Big picture transdisciplinary practice - extending key ideas of a Department of Methodology towards a wider ecological view of practitioner-scientist integration.

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Published version

OTTE, Fabian, ROTHWELL, Martyn and DAVIDS, Keith (2022). Big picture transdisciplinary practice - extending key ideas of a Department of Methodology towards a wider ecological view of practitioner-scientist integration. Sports Coaching Review, 1-24.

Big picture transdisciplinary practice - extending key ideas of a Department of Methodology towards a wider ecological view of practitioner-scientist integration

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Abstract

In high-performance sport, a multidisciplinary approach is proposed as essential in providing an effective environment to service all aspects of athlete development and performance. A Department of Methodology (DoM) conceptualisation, based on an ecological dynamics rationale, provides a framework for coaches, sport scientists and support practitioners to collaboratively conceptualise integrated team and athlete development practices. Previous research has highlighted several principles for holistic system development of athletes, such as importance of embracing non-linearity, prioritising athlete-environment relations, and identifying constraints on performance. While sports organisations are continuously shaped by constraints operating at multiple scales, the overarching purpose of this paper is to highlight specifically how macro-scale ecological constraints may shape integrated practice design from a transdisciplinary perspective. To achieve this aim, we expound on the DoM concept by drawing on Bronfenbrenner's bioecological model of human development, to elaborate on how interconnected system components, simultaneously operating at multiple scales, continuously contextualise athlete development experiences. Further, we seek to sensitise coaches, scientists, and support staff to the 'big-picture of athlete development', discussing how sports organisations may adapt to the ubiquitous influences of macro-scale ecological systems (e.g., national associations and sport governing bodies). Finally, numerous association football (soccer) examples, and a recent case report about developments within the German FA (DFB) and youth football structure, attempt to make theoretical ideas tangible and understandable for coaching practitioners in the field.

Keywords: Department of Methodology; Ecological Dynamics; Football Coaching; Athlete development; Transdisciplinarity; Macro-scale system constraints.

1. Introduction

Attaining high sports performance levels requires excellence across multiple physical, psychological, and social dimensions. Therefore, it is no surprise that, in the current sporting landscape, professional football organisations and National Associations seek to employ multidisciplinary sport science support teams (i.e., psychologists, performance analysts, physiotherapists, strength and conditioning staff and skill acquisition specialists), to work with coaches to enhance player development and performance preparation (e.g., Premier League, 2011). Indeed, a multidisciplinary approach is viewed, by some, as essential in providing an effective development environment to service all aspects of players' developmental and performance needs (Inchauspe et al., 2020;Vaughan et al., 2019).

Growth of multidisciplinary working systems to support coaches is particularly evident across professional European football (Raya-Castellano & Uriondo, 2015). In England, for example, following the publication of the English Premier League's Elite Player Performance Plan (EPPP), it became a statutory requirement for academies to deliver multidisciplinary sport science support to facilitate coaching and development of players (Premier League, 2011).

But is multidisciplinarity the most theoretically appropriate way to frame the professional practice of high-performance sports organisations? Despite the best intentions of multidisciplinary sport science support teams, difficulties associated with integrating subdiscipline specialists have become apparent (Sporer & Windt, 2018; Reid et al., 2004). In European football, for instance, issues associated with multidisciplinary working and integration have been raised by Raya-Castellano and Uriondo (2015). They identified questionable player development practices because of disjointed technological procedures, practice activities lacking the guidance of a theoretical framework for learning, and the ambiguous role of fitness coaches and psychologists. Moreover, without carefully framed integrative practice, support teams from multiple disciplines can still result in a 'silo operating system', leading to over-specialisation of support services, disjointed athlete development practices, inhibiting performance outcomes (Springham et al., 2018).

A key recommendation by Raya-Castellano and Uriondo (2015) was for coaches and sport scientists in football to improve communications, and to collaborate more effectively to *integrate* player development practices (e.g., when supporting the transition of talented football players from the academy to the senior squad in team sports). Although these systemic recommendations have been proposed to improve player development practices of European youth football players, there have been few attempts to produce a theoretical rationale to address these challenges from practical or academic perspectives. Understanding the role that coaches, sport scientists, support staff and, on a wider scale, key stakeholders (e.g., regulators, club owners, politicians) have in supporting integrated preparation for performance is crucial. Based on one's individual role within the entire ecology of a high-performance sport organisation, considered as a complex adaptive system (Davids et al., 2014) (e.g., athlete, coach, support staff, manager, club owner, sponsors, business partners and politicians), it is critical to understand the nature of mutual interactions that continuously contextualise athlete experiences (Otte et al., 2021).

It was recently argued that to substantiate a holistic, integrated framework for athlete development and performance preparation, sports organisations need to implement a Department of Methodology (DoM), framed by a clear theoretical perspective to enhance athlete experiences in skill acquisition and talent development programmes (Rothwell et al., 2020a). The overarching purpose of the current paper is to re-visit the DoM concept introduced by Rothwell et al. (2020b) and elaborate upon it by drawing on key concepts from Bronfenbrenner's bioecological model of human development (Bronfenbrenner, 2005). The specific objective is to help football coaches identify the interconnected arrangement of systemic properties in organisations that continually influence coaching practitioners' and sport scientists' integration, ultimately shaping athlete development experiences. To support our elaboration of the DoM concept here, we present a football coaching case study to render these theoretical ideas tangible and understandable from a practical perspective.

Our elaboration of a DoM seeks to sensitise understanding of 'big-picture' scientist-practitioner integration, providing a framework for key stakeholders in athlete development to work more efficiently and effectively together in corresponding with changes induced in wider ecological systems (e.g., national associations). Specifically, there are three main intentions behind this paper: 1) to elaborate on the DoM concept for collaboration and co-design between coaches and transdisciplinary (rather than multidisciplinary) support teams functioning at a variety of locations in a heterarchical system, whether micro-, meso-, exo- and macro-levels, 2) to extend key ideas of a DoM towards an ecological view, revealing critical influences on interactions and processes within a highly integrated high-performance sport system, and 3), to exemplify the nature of interactions within such heterarchical systems by drawing attention to the macro-scale ecological constraints that continually shape player development.

2. A Department of Methodology: An ecological dynamics rationale

To address issues associated with multidisciplinary practice, an operational framework called a *Department of Methodology* (DoM) has been proposed (Otte et al., 2020a; Rothwell et al., 2020a). A DoM is an organisational entity, conceptualised as a complex adaptive system, integrating the work of coaches and subdiscipline specialists into a unified athlete development and performance preparation team. A DoM supports coaches and support staff in functioning as a cohesive and integrated unit (*department*), based on shared scientific concepts and principles of practice to collectively design environments for athlete development and performance preparation (*methodology*). The DoM concept can circumvent the (often problematic) notion of multidisciplinary teams and staff operating in 'silos' in a hierarchical, non-integrated fashion (e.g., not understanding the value of working collaboratively to design practice tasks). Rather, adopting a transdisciplinary view of integration within a DoM aims to implement a shared scientific language and conceptual framework needed in a truly integrated approach to co-design learning environments (Davids et al., 2014; ; Vaughan et al., 2022). The merit of transdisciplinary working (compared to multidisciplinary working) concerns the functioning "in-between, through and beyond disciplinary conventions […] by weaving lines of inquiry that may have remained isolated […] due to disciplinary traditions and perceived boundaries." (Vaughan et al., 2022, pp. 2-6; see Woods et al., 2021, for a detailed theoretical rationale located in social anthropological ideas).

Ecological dynamics is a suitable theoretical framework to guide integrated practice within a DoM, because: (i) the orientation towards understanding complex system dynamics emphasises the heterarchical nature of system organisation, predicated on components at different scales of analysis mutually influencing each other (Kugler & Turvey, 1987); (ii) a central theme within ecological science is to understand factors that enrich component interactions in the organism (athlete)-environment system (e.g., Handford et al., 1997); and (iii), it provides a powerful framework for studying emergent athlete development from the integrated perspective of multiple coexisting disciplines, such as biological, physical, social, engineering and anthropological sciences (see Woods & Davids, 2021).

Key concepts in ecological dynamics include: (i) *Athlete-environment mutuality* as a relevant scale of analysis for understanding skilled behaviours. In ecological dynamics, athletic performance is predicated on regulation of actions by surrounding information from the environment. From this perspective, behaviours emerge from continuous interactions between components at different scales of an athlete-environment system. In such complex adaptive systems, perception is of affordances, and action emerges from the realisation of affordances available under multiple constraints placed on an athlete from moment to moment (Araújo et al., 2019). Gibson's (1979) concept of *affordances,* applied to understanding athlete experiences during sport performance, highlights the key notion that 'context is everything' (see Davids et al., 2021). An ecological dynamics framework proposes that the context within which a player develops continuously influences their development for better or worse. A crucial component of the athlete-environment relationship is a footballer's ability to strengthen direct perception of environmental information (from playing surfaces, objects, and movements of teammates and opposition players) to guide skilled action in practice and competition. A truly integrated, transdisciplinary performance preparation team can more effectively identify ways to educate an athlete's attention towards key specifying information sources (e.g., a performance analyst and movement specialist could play an important role in enriching an athlete's visual exploratory behaviours (Ribeiro et al., 2021)).

(ii) *A complex adaptive systems perspective* considers coaches, sport scientists and athletes as functioning in one integrated system and not as separate entities. In complex system theorising, individual and collective actions in sport are considered context-dependent (skilled athletes and successful teams become progressively attuned to surrounding information sources that regulate their behaviour and actions). This conceptual rationale highlights how the design of learning environments by transdisciplinary teams can more effectively support athletes to perceive specifying information sources to select affordances available to regulate appropriate actions as dynamic performance contexts change. In contrast, when subdiscipline specialists prepare athletes and teams for performance and development in isolation, practice is likely to be embedded in reductionist thinking, leading to monodisciplinary practice designs that are context-independent (devoid of environmental information sources and affordances that provide context to support representative decision-making opportunities) (Araújo et al., 2019; Vaughan et al., 2022). For example, problems in football could arise from over-use of decontextualised S&C programmes (e.g., over-use of gym-based strength training and track sprinting to enhance running speed), undertaken in isolation from representative on-pitch training sessions (which contextualise athletes' use of speed, power and endurance by integrating actions and problem solving to achieve intended performance outcomes). Decontextualised programmes, over time, may not prepare athletes for performance-specific demands and loading dynamics, leading to increased injury risk and poorer competitive capacities (Burnie et al., 2022).

(iii) *Athletes considered as nonlinear dynamical systems.* In nonlinear dynamics, biological movement systems (e.g., athletes) are deemed to function under the constraints of their natural (performance) environments. Key to modelling athlete development in this way is identification of system *control parameters* that act as information to continually guide transitions between different states of (re)organisation (Kelso, 2012). In sport, control parameters are exemplified by key performance variables that athletes could harness to contextually (re)shape their movement dynamics. Put simply, as athletes move, they create information (e.g., visual, proprioceptive, acoustic) which they can use to re-organise and adapt their skilled actions. This profound idea has important implications for designing practice tasks in talent development programmes and performance preparation. The relationship between system control parameters and changes in an athlete's skilled behaviour is nonlinear; for example, a minute change in the value of a control parameter (e.g., visual information from an approaching opponent) can bring about substantial changes in the global system (e.g., a player using ball dribbling skills to advance beyond the approaching opponent to assist a team in transitioning from defence to attack). If transdisciplinary teams embrace an integrated ecological approach to solve performance problems, they can collaborate with the collective intention of refocusing performance analytics to identify system control parameters.

(vi) The pedagogical principle that practice should comprise '*repetition without repetition*', as noted by Bernstein (1967, p.234). Whilst repetition is viewed as a fundamentally important component of skill practice and acquisition, the nature of repetitions undertaken is even more important, although there have been few attempts, in the literature, to carefully define what is meant by this term. Mere technique repetition and rehearsal of a tactical manoeuvre without context will lead to a shallow level of learning, with 'rote learning' especially discredited (Bernstein, 1967, p.234). In contrast, 'repetition without repetition' advocates that, rather than technique repetition and tactical choreography and rehearsal, what should be repeated in practice designs is the *solving of a performance problem*, such as: a) a collective system (e.g. a midfield group or a defensive line) denying the opposition attacking space, or b), the creation of scoring opportunities by playing penetrative passes through a defensive line, viewed as an affordance landscape, inviting through-balls to attacking teammates (Passos et al., 2020). 'Repetition without repetition' involves far more context-dependent variability and affordances (invitations for action in competitive performance) to be perceived and used in practice designs: the very basis of skill adaptation (Otte et al., 2021).

The aim of a DoM in a football organisation is to support coaching staff and subdiscipline specialists to utilise a unified conceptual framework to: (i) continuously communicate values, beliefs and ideas on playing philosophies, styles and attitudes through coaching methods; (ii) collaborate in designing practice tasks rich in information and affordance landscapes (i.e., guiding players' attention and perception on various visual, acoustic, proprioceptive, and haptic levels); (iii) contextualise activities and developmental approaches for personalised and periodised learning experiences; (iv) implement shared pedagogical principles and a conceptual framework; and (v), educate players' intentions and self-regulation during integrated learning experiences (Morris et al., 2022; Rothwell et al., 2022; Vaughan et al., 2021).

To exemplify, a transdisciplinary team can collaborate to identify constraints for training design manipulations by collectively merging specialist knowledge derived from data insights, sport science, and tactical match analysis. For instance, knowledge about the opposition tendency to press high up the pitch may be used to design training sessions that allow players to directly develop effective solutions in response to these task constraints. Hence, transdisciplinary teams may effectively work together and integrate understanding to create representative training environments that allow players to perceive affordances (e.g., opportunities for deep passing), to be coupled with functional actions (e.g., deep runs into open spaces and effective passing solutions). Although the DoM conceptualisation may appear a logical process in practice, our own experiential knowledge from sports practice and empirical knowledge in the coaching science literature suggest that various system levels of influence can affect the functioning of a DoM. Next, we highlight the interacting factors that can serve to influence collaboration and integration within transdisciplinary teams that ultimately shape player development and performance preparation practices.

3. System levels of influence on subdiscipline integration and player development

An ecological view of sport expertise views the continuous and reciprocal interactions between the individual-environment system as central to an athlete's development (Araújo & Davids, 2011). Aligned to Bronfenbrenner's bioecological theory of human development (2005), understanding athlete development in this way identifies multiple nested and embedded systems that function heterarchically, simultaneously interacting and influencing athlete developmental trajectories and performance. In human development, Bronfenbrenner advocated four key defining properties, including process, person, context, and time

(Bronfenbrenner & Morris, 2006; Tudge et al., 2016). Particularly, ideas of scientist-practitioner integration concern how context (e.g., macro-, exo-, meso-, and microsystems, see bar on right-hand side of Figure 1) influences proximal processes between coaches, subdiscipline specialists, and players. Bronfenbrenner (2005) described proximal processes as complex reciprocal interactions between people, objects, and symbols that influence human development. Examples of these processes are evident in sport and demonstrate how multiple entangled systems, shaped by constraints operating at different scales of analysis, can simultaneously influence athlete development (e.g., Rothwell et al., 2020b; Uehara et al., 2014). The heterarchical nature of Bronfenbrenner's (2005) *context* (macro-, exo-, meso- and microsystems) framework highlights how ecological constraints, functioning at a variety of scales, continuously influence proximal processes (for an explanation in sport see, Araújo et al., 2010). Clearly these ideas have important implications for the reciprocal interactions that emerge between scientists and practitioners in athlete development and performance preparation programmes, for better and for worse.

[Insert Figure 1 here]

3.1 Macrosystem - Socio-cultural-historical constraints

A common barrier to scientist-practitioner integration comprises the daily, 'mundane', working practices of a team or organisation. These practices are embedded in wider social, cultural, and historical influences that lead to the contextualisation of specific behaviours, skills, capacities, attitudes, values, beliefs, and customs of performance preparation that can become difficult to change. Bronfenbrenner suggested that these overarching characteristics are the hallmark of the macrosystem and form basic patterns of social organisation (Bronfenbrenner, 1979; see blue, outer macrosystem level in Figure 1). Micro-scale activity patterns can proliferate and interact with influences emerging at other system scales influencing a sports organisation in a community, leading to the emergence of a specific *form of life* (Rothwell et al., 2018). In such a form of life, certain features (i.e., philosophical approach to player development, community expectations and traditions, expertise and skills of professional practitioners) continuously shape how a DoM operates. A form of life can, therefore, explain why certain performance styles and applied practices are developed in certain sports across different regions. For instance, in an ethnographic study on football player development, Vaughan and colleagues (2022) investigated a myriad of socio-cultural constraints on youth football's form of life in Stockholm, Sweden. Results indicated players' behaviours to be significantly influenced by socio-cultural norms and expectations in Swedish communities and organisations, led by value-directedness towards individual competition and elitism. For example, players' responsiveness to affordances to play and pass the ball was often overshadowed by 'bee-like swarming tendencies' around the ball, compared to skilled exploitation of spaces and gaps (p. 14). As a consequence, the authors conclude:

> "The role of club personnel, including coaches and practitioners, is to develop, substantiate and work within (and understand) their form of life to shape player-environment intentionality that is progressively skilled. We propose that a key aspect of fostering skilled intentionality is appreciating the sociocultural constraints and associated value directedness resonating within one's form of life. […] sociocultural constraints might be amplified or dampened by re-shaping the value-directedness of player-environment intentionality toward optimal relations (i.e., affordance utilization) that enhance skill development." (Vaughan et al., 2022, p. 14)

In another example on the impact of macro-level socio-cultural-historical constraints, Uehara et al.'s (2021) exploration of Brazilian football identified the socio-cultural constraint of *Malandragem* (moving between cunning and deception) as a major influence on the development of skill and the *Ginga* playing style. The Brazilian history of Malandragem can be traced back to the 1880s, where it served the disadvantaged as a tool to seek social justice in response to socio-economic imbalances and difficulties such as corruption, unemployment, and inequalities. This can take the form of a counterculture, asserting independence and expressing dissatisfaction with the status quo through arts and sports. The Malandro counterculture emerged due to constant oppression, forcing people to adapt by manipulating others, misleading untrustworthy authorities, and circumventing rules just to survive and flourish. At the micro-level of Brazilian football, characteristics such as adaptability, cunning, and deception are synonymous with *Malandragem*, expressed in the skills prevalent in many of Brazil's national players, (Uehara et al., 2021). These national attributes can also influence training methodologies within a DoM, where small-sided games that have similar features to *Pelada* (i.e., pick-up games) are a common form of cultural practice in Brazilian football (for insights into São Paulo Football Club see Uehara et al., 2018).

A key challenge for coaching practitioners and sport scientists joining an existing and well-established DoM is encountering *status quo bias* that preserves the everyday practices of a specific form of life. Ross et al. (2018, p.8) highlighted how status quo bias in elite sport organisations can lead to "resistance to innovation, innovative practice or simply to change in general". If a DoM is characterised by a form of life of this nature, then effective collaboration and integration through coach practitioner-scientist interactions will be difficult to achieve. Exemplifying further, the socio-cultural constraints of different countries (macrosystem) can influence system functioning in diverse forms of life. Roca and Ford's (2020) examination of European (England, Germany, Portugal & Spain) youth football coaches' practice designs, revealed significant differences in time spent in active decision-making activities, perhaps implying different philosophical views on human development. Portuguese and Spanish coaches emphasised practice experiences in which players spent higher amounts of time in active decision-making activities (Portuguese 68 ± 9%; Spanish 67 ± 10%) compared to English (56 ± 8%) and German (57 ± 10%) coaches. In contrast, English players spent more time in unopposed technical-based drills compared to European counterparts. Differences in practice designs, and a desire to use decontextualised methodologies for player development, could indicate different philosophical world views or ideologies towards skill acquisition and expert decision-making (Raab & Araújo, 2019) within DoMs.

3.2 Exosystem – External influences situated within the wider ecological context

Bronfenbrenner (1977) defined the exosystem as an ecological system that a developing individual is not specifically situated within, but can formally and informally influence their development (see exosystem level in green in Figure 1). For example, a National Governing Body of Sport could make decisions about where to target funding or situate academy programmes that could influence coaching quality and accessibility for developing players. Equally, coach education policies, agreed in high level strategy meetings, could lead to certain pedagogical approaches that may prove more beneficial to the long-term development of players (see report in section four for a case example). Like all other designated system scales of analysis in his model, Bronfenbrenner's (1977) approach exemplified how the exosystem in high-performance sport can influence how a DoM operates and the extent to which scientists and practitioners integrate their practice.

To exemplify the impact of the exosystem on the functionality of a DoM, we consider the recruitment of a Manager or Sporting Director in a football club. Professional football has a tradition of high employee turnover rates (Parnell et al., 2018), since backroom staff within a club may also change as Managers arrive and depart. Therefore, recruitment decisions made in the boardroom, by club owners and other relevant key stakeholders, can have direct consequences for the integration of a DoM due to instabilities in key positions (e.g., Head of Sport Science). In addition to an unpredictable job market, many Managers and Sporting Directors may display varying levels of understanding and receptiveness to contemporary applied scientific practices, previous experiences (e.g., playing in different countries), and education; this, may potentially contribute to empirical knowledge of sport science being rejected in some cases (Martindale & Nash, 2013).

These findings, along with the fickle nature of employment, can lead to inconsistent and disjointed multidisciplinary practices, hindering valid scientist-practitioner integration. Yet, in football and most other professional sports, the integrated use of scientific data and knowledge may lead to competitive advantages for organisations. To exemplify, the recruitment of Liverpool FC's manager Juergen Klopp in 2015 has turned out to be of one of the most successful decisions in the club's recent history. According to Schoenfeld (2019), Liverpool incorporated data analytics and mathematic algorithms, along with other recruitment processes (e.g., interviewing), to identify and select Klopp as the previous manager's replacement. Use of match data from Klopp's time at Borussia Dortmund revealed the likely fit between the German manager and Liverpool FC (see Schoenfeld, 2019, for the full story). Data analytics at the club is also used in player recruitment strategies. Given Liverpool FC's recent (and continuing) successes in national and international competitions, this integrated approach strongly showcases an effective mix of data-driven knowledge and the coaching staffs' empirical knowledge and intuition (Schoenfeld, 2019). This contemporary example in professional football supports our arguments, highlighting the numerous benefits (especially key coaching appointments) of a refined, data-informed, and well-coordinated transdisciplinary integration of various departments and parties within the ecology of a high-performance sport organisation.

3.3. Mesosystem – The relationship between empirical and experiential knowledge and scientist-practitioner integration

Traditionally, applied science support for players and coaches has been dominated by empirical knowledge (theory and data) derived from separate subdisciplines of science (e.g., biomechanics, performance analysis, physiology, psychology and sports medicine). Traditionally, in sport, empirical knowledge often imposes a hierarchical relationship over experiential knowledge (i.e., experience of knowing what works in practice) (Buchheit, 2017; Ross et al., 2018). In other words, empirical knowledge is considered by some in sport science to be superior to experiential knowledge, driving so-called *evidence-based* approaches, particularly when making decisions about performance preparation practices. This inaccurate construal of the deeply integrated relations between experiential and empirical knowledge has been critically evaluated and considered problematic for a number of reasons (e.g., see Renshaw et al., 2019). For example, one important concern is because much empirical research in sport science is often conducted within a natural science paradigm that seeks to explain movement through analysis methods dominated by reductionism (e.g., an over-reliance on laboratory testing procedures for performance analysis). This approach has been predicated on over-use of experimental tasks which lack representative design or which involve a single degree of freedom to study coordination processes in complex adaptive systems (Newell, 1985). These trends have caused major issues in over-emphasising deductive reasoning, even though these approaches have failed to provide sufficient descriptions about human behaviours in interacting with the environment. In traditional, applied, sport science practice, context and history are rejected in favour of a cause-and-effect atemporal and acontextual accounts of performance. The study of complex adaptive systems (i.e., a DoM) is treated in the same manner as isolated and linear systems, where the aim is to enhance predictability and reduce uncertainty through establishing causal relationships. Buchheit (2017) has challenged DoMs to rethink the value of simple scientific conclusions formed in a cause-and-effect relationship, rather appreciating the importance of context when making decisions about applied practice.

These ideas reflect Bronfenbrenner's conceptualisation of how the mesosystem integrates with systems functioning at other scales of analysis. They can be taken to imply how two systems can be made to function in a more refined way by simultaneously and mutually influencing each other at different scales in the organisation, e.g., two bodies of knowledge (i.e., empirical and experiential knowledge) used in a DoM continuously shaping (and being shaped by) scientist-practitioner integration, at different scales in the sports organisation (see yellow mesosystem level around the Department of Methodology structure in Figure 1). This type of systems level integration is needed in high performance sports organisations because there is little evidence to suggest that coaches rely on sport scientists for information to improve athlete performance (Gilbert et al., 2006), perhaps indicating the paucity of interaction quality between sport scientists and coaches. Rather, coaches' preferred knowledge sources tend to be informal (peer interactions and observations, and modelling) and formal (coach education) (Grecic & Collins, 2013). Sport scientists and their publications are ranked very low by coaches as a likely source of professional information (Reade et al., 2008). A case study of 20 high-performance coaches revealed that coaches: (i) did believe that sport science can contribute to coaching, (ii) are interested in having a sport scientist work with them, and (iii), are motivated to find and implement new ideas in their sport programs (Reade et al., 2008). However, reasons why coaches do not utilise sport science include: (i) a lack of time to look for new ideas, and (ii), a lack of interest in academic publications (Reade et al., 2008). A more integrative relationship between scientific findings and applied practice has been proposed to circumvent issues between empirical and experiential knowledge (Woods et al., 2022). Closer collaborations could support a symbiotic, heterarchical relationship between scientists and practitioners to facilitate a more productive econiche dedicated to integrated athlete development practices.

3.4 Microsystem – The strength of scientist-practitioner integration can influence player-environment interactions

The microsystem is an important component of Bronfenbrenner's deeply integrated bioecological model of human development, defined as the most influential system in which an individual is situated (Bronfenbrenner, 1979). In sport, the microsystem relates to the environment that a developing player inhabits from day to day, exemplified in the training programme of a first team squad or academy (see orange microsystem level in orange in Figure 1). Sustained engagement in daily practice activities, and relationships with teammates and support staff, within these environments have a significant impact on their development (Rothwell et al., 2018). Within a DoM the macro-, exo-, and mesosystems simultaneously contextualise scientist-practitioner integration within the organisation, for example at the micro-level, leading to more or less functional performance preparation practices. For example, when planning set-piece strategies preceding an important cup match, collaboration between (specialist) coaching staff, data analysis departments, psychologists and researchers could support the design of effective attacking strategies and holistic training interventions (including tactical, technical, mental and collective levels of performance). In a DoM, microsystems would focus on constantly modifying the balance between designing specifying information sources (i.e., relevant information in practices to contextualise a player's decisions and movement; Pinder et al., 2011) and players' intrinsic dynamics (e.g., players' individual capacities at any given moment; see Rudd et al., 2021). Implementation of the key practice principle of 'repetition without repetition' emphasises the significance of a transdisciplinary approach in which each individual player is located at the centre of the design activities of the coach and support staff. Their integrated activity could design learning tasks, predicated on problem solving, and dedicated to the specific enrichment needs of each athlete (e.g., individualised psycho-social, perceptual, cognitive, and physical development) (Rothwell et al., 2020a). The coordinated activity of coaching practitioners and sport scientists in a DoM is underpinned by the idea that 'context is everything' in analysing and understanding how players form functional (successful) relationships with their performance environments (Davids et al., 2013).

The 'Periodisation of Skill Training' framework (termed 'PoST' framework) provides a helpful model for coaching practitioners and sport scientists to collaboratively design learning tasks, inform (skill) training periodisation, and enrich player education and development (Otte et al., 2019, 2020b). The 'PoST' framework can open channels of communication within a DoM to design, plan, and integrate three skill development stages (grounded on Newell's (1985) model of motor learning). First, the 'Coordination Training' stage stresses exploration and stabilisation of relationships between motor system components; second, the 'Skill Adaptability Training' stage highlights exploration for movement adaptation and optimisation for efficiency; and third, the 'Performance Training' stage focusses on the need for opportunities for performance preparation and stability (Otte et al., 2021). Further, these nonlinear athlete development stages are integrated with the idea of periodising and assessing training designs based on: i) the level of practice representativeness, and ii), the degree of (players' perception of) task complexity (Otte et al., 2019, 2020b; Morris et al., 2022). To showcase how the 'PoST' framework can be used to integrate transdisciplinary practice while navigating the wider ecological landscape, a football case report, next, aims to make theoretical ideas (Figure1) understandable for coaches and sport practitioners.

4. Multisystem influences on developing footballers: An example from German Football

In recent years various high-performance football organisations, such as AIK (Sweden), Southampton FC (UK), and TSG Hoffenheim (Germany) have worked at the forefront of driving an integrative scientist-practitioner approach. AIK may be regarded as a current 'best practice' environment in youth football through implementation of effective coach education programs and a *learning IN development framework* for player development (see Vaughan et al., 2021). Southampton FC and TSG Hoffenheim have been active and innovative at establishing university partnerships and science programs in order to drive research on topics like injury prevention, mental fatigue or protecting players from arthritis in later years (TSG ResearchLab, 2022; University of Southampton, 2017).

Linked to attempts towards scientist-practitioner collaboration, we present the case of recently-introduced structural changes to youth player development by the German Football Association (DFB). The case re-iterates the key notion of integrating *experiential* and *empirical knowledge* to enhance the collaborative design of innovative and effective youth development practices. One should bear in mind that coaches' and practitioners' transdisciplinary functioning in a DoM needs to consider a multitude of constraints that continually influence their work at macro- and micro-scales of analysis (capturing the interacting environmental, task and personal constraints on each athlete). Since this report displays relatively recent and ongoing developments within German youth football, the case study focuses on how reforms and multi-system level interactions may be connected to theoretical ideas for implementing a DoM model, informed by best practice.

4.1. Context of the football case report: Macro influences on wide scale change

Following the 2014 World Cup championship, the German senior men's national team experienced a rather unexpected and humiliating early knock-out in the group stages of the 2018 World Cup in Russia. In response to professional reflection on this performance, and other developments in German football (e.g., German clubs signing young foreign players over homegrown, domestic players), a strategic shift was proposed by the national association (Austin, 2019). In the words of Germany's Director of National Teams and the Academy, Oliver Bierhoff:

> "If clubs prefer to bring in young Englishmen, Frenchmen and Belgians, there is only one solution - the young Germans need to get better [.] We need to get back to the full potential of our talent pool; we need to develop our junior teams in the best possible way." (Austin, 2019; DPA, 2019). Admittedly, Bierhoff further stated: "We have a lot of talent in Germany but turning these talents into exceptional players who can be the best in the world is the big challenge." (Austin, 2019).

Aiming to re-enter the football world's elite, the DFB introduced a multi-year plan including various regulatory changes to youth football development and competition design (DFB, 2022a). While these changes could invoke the impression of top-down regulatory changes from the DFB, proposed structural alterations were predicated on bottom-up feedback from all 21 German regional associations, including feedback from numerous clubs, coaches, and young football players themselves (Harding, 2022). During a two-year pilot project, involving trials of proposed changes in youth football game structures, play and rules, clubs and members provided advice and feedback on practical experiences and ideas to the DFB. While the integrative approach towards co-influencing the pilot project from various system levels has merit, some caution is needed in interpreting whether the DFB, during the implementation and analysis stages, did enough to problematise and understand the socio-cultural contexts and differences between its regions and regional associations. For example, consideration of club and participant numbers, available resources, socio-cultural constraints and environmental forces between the rather large Bavarian football association and the smaller Bremer football association, with their 4510 and 87 football clubs respectively (DFB, 2020), warrants a gateway for local to global system adaptations. Put simply, awareness of the need to locally adapt new youth development structures for different socio-cultural contexts and regions may be highlighted as one critical performance indicator for future assessment of the DFB's entire project. This cautious interpretation recognises that cultural sensitivity and adaptation to context cannot be understated when undertaking transdisciplinary inquiry (Songca, 2006).

4.2. Changes to German youth football: The need for integration

Following the two-year pilot project, in 2022 the DFB ratified changes to the playing structure in German youth football at age groups from U6 to U12 years (DFB, 2022a; Schofield, 2022). Changes to be implemented by regional federations and clubs from (at the latest) the 2024/25 season included various factors, such as:

> "small-sided games; short playing times; players regularly rotated with everyone involved; no referees and minimal involvement from coaches and parents; 'game afternoons' and festivals, rather than formal matches and leagues; [and] heading practically eliminated." (Austin, 2022)

Theoretically, the scaling and formatting of small-sided and conditioned games and activities could be facilitated by manipulations of coaches and practitioners in a DoM to focus on development of specific performance characteristics and dimensions, holistically emphasising aspects including intrinsic enjoyment, ball manipulation skills, strength and conditioning, tactical awareness, decision-making, perceptual and cognitive skills (Davids et al., 2013). This focus could challenge coaches and practitioners working in a DoM to co-design (with developing athletes) practice activities, tasks, and games and thus, seeking to simulate key aspects of performance, individualised for the needs of the group or performers. The DoM focus could narrow on *adaptation to context*: of relevant performance skills (e.g. ball manipulation, passing, tackling, dribbling, and others), deeply emphasising skilled perceptual awareness, physical condition and decision making capacities. A key design principle to consider (amongst others) would be ‘repetition without repetition’ to enhance competitive performance.

The changes described to football structure will not solve talent development issues through their mere presence. Rather, structural changes to the macro-scale environment need to be complemented with changes to the work organisation and skills of coaches and practitioners in a DoM. Several strategical and conceptual pillars, such as the newly-built DFB Academy campus in Frankfurt, the structure of children’s and youth football competition and (in)formal coach education, based on contemporary knowledge and theory, were set out to play key roles and undergo reformation (DFB, 2022a,b). The result of some of these proposed changes to football at the grassroots and youth level are displayed in Figure 2 (as adopted from DFB, 2022b).

[Insert Figure 2 here]

Figure 2, as introduced by the DFB (2022a,b), provides general information on pitch dimensions, goal sizes and small-sided games playing formats at different age groups (e.g., 2vs2 in U6/U7 or 7vs7 in U10/U11yrs; see Austin, 2022). The overarching idea is for integrating contemporary scientific knowledge on scaling of practice designs in youth player development, allied with experiential coaching knowledge. This gap, between experiential (i.e., practical information gained from elite coaching experience) and empirical (i.e., data and theory) knowledge and practical applications, is often cited as the most significant barrier coaches and sport practitioners face as they negotiate the pragmatics of integrated practice design (Greenwood et al., 2014). A practical example to circumvent this barrier is based on recent medical recommendations towards heading footballs in younger age-group players. The DFB is seeking to significantly reduce risks to player brain health of repetitive ball-heading practice by constraining pitch sizes, playing numbers and actual play through use of dribbling to re-start the game instead of goal kicks (DFB, 2022a). This notion of integrating scientific (medical) knowledge into applied coaching has particularly been emphasised by the DFB academy's introduction of the 'Think Tank', a multidisciplinary and international space for "exchange of different perspectives: football experts, technology, science, philosophy, arts and culture." (DFB, n.d, 2017). This template for regular events supporting multidisciplinary exchanges between various experts provides a channel for the continuous transfer of theoretical, empirical and practical knowledge to applications of coaching and player development, and vice versa. These exchanges will not only influence youth football structure and practice, but also enhance coach-scientist integration by sensitising practitioners to merits of adopting an empirical and theory-driven view on player development.

The examples discussed characterise (parts of) the implementation of a DoM model for knowledge transfer, supported by the interdependent, heterarchical relationship of various macro-, exo-, meso- and microsystem levels to each other. Such a systems-oriented DoM model (see Figure 1) is needed to facilitate aspired improvements and refinements to education, training and professional practice in football coaching at different levels. Structural organisation changes, facilitated by a transdisciplinary DoM set-up, could: (i) be integrated with changes to daily micro-practices when working with athletes, and (ii), consider socio-cultural constraints of national and regional identities in developing youth athletes.

4.3. Multi-system integration of experiential and empirical knowledge for player development

The case report of the DFB's newly ratified youth football reforms illustrate the integration of experiential and empirical knowledge for player development in a DoM. This ecological view of sport expertise highlighted how the multiple systems that reciprocally interact influence the developmental trajectory of youth football players. The continuous interactions between the individual-environment system at meso- and micro-levels are central to a player's development (i.e., through co-designed, less structured game and training environments, enabling 'repetition without repetition' and including more space for individuality of development; Chow et al., 2022). The case report stresses the influence of interacting micro-scale and macro- and exo-system factors, through multidirectional feedback processes between regulators, clubs, coaches and players, supporting interdependence of interactions between various system scales. The socio-cultural-historical role of football in Germany (on a macro-system level) shaped the DFB's stress in reflecting upon past performances and re-organising player development structures. The urgency of the collaborative re-organisation emerged, despite reforms and political changes within the association being slow due to the legal way German football is structured; this, driven by individual organisations and regional associations traditionally displaying strong identities and significant power in decision making (Harding, 2022). Along with macro-level regulatory attempts to adjust and reform player development approaches (including changes to physical infrastructure, such as the DFB Campus), a DoM at the exo-level could help shape the newly-ratified regulations that will influence organisational environments. For example, a DoM structure could support ways in which clubs could re-organise less formal football competitions, likely impacting behaviours of external stakeholders (e.g., parents or spectators) during events.

At another scale of analysis (at micro- and mesosystem levels), a DoM organised at the level of the national governing body could oversee further reforms of formal coach education within the association (i.e., for coaches working towards official UEFA coaching badges). A DoM could emphasise a mixture of in-person and virtual study programmes, allowing coaches to contemporise their skills and understanding, while spending less time away from their clubs and more time working towards individualised player development

(Austin, 2019). Multidirectional exchange and feedback processes between DFB regulators, coach educators and coaches again appears critical at all stages.

Overall, the case example of the DFB's youth football reforms highlights how re-organisation of coaches, educators and professional support staff into a DoM could contemporise player development in football. The actions of one of the world's largest FAs, their critical self-assessment (after sub-optimal performances) and openness for transdisciplinary scientist-practitioner exchanges, indicate how coaches can be sensitised to the constraints of a wider ecology (i.e., environment) that continually shape player development.

5. Conclusion

This paper highlighted how macro-scale ecological constraints may shape integrated practice design from a transdisciplinary perspective. Based on key concepts in Ecological Dynamics, this paper reiterates the DoM concept for collaboration and co-design between transdisciplinary teams. It extends current ideas of a DoM towards a wider ecological view, emphasising critical interactions within high-performance sport systems and sensitising coaches and support staff to the 'big-picture' that shapes player development. Drawing on key concepts of Bronfenbrenner's bioecological model of human development, the elaborated DoM model illustrated the interconnected arrangement of socio-cultural structures that influence player development experiences at varying scales of analysis. Within DoMs, macro-, exo-, and mesosystems mutually influence the strength of practitioner-scientist collaborations functioning within the microsystem, leading to more effective performance preparation practices. Various professional football case examples, such as recruitment processes at Liverpool FC, scientist-coaching integration at Southampton FC or youth football structure reformation in Germany, aimed to highlight this notion. Finally, adopting the unified conceptualisation can support key parties and practitioners in refining and co-designing athlete development structures and strengthening the athlete-environment system.

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Figures

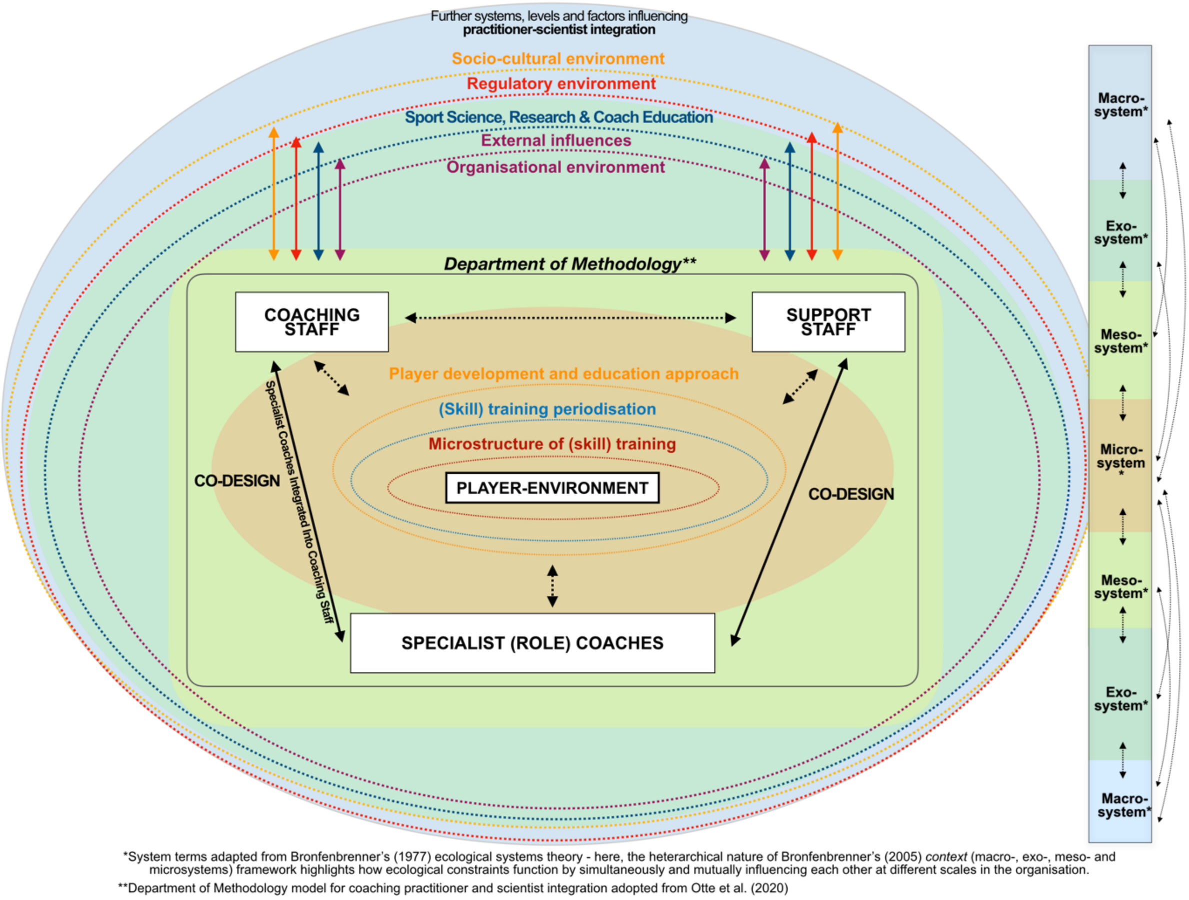

Figure 1. An overview framework of various heterarchical systems and constraints linked to the DoM conceptualisation, including the microstructure of (skill) training, (skill) training periodisation, player development and education, the organisational environment, external influences, sport science research and coach education, the regulatory and socio-cultural environment. Notably, different systems functioning at multiple scales continuously and simultaneously influencing each.

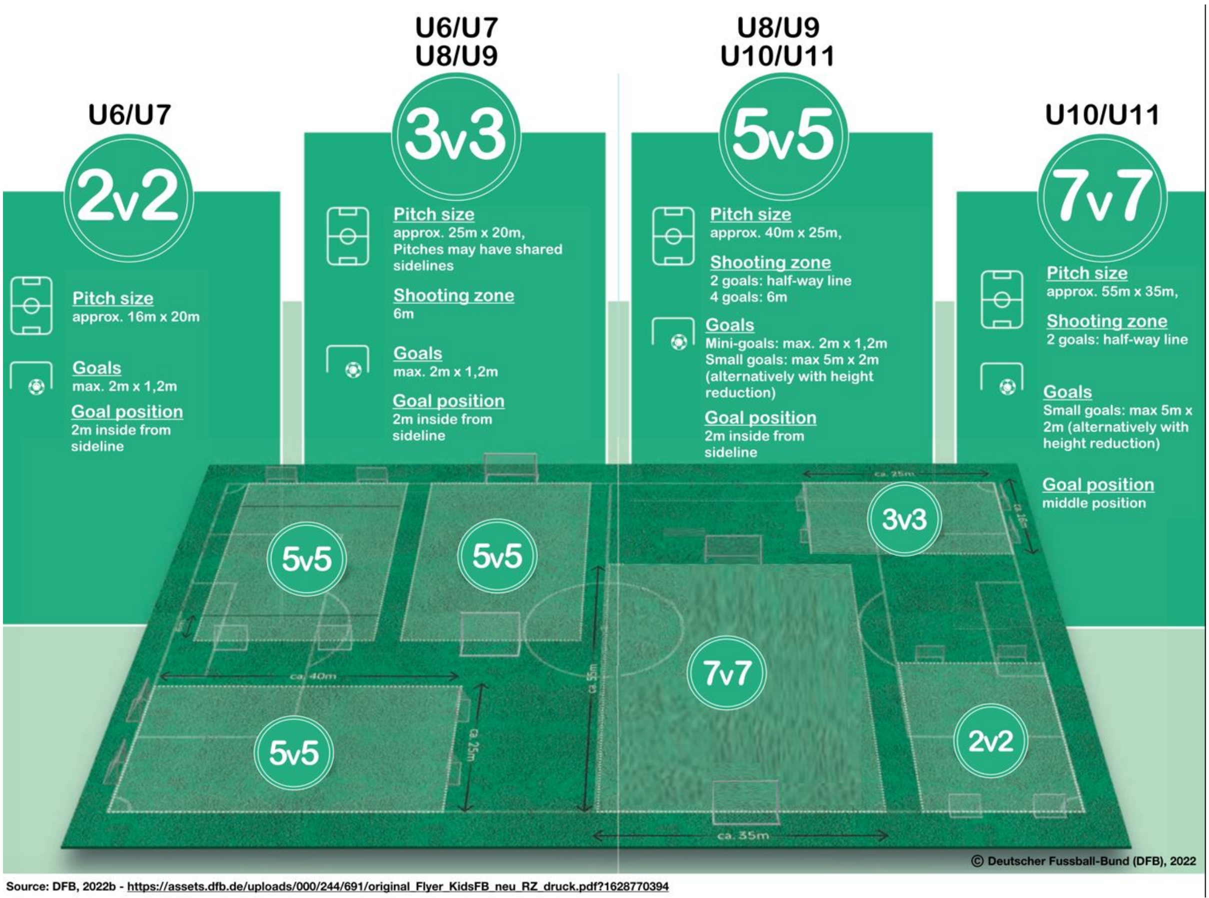

Figure 2. New regulations for youth football in Germany from the 2024/25 season (Austin, 2022; adapted and translated from DFB, 2022b).