respect, the  
18 ecological dynamics framework has conceptualised and empirically explored how nonlinear  
19 performer-environment interactions continuously evolve to shape sport performance (Araújo et  
20 al., 2021; Davids et al., 2015).

21 Third, an ecological paradigm has been adopted using cross-sectional designs framed  
22 upon positivist research premises, in which interventionist protocols are implemented over the  
23 first or last 20 mins of training sessions (e.g., Oppici et al., 2018). Interestingly, research has  
24 demonstrated that changes in short-term performance are frequently unrelated to long-term  
25 learning, creating a powerful illusion of competence (Björklund, 2013; Soderstrom & Bjork,

1 2015). Indeed, modelling and investigations from an ecological perspective have shown how  
2 performance during learning over short timescales can look messy, noisy and highly variable,  
3 although looking smoother over longer timescales (Newell et al., 2001). Empirical data reported  
4 by Newell and colleagues (e.g., 2001) have important implications for how academics and  
5 coaches could view the relational timescales for interpreting *performance outcomes* and  
6 *learning*. However, in understanding sport performance and practice, further work is needed to  
7 explain and interpret effects of ecological assumptions on athletic performance. To support this  
8 advance in research, it is vital to consider the *training process as a whole*, taking into account  
9 the global training context and structure, and re-designed learning tasks throughout extended  
10 timescales.

11 Fourth, many empirical investigations, despite innovative, explicitly require in their  
12 research designs that coaches do not provide any feedback to athletes (e.g., Travassos et al.,  
13 2018). This requirement is not representative of pedagogical practice since the coach's role is  
14 reduced to a mere prescriber of training tasks. This reductionist pedagogical position has been  
15 broadly criticised because coaches are not allowed to be actively engaged in athlete  
16 performance development (Robertson et al., 2019). Indeed, sport practitioners have a significant  
17 role in helping athletes to understand what to do in order to improve their interactions with a  
18 performance environment. For instance, using interrogative feedback, the coach could scaffold  
19 an individual's actions without compromising their autonomy in building their own knowledge  
20 of the environment. Recently, Ribeiro et al. (2020) showed how pedagogical principles of  
21 ecological dynamics asserts that a subtle balance is continuously needed to provide *local* athlete  
22 interactions, supported by *global* coach guidance, so that functional and adaptable coordination  
23 tendencies could emerge in performance.

24 Overall, these critical issues illustrate how some competition-training informational  
25 linkages in pedagogical practice may be currently dysfunctional, giving rise to the following

1 overarching questions: (i) Has sport science research focused enough on the relevance of *how*  
2 practitioners use competitive data to interpret practice and its effects on performance over  
3 longer timescales? This mutual interaction between *product-process* oriented data could favour  
4 an interpretative analysis about *how* performance can be developed over-time, rather than  
5 focusing on *what* performance outcomes can be immediately achieved; (ii) Have prevalent sport  
6 science research designs been appropriately aligned with the need to understand how athletes  
7 prepare to compete? (iii) What role may coaches' experiential knowledge (CEK) play in driving  
8 competitive performance preparation and athlete development? and (iv), Can CEK emphasise  
9 the links between theory and practice within an applied sport science context?

10 To consider these issues, research needs to focus on understanding the relations between  
11 performance achievements as end products of a dynamical learning process. Applied sport  
12 science research needs to focus on examining how competitive performance preparation is  
13 planned, implemented, and adapted to help individual athletes develop and prepare to face  
14 demands of competing. Specifically, it is worth examining why, and how, sport practitioners  
15 design training sessions within programmes, as well as the implications of these design  
16 processes for preparing athletes to perform in competition. In this critical research note, we  
17 highlight the importance of considering the nuanced interplay of information between  
18 competitive and performance preparation data, within an ecological dynamic framework. We  
19 seek to examine the methodological implications of evaluating, elaborating and refining the  
20 performance-preparation relationship in future research. Accordingly, we start by scrutinising  
21 how competitive performance data can guide coaching processes during athlete preparation for  
22 performance development and competitive performance. Next, we propose alternative  
23 methodological research designs so that future applied scientific studies can monitor, explore,  
24 and examine in-depth the processes underpinning performance development. Finally, we

1 discuss the role of CEK and sport practitioners in bridging practice and theory for the purposes  
2 of enhancing sport performance and athlete development.

3

#### 4 **Using data analytics in performance preparation: Opportunities and barriers to athlete** 5 **performance enhancement**

6 Generally, performance analytics can inform practice designs by: (i) providing feedback  
7 about previous competitive performances, (ii) advising on critical events, features and/or  
8 performance tendencies that may arise during future competitions, and (iii) offering feedback  
9 for designing representative training sessions (Araújo et al., 2021; Eccles et al., 2009; Woods  
10 et al., 2019). Framed upon competitive performance data, practice programmes broadly have  
11 two overarching interventionist purposes: coaching for athlete development and coaching for  
12 competitive performance.

13 The focus of *coaching for athlete development* is on the enrichment of athlete skills and  
14 expertise over time. In contrast, *coaching for competitive performance* aims to achieve  
15 successful performance outcomes, such as winning a competition. Overlapping at times, from  
16 novice to expert stages, the relationship between performance and development can be observed  
17 at different levels of accomplishment and varied scales of analysis (see Otte et al., 2021;  
18 Sullivan et al., 2021; Wormhoudt et al., 2018). Acknowledging the importance of competitive  
19 performance, from a macro-scale of analysis during athlete development pathways, the main  
20 focus should be on supporting athlete development. Indeed, such a standpoint avoids the  
21 (mis)treatment of children and youth as ‘mini-adults’. At expert performance levels this  
22 relationship is never eliminated, but re-prioritised to place greater emphasis on competitive  
23 performance. From a meso-perspective, when coaches are structuring their weekly practice  
24 micro-cycles, the beginning of the week is commonly dedicated to athlete and/or team  
25 development. Later, competitive performance demands become more prominent closer to a  
26 competitive event. At a micro-perspective, training designs starts involving athlete

1 development, ending in preparing individuals for competitive performance in collective tasks.  
2 To exemplify, training sessions often start by addressing a tactical problem for each team sub-  
3 unit and ends with all the sub-units being integrated in a full-game practice, intentionally  
4 constrained by specific conditions to readdress the initially identified problems.

5 To support performance preparation, sport practitioners have used notational analysis  
6 for decades to structure training content (Lord et al., 2020). However, by correlating action  
7 frequency with final performance outcomes, like score or error, the processes underpinning  
8 continuous and dynamic athlete-environment interactions are often disregarded (Duarte et al.,  
9 2012). To deal with this issue, the ecological dynamics framework, aided by non-linear metrics,  
10 such as sample entropy or relative phase, have been used to explain how such dynamical  
11 interactions constrain the emergence of different game patterns (Marcelino et al., 2020).

12 By cross-sectionally analysing the impact of isolated experiments, investigations have  
13 provided detailed and relevant information about how constraints manipulations affect sport  
14 performance (e.g., Travassos et al., 2018). However, a challenge for such studies has been how  
15 to consider the representative design inherent to effective competition-training interactions.  
16 Furthermore, despite seeking to focus on athletes' needs, these empirical studies have rarely  
17 considered or reported *why* specific task constraints were manipulated, neither its relevance for  
18 athlete development and performance preparation. The result is often ineffective and inefficient  
19 practice designs for athletes and decontextualized data for coaches. In this regard, Fullagar et  
20 al. (2019) argued exactly that practitioners have lamented that research questions remain  
21 misaligned with coaches' needs for implementing scientific evidence into practice. Indeed, the  
22 representative design of practice in coaching needs to be carefully considered since learning  
23 and performance development is athlete-dependent. Both processes emerge over different  
24 timescales based on athlete needs, intentions, and interactions with the environment and not  
25 necessarily when coach desires. Thereby, the focus of teaching-learning processes should be

1 athlete-centred (Ennis, 2014). Here, the athlete is placed at the core of the learning process,  
2 playing an active role in building their knowledge of, and skills for, competitive performance.  
3 Thereby, sport practitioners can assume the role of learning facilitator, for instance by setting  
4 challenges, problems or goals, simplifying or complicating learning tasks, and providing  
5 opportunities for learners to seek performance solutions within a representative practice design  
6 (Dyson et al., 2004).

7         Because of these methodological issues, the processes inherent to holistic performance  
8 development have been somewhat overshadowed by the intrinsic competitive nature of sport.  
9 Nevertheless, this product-oriented approach, captured frequently in the form of generalised  
10 recipes or quick fix programmes, may not lead athletes towards long-term personal  
11 development and learning (Soderstrom & Bjork, 2015). Countering this trend requires the  
12 retrieval of accessible information from competitive performance that considers the interactive  
13 nature and complex character of the environment so that training designs can be more  
14 representative of competition (Araújo et al., 2021). There is also a need to examine training as  
15 an *individualised holistic process* to fully understand how practice may be designed to support  
16 each athlete's needs in competition. The (re)establishment of competition-training retroactive  
17 feedback requires in this vein a re-orientation from a *product* to a *process* perspective.  
18 Specifically, it entails moving from an outcome-oriented to an emergent-behaviour rationale  
19 underpinning practice design. The reverse of this trend can be supported by adopting an  
20 ecological perspective, an interpretative paradigm, and inductive reasoning, as we next address.

21

22 **What can we do in future research investigations into the performance-practice relation?**

23 **– Redefining methodological routes**

24         Sport is a largely social phenomenon, and therefore, the paradigm adopted for its  
25 analysis must be aligned with its human (i.e., social and cultural) context (Giulianotti, 2016).

1 The well-established interpretative paradigm (Carr et al., 1994), more popular in the social  
2 sciences and humanities, should play an important role in this respect. An interpretivist  
3 approach advocates an inductive reasoning that seeks to make broad generalisations from  
4 specific observations. Specifically, many events are observed in detail, patterns are discerned,  
5 and explanations are inferred by individuals seeking to maintain objectivity, while recognising  
6 the inherent subjectivity of human experience (Klauer, 1992). The main advantage of the  
7 interpretative paradigm is that it tries to understand a phenomenon in-depth, such as the  
8 meaning of athletes' behaviours within a particular performance context (Smith & Sparkes,  
9 2018). Here, we advocate *inductive reasoning* to comprehend the training process, instead of a  
10 deductive reasoning that seeks to explain performance outcomes as products. However, to  
11 achieve this change it is essential to reformulate traditional research designs. Next, we propose  
12 several somewhat innovative ideas that could (*and perhaps should*) be included in the research  
13 designs of future investigations.

14 First, regarding data analysis in competitive performance, there is a need for more  
15 longitudinal investigations with ongoing tracking of '*dynamic performance-analysis*'.  
16 Specifically, the selection and recording of performance variables is most relevant, with the key  
17 performance indicators being used to underpin designs of training contexts. As athletes train to  
18 compete, the information retrieved from analytics of competitive performance must be aligned  
19 with what was intended to be achieved. For that purpose, we endorse the integration of  
20 nonlinear metrics, like the cluster-phase method (Richardson et al., 2012), with robust and  
21 linear statistical methods. Adopting a nonlinear methodological approach would ensure that  
22 information collected is representative of the competition environment. Such approach  
23 considers the complexity of athlete(s)-environment interactions, without fragmenting them into  
24 a discrete set of cumulative statistical procedures that disregards the ecology of performance.  
25 Later, follow up comparisons and/or inferences from data may be analysed with linear

1 procedures. Finally, applicable and relevant information can be shared by practitioners. To  
2 exemplify, Ribeiro et al. (2020) used a multilevel hypernetworks approach to collect data on  
3 player-simplice synchronies in two distinct performance conditions. First, they assessed the  
4 ecological dynamics of play, adopting nonlinear procedures, namely using cluster-phase  
5 method and sample entropy. Then they followed up these observations by testing effects on  
6 synchronies of both conditions using a conventional statistical analysis such as univariate  
7 analysis of variance.

8         Second, we recommend a greater focus on implementing Action-Research (AR) designs  
9 (Lewin, 1946). The AR is characteristic of a process-oriented interpretative paradigm, which  
10 have rarely been applied to sports training contexts (e.g., Ramos et al., 2020). Studies focused  
11 on understanding sport performance enhancement could benefit from this design given its  
12 cyclical, interventive and reflexive nature (Ollis & Sproule, 2007). In fact, AR affords the  
13 capacity to monitor, assess and intentionally adapt coaching interventions designed to develop  
14 performance over extended time-periods. Also, aligned with interpretative approaches, the  
15 adoption of qualitative research designs could unearth unique information, like the ‘hows and  
16 whys’, for sport practitioners. For instance, through qualitative analysis, McCosker et al. (2019)  
17 extended our understanding of how elite long jump athletes adapt their actions during  
18 performance in structured competition. Thus, the authors offered to sport practitioners some  
19 insights on how elite athletes regulate their performance behaviours while interacting with  
20 different competitive contexts, highlighting the perform, respond, and manage contexts of  
21 performance.

22         Third, and perhaps the most innovative idea, we suggest the integration of nonlinear  
23 metrics and linear statistics within an interpretative approach to extend the comprehension of  
24 observations. For instance, Ramos et al. (2021) analysed the development of competitive sport  
25 performance over three AR-cycles implemented throughout a sport season. They used nonlinear



1 metrics to collect information about how performers ongoingly synchronized tendencies in  
2 competition, and traditional statistics to compare such interactions at different periods over the  
3 season. Adopting a collaborative and interventive approach, within a qualitative interpretation  
4 monitored over time, they described and explained the main events that dictated changes in  
5 collective performance. Doing so, they emphasized the essence of a *process-oriented approach*.

6 Despite the methodological designs exemplified, these studies currently represent  
7 exceptions, and not a trend, within the field of sport performance research. Redirecting research  
8 focus towards *process* analysis to guide interpretation, understanding and explanations of  
9 performance *outcomes* remains thereby urgent.

10

### 11 **Coach's experiential knowledge (CEK): The secret ingredient disregarded by current** 12 **research designs**

13 Implicitly embedded in athlete development, coaches are undeniably orchestrators of  
14 performance preparation (Jones & Wallace, 2006). Being responsible for the process of  
15 preparing athletes to accomplish superior outcomes, coaches frequently analyse competitive  
16 data, interpreting it based on their experiential knowledge acquired over years of practice and  
17 reflection (Woods et al., 2020). As such, the CEK can be considered a crucial ingredient within  
18 the methodological designs proposed for study of athletes' performance. Specifically, coaches  
19 can be viewed as bridges that mediate the information exchange process between training and  
20 competitive data. By conceptualising and designing representative and meaningfully practice  
21 tasks for athletes, based on relevant competition data, practitioner also act like *facilitators* of  
22 learning, being a "guide on the side" (Goodyear & Dudley, 2015). Hence, grounded on CEK,  
23 the triangulation of performance information could be conceptualised in a 'competition-coach-  
24 training' triad, which needs to be better acknowledged in the design of future research  
25 investigations. Attempting to call out this issue, Greenwood et al. (2013) demonstrated how  
26 experiential knowledge could be a vital information source.

1 *\*\*\*please, insert Figure 1 around here\*\*\**

2 Although gaining greater traction, the inclusion of CEK, or even the implicit  
3 participation of coaches, in the analysis of different pedagogical interventions remains  
4 somewhat scarce in the sport performance psychology literature. Accordingly, future  
5 investigations may adopt AR-designs, with coaches acting as an insider or external participants,  
6 but surely including and analysing their intentional influence on athletes' performance  
7 development. By doing so, understanding of how learning contexts and coaching practices may  
8 affect performance development could be made broader and richer. This research perspective  
9 has already been applied in Physical Education contexts. For instance, Farias et al. (2018)  
10 examined the scaffolding process used by teachers during classes over a yearlong-AR  
11 investigation,. They highlighted the importance of using simplified questioning, prompting  
12 active discovery game problem-solving, and adapting the instruction to the particularities of the  
13 context. However, these approaches to research are still infrequent in analyses of training  
14 contexts (for exceptions to this trend, see Ramos et al. (2020) and (2021)).

15 Contemporary pedagogical models which include CEK as a component integrated with  
16 empirical knowledge to mediate training-competition information exchanges, could be  
17 empirically investigated using a mix-methods design within an AR. Particularly, in Figure 1 the  
18 area shared between the bodies of experiential and empirical knowledge used by practitioners  
19 needs to be carefully researched (Rudd et al., 2021). By combining qualitative and quantitative  
20 data, mixed methods could be used to gain high quality evidence in this interactive area. This  
21 innovative research approach will allow applied sport scientists to analyse competitive  
22 performance and athlete development through exploring the perceptions of sport practitioners  
23 and athletes. Concomitantly, AR may enhance contextual understanding of the effectiveness of  
24 purposive practical modifications in athlete preparation and development over time. This  
25 integrative approach to knowledge transfer and exchange can be facilitated by an ongoing

1 interchange using inductive and deductive reasoning to develop evidence on effectiveness and  
2 efficiency of coaching practice.

3

#### 4 **Conclusion**

5 In this critical research note, we have re-visited the importance of practically and  
6 theoretically refreshing our understanding on how informational constraints support athlete  
7 interactions in training and their preparation for performance in competitive environments.  
8 Framed upon an ecological perspective on athlete-environment relationships and an  
9 interpretative paradigm, we have highlighted some innovative research designs for developing  
10 our in-depth understanding of athlete preparation and development. We have highlighted the  
11 value of integrating detailed, accurate and relevant performance data which needs to be  
12 mediated by the experiential knowledge of sport practitioners. A key suggestion is that the  
13 development and implementation of an *competition-coach-training* triad should be investigated  
14 more extensively in future research. By adopting mixed-methods research designs, aligned with  
15 experiential knowledge from practitioners and athletes, sport scientists could better bridge the  
16 gap between theory and practice.

17

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