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Opinion

Towards An Integration of New Motor Pedagogy Paradigms in Sports Medicine and Exercise Science

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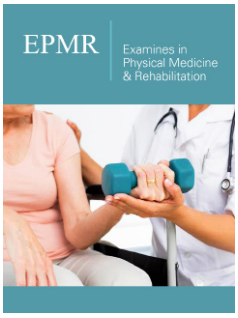
ISSN: 2637-7934



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Submission: April 14, 2026
Published: April 29, 2026

Volume 5 - Issue 4

How to cite this article: Tomas Bonino-Covas*. Towards An Integration of New Motor Pedagogy Paradigms in Sports Medicine and Exercise Science. Examines Phy Med Rehab. 5(4). EPMR. 0005618. 2026.
DOI: 10.31031/EPMR.2026.05.000618

Abstract

In sports medicine and exercise science, emphasis has traditionally been placed on physiological and biomechanical variables, while the pedagogical processes underlying movement instruction have received comparatively little attention. This opinion paper critically examines the persistence of traditional instructional models, characterized by a predominant reliance on explicit instructions and an internal focus of attention. These approaches are contrasted with contemporary, evidence-based frameworks from motor learning, including implicit learning, the constraints-led approach, differential learning, nonlinear pedagogy, and motivational models such as the OPTIMAL theory and the TARGET framework. Collectively, these perspectives emphasize self-organization, external focus, variability, and learner autonomy as key drivers of effective motor learning. We argue that the limited integration of these paradigms into clinical and sports practice constrains motor learning, reduces transfer to real-world contexts, and may negatively impact both performance and patient outcomes. This gap appears to reflect shortcomings in professional education rather than a lack of scientific evidence. To address this issue, we propose strategic directions for the evolution of professional training, including the systematic integration of motor learning principles into curricula and continuing education, as well as a greater emphasis on pedagogical competencies. Aligning movement instruction with contemporary evidence may enhance learning, performance, and the overall quality of care.

Summary

In sports medicine and exercise science, attention has historically focused on physiological and biomechanical variables, often relegating the pedagogical processes underpinning movement instruction to a secondary role. This opinion paper critically examines the persistence of traditional instructional models, characterized by a predominant reliance on explicit learning instructions and an internal focus of attention. These practices are contrasted with contemporary approaches, including implicit learning, the constraints-led approach, differential learning, nonlinear pedagogy, and motivational frameworks such as the OPTIMAL theory and the TARGET framework. I argue that the limited integration of these paradigms constrains motor learning, impairs transfer, and may negatively affect both performance and the health of patients and athletes. Finally, strategic recommendations are proposed to guide the evolution of professional education in this field.

Keywords: Sports medicine; Exercise science; Motor learning; Biomechanics

Introduction

Exercise instruction is a fundamental pillar of athletic performance, injury prevention, and rehabilitation. However, despite the exponential growth of evidence in exercise physiology and biomechanics, the pedagogical dimension of movement remains insufficiently addressed in both clinical and sports practice.

This situation is particularly paradoxical given that disciplines such as motor learning and neuroscience have, in recent decades, generated a robust theoretical and empirical body of knowledge that challenges many still-dominant practices. Movement instruction

thus remains frequently anchored in traditional models based on explicit instruction, continuous error correction, and the pursuit of idealized technical patterns, often at the expense of approaches that foster self-organization, exploration, and adaptability.

Limitations of Traditional Motor Learning Approaches

A defining feature of conventional exercise instruction is the predominantly use of explicit learning instructions (a way of learning which generates verbal knowledge of movement performance -e.g., facts and rules-, involves cognitive stages within the learning process and is dependent on working memory involvement) [1] and internally focused cues (where attention is directed towards one's body movements). Instructions such as "engage your core," "control your knee," or "keep your spine neutral" direct attention toward specific body segments. However, substantial contemporary evidence suggests that this type of attentional focus can interfere with automatic motor control processes, as described by the "Constrained action hypothesis". Rather than enhancing performance, an internal focus tends to disrupt movement efficiency and fluidity [2-7]. This issue is compounded by a tendency of excessive provision of technical information and constant correction of errors can increase cognitive demands and exceed the learner's processing capacity [7-10]. Moreover, this approach may foster reliance on externally provided feedback and limit learner autonomy, factors that have been associated with reduced transfer to dynamic, real-world contexts [5,7,11-17]. Another critical limitation lies in the persistence of normative models that promote the existence of an "ideal technique." Such models overlook the inherent variability of the human motor system and disregard individual differences in structural, functional, and contextual factors. Imposing rigid movement patterns not only constrains adaptability but may be counterproductive in dynamic environments where movement variability is essential for adaptability, performance, and potentially injury resilience [17-24].

Contributions of Contemporary Approaches

In response to these limitations, contemporary motor learning approaches advocate for a paradigm shift, positioning the individual as a dynamic, self-organizing system, whose behavior emerges from the interaction between task, environmental, and individual constraints [17,19,25,26]. Within this framework, implicit learning (learning which progresses with no or minimal increase in verbal knowledge of movement performance - e.g., facts and rules- and without awareness) [1] emerges as a particularly valuable strategy, which reduces cognitive load, facilitates automatization, and has been shown to be more robust under cognitively demanding or high-pressure conditions [7-10,27,28]. The use of an external focus of attention (where attention is centered on the intended movement effects or movement goals) is one of the most effective tools within this approach. Instructions such as "push the ground" or "hit the target" promote more efficient and coordinated movement execution [4-6, 29-33].

Additionally, the use of analogies, metaphors, and strategies such as guided exploration enable the communication of complex information in a simplified and implicit manner, reducing reliance on lengthy technical explanations [7,17,26,32,34]. Several well-supported models fall within this broader framework. Nonlinear pedagogy, grounded in dynamic systems theory and ecological dynamics, conceptualizes motor learning as a non-linear, individualized, and exploratory process emerging from the interaction of individual, task, and environmental constraints [17,22,25,35,36]. Similarly, the constraints-led approach suggests that learning should not be driven by prescriptive instructions but rather facilitated through the manipulation of organism, task, and environmental constraints, thereby encouraging exploration and the emergence of functional movement solutions [17,21,26,35].

The concept of differential learning further emphasizes the systematic introduction of variability and perturbations as a means of enriching the motor repertoire. Rather than striving for exact repetition, this approach views variability as a key contributor to adaptable and transferable motor behavior. In line with the recent probabilistic framework of human motor control, movement variability is not considered undesirable noise but a functional resource that supports adaptation and learning [18-20]. The probabilistic landscape model further illustrates how the motor system balances stability and flexibility through processes of self-organization and entropy [19].

Finally, contemporary evidence highlights the central role of motivation in motor learning. The OPTIMAL theory of motor learning integrates factors such as autonomy, enhanced expectancies, and external focus, demonstrating their influence on performance, retention, and, in some contexts, adherence [6,11-14]. Complementarily, the TARGET framework provides a practical structure for designing learning environments that promote engagement and active participation. Its six components consist of; 1) designing varied and differentiated tasks with personal goals; 2) delegating authority by allowing users to participate in decision-making; 3) granting recognition based on effort and self-improvement; 4) using mixed and cooperative groupings; 5) conducting formative assessment focused on individual progress; and 6) managing time flexibly to adapt to each student's learning pace [37].

Discussion

The persistence of outdated pedagogical practices in sports medicine is unlikely to reflect a lack of evidence, but may instead be related to limitations in professional education and knowledge translation. A clear disconnect appears to exist between advances in motor learning research and their application in clinical and sports settings [32]. This gap may be further reinforced by cultural and professional factors, including entrenched traditions, instructor-led practices, and the tendency to oversimplify inherently complex phenomena. Addressing this issue likely requires more than the adoption of new tools; it may necessitate a fundamental shift in how the teaching-learning process is conceptualized.

Implications For Professional Education

Bridging this gap requires a rethinking of how exercise and health professionals are trained. First, the systematic integration of motor learning and pedagogical content into undergraduate and postgraduate curricula in sports science, physiotherapy, and medicine is essential. Continuing professional development should prioritize updates in contemporary evidence-based approaches, with a particular emphasis on the development of pedagogical competencies rather than the mere accumulation of technical knowledge. In this context, professional assessment should extend beyond the ability to prescribe exercise to include the effectiveness of motor pedagogy. Finally, there is a need to promote applied research that examines the real-world implementation of these approaches in clinical and sports contexts, as well as their impact on key outcomes such as performance, adherence, and injury prevention.

Conclusion

Motor pedagogy is an essential, yet historically undervalued, component of sports medicine and exercise science. The current body of contemporary scientific evidence calls for a critical reappraisal of traditional practices and the adoption of pedagogical approaches that better reflect the complex and dynamic nature of the human motor system. Advancing in this direction has the potential not only to optimize learning and performance but also to enhance the overall quality of professional practice.

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