



Modeling Physical Education as a Learning System: Regional and International Perspectives

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Abstract

Background. Contemporary learning research increasingly conceptualizes educational processes as controllable, adaptive, and feedback-driven systems. Despite this shift, physical education is often treated as conceptually separate from general learning theory and predominantly interpreted as an applied or norm-oriented activity. Such a reduction limits opportunities for systemic analysis, instructional design, and the integration of formative assessment mechanisms.

Objectives. The purpose of this article is to reconceptualize physical education as a learning system from the perspective of learning theory and to analyze regional and international approaches to modeling learning processes and pedagogical regulation of learning outcomes.

Materials and Methods. The study was conducted as a narrative review. Its methodological basis is a conceptual analysis of monographic works and publications in peer-reviewed journals addressing learning process modeling, pedagogical control, adaptive learning, and instructional design in physical education. Source selection followed a conceptually oriented strategy aimed at identifying theoretically and empirically grounded models of learning systems.

Results. The analysis demonstrates that physical education can be interpreted as a structured learning system comprising learning goals, operationalized outcomes, feedback mechanisms, and regulatory pedagogical decisions. Learning outcomes are conceptualized as dynamic states of learning that change in response to instructional organization. Regional models illustrate how pedagogical control and the classification of learning states can be used to adapt instructional influences under conditions of learner heterogeneity.

Conclusions. Physical education can be regarded as a legitimate domain of learning theory capable of providing conceptually coherent and empirically grounded examples of controllable and adaptive learning systems. Integrating motor learning within the learning sciences expands opportunities for interdisciplinary analysis of learning processes and contributes to bridging cognitive, procedural, and physical domains of learning.

Keywords: physical education, learning system, learning theory, modeling, pedagogical control, adaptive learning, instructional design.

Introduction

In contemporary research on learning, there is a growing tendency to expand the understanding of what constitutes a learning process. Learning is no longer limited to the transmission of declarative knowledge or the development of purely cognitive skills but increasingly encompasses complex systems of action, regulation, feedback, and adaptation (Bransford et al., 2000; Sawyer, 2014). In this context, physical education emerges as a legitimate object of learning theory, as it involves the purposeful formation of motor actions, the development of functional capacities, and the management of learning outcomes under conditions of limited resources and

heterogeneous individual learner characteristics (Schmidt & Lee, 2019).

Despite this, in many educational systems physical education remains conceptually separated from general learning theory. It is often treated either as an auxiliary activity aimed at health promotion or as an applied domain of sports training that does not require sophisticated learning models (Bailey, 2006; Kirk, 2010). Such an approach constrains opportunities for systematic analysis and instructional regulation, reducing pedagogical decision-making to empirical or intuitive practices.

This problem becomes particularly acute in the context of declining levels of motor competence and physical activity among children and adolescents, a trend documented across countries regardless of socio-economic context (World Health

Organization, 2020; van Sluijs et al., 2021). International research points to fragmented approaches to organizing physical education, insufficient integration of assessment into the learning process, and weak alignment between instructional goals and actual learning outcomes (OECD, 2019). At the same time, regional educational systems, particularly in Central and Eastern Europe, face additional challenges related to limited resources, normative inertia, and a lack of tools for pedagogical control and instructional regulation.

Within this context, the concept of modeling the learning process acquires particular significance. In learning theory, modeling is viewed as a means of formalizing complex educational systems, identifying key variables, and establishing relationships between instructional inputs and learning outcomes (Biggs, 1996; Reigeluth, 2013). Models make it possible to move beyond descriptive analysis toward prediction and evidence-informed pedagogical decision-making. Applying this approach to physical education opens the possibility of reconceptualizing it as a controllable learning system rather than a collection of isolated exercises or standardized norms.

Regional scientific traditions in physical education, particularly those developed within the Ukrainian pedagogical context, have accumulated substantial empirical and theoretical material related to the modeling of learning processes, pedagogical control, and the diagnosis of motor preparedness. These studies were typically oriented toward practical objectives of school education, such as optimizing instructional loads, individualizing learning, and improving the effectiveness of motor skill acquisition. However, their potential contribution to the development of general learning theory has often remained insufficiently articulated in the international context (Sfard, 1998; Greeno, 1998).

At the same time, international scholarly discourse increasingly employs concepts such as learning systems, adaptive learning, formative assessment, and evidence-based instructional design (Black & Wiliam, 1998; Hattie & Timperley, 2007). Within this body of research, physical and motor learning are recognized as important components of the broader learning sciences, yet often without reference to the pedagogically grounded models developed within regional educational traditions (Sawyer, 2014). This situation creates a gap between local empirical developments and global theoretical frameworks.

Against this background, there is a clear need to integrate regional experience in modeling physical education into the broader context of learning theory. Such a reconceptualization not only enhances the theoretical visibility of regional research but also enriches international discourse with concrete examples of controllable learning systems oriented toward the development of motor actions and functional capacities of learners.

The aim of this narrative review is to provide a conceptual analysis of approaches to modeling physical education as a learning system from the perspective of learning theory and to interpret regional and international perspectives on their application. The article synthesizes theoretical positions and empirical generalizations that support viewing physical education as an integrated learning system with clearly defined goals, feedback mechanisms, and instructional control strategies (Illeris, 2018; Merrill, 2002).

Materials and Methods

Methodological Positioning of the Narrative Review

This article is conducted in the format of a narrative review. The choice of this methodological approach is determined by the nature of the research task, which is not focused on synthesizing the results of individual experimental studies but on the conceptual reconceptualization of physical education as a learning system from the perspective of learning theory (Baumeister & Leary, 1997; Grant & Booth, 2009).

Unlike systematic or meta-analytic reviews, a narrative review allows for the integration of heterogeneous sources of knowledge—including theoretical frameworks, methodological approaches, and generalized empirical findings—into a coherent conceptual framework. This format is particularly appropriate when the aim is to identify conceptual linkages, explain the evolution of ideas, or interpret evidence within a broader interdisciplinary context of the learning sciences (Green et al., 2006; Grant & Booth, 2009).

The methodological foundation of the review is based on the analysis of monographic works addressing the modeling of physical education processes, pedagogical control, and the management of learning outcomes in school education. These sources are treated not as isolated empirical reports but as a coherent conceptual system integrating theory, research methods, and pedagogical practice. Particular attention is given to the logic of model construction, approaches to interpreting results, and their alignment with key principles of learning theory (Sawyer, 2014).

Within the review, the following analytical strategies are employed:

- **conceptual analysis**, aimed at identifying core concepts and assumptions underlying the modeling of physical education;
- **interpretative synthesis**, enabling the integration of regional research traditions with international theoretical approaches;
- **pedagogical interpretation**, focused on examining physical education as a learning process through the lenses of learning theory, instructional design, and educational measurement (Illeris, 2018; Merrill, 2002).

The narrative character of the review implies a selective approach to sources, prioritizing conceptual relevance over formal inclusion criteria typical of systematic reviews. This approach is methodologically justified when the objective is to construct a generalized theoretical perspective rather than to evaluate the effectiveness of specific interventions (Baumeister & Leary, 1997; Green et al., 2006).

A key methodological assumption of the review is the treatment of motor learning as part of a broader educational process. Accordingly, the analysis employs concepts central to learning theory, including learning goals, feedback, adaptation, control, learning outcomes, and instructional regulation. This perspective avoids reducing physical education to biomedical or purely sport-oriented models and ensures its integration into the interdisciplinary domain of the learning sciences (Sfard, 1998; Greeno, 1998).

Thus, the methodological position of this narrative review lies in combining regional monographic expertise with international theoretical frameworks of learning theory.

Table 1. Conceptual Mapping of Source Types Included in the Narrative Review

Source category	Focus	Role in the review
Learning theory frameworks	Learning systems, feedback, regulation	Conceptual anchoring
Instructional design models	Goal alignment, task sequencing	Structural modeling
Motor learning research	Skill acquisition, retention, transfer	Domain-specific learning logic
Pedagogical control studies	Measurement, adaptation, differentiation	Feedback and regulation mechanisms
Regional monographs and studies	Modeling and control in PE	Empirical grounding and contextualization

This approach provides a foundation for the subsequent analysis of physical education as a learning system and for discussing its conceptual contribution to contemporary learning research.

Data Source and Search Strategy

This narrative review is based on an integrative analysis of monographic works, articles published in peer-reviewed journals, and international conceptual documents addressing physical education, motor learning, and learning systems. Primary attention was given to sources in which physical education is explicitly or implicitly interpreted as a structured, controllable, and feedback-driven learning process.

Source selection was conducted through targeted searches in scientific databases and publisher platforms (Scopus, Google Scholar, Crossref, journal websites), as well as through backward citation tracking of key theoretical works. The review primarily focused on sources published between 1995 and 2025, reflecting the development of contemporary learning theory and instructional design. The selection process was conceptually oriented, consistent with the aims of a narrative review rather than exhaustive literature coverage.

Sources were included if they contained at least one of the following conceptual components:

- modeling of learning or instructional processes;
- pedagogical control and feedback mechanisms;
- adaptive or differentiated learning in physical education;
- operationalization of learning outcomes in the motor domain.

Sources were included if they provided either (a) theoretically grounded models of learning systems, or (b) empirically validated approaches to pedagogical control and adaptation relevant to physical education. Priority was given to works that explicitly connected instructional design, feedback, and learning outcomes.

Regional sources were included when they presented clearly articulated models, pedagogical decision-making logic, or instrumental approaches relevant to learning theory. International sources were used to conceptually anchor the analysis within the learning sciences and instructional design. This strategy enabled a theoretically grounded synthesis of regional and international perspectives on physical education as a learning system.

The table 1 illustrates the conceptual logic of source selection rather than an exhaustive list of included publications, consistent with the aims of a narrative review.

The present review deliberately refrains from proposing a new schematic framework or visual model of physical education as a learning system. Although diagrammatic

representations are common in educational research, their proliferation has not necessarily led to greater conceptual clarity or cumulative theoretical progress. In the context of this narrative review, the primary analytical contribution lies not in introducing another formalized scheme, but in reinterpreting physical education through the conceptual language of learning theory—specifically, by treating learning outcomes as dynamic learning states shaped by feedback, regulation, and instructional decision-making.

Results

Physical Education as a Learning System: Conceptual Foundations

Viewing physical education as a learning system is grounded in the understanding of learning as a controlled, goal-oriented, and feedback-dependent process. Within this framework, physical education ceases to be a collection of isolated exercises or normative requirements and is instead conceptualized as a structured educational process in which outcomes are determined not only by the volume of physical activity but also by the quality of instructional design, regulatory mechanisms, and the adequacy of feedback (Bransford et al., 2000; Sawyer, 2014).

Learning Goals and Outcomes in Physical Education

From the perspective of learning theory, any learning system presupposes clearly defined goals and operationalized outcomes. In physical education, such outcomes include acquired motor skills, levels of motor abilities, functional readiness, and students' capacity for further learning and physical activity. Importantly, these outcomes have a learning character: they are formed gradually, depend on prior experience, and are subject to pedagogical influence (Illeris, 2018; Schmidt & Lee, 2019).

In contrast to approaches that emphasize final indicators or normative achievements, a learning-oriented perspective conceptualizes physical education outcomes as dynamic learning states that change in response to the organization of the instructional process. This creates opportunities to adapt learning goals and instructional means to individual learner characteristics (Biggs, 1996).

Structure of the Physical Education Learning System

Within a systems approach, physical education can be described as a learning system comprising interrelated components: learning content, learning conditions, learners, feedback mechanisms, and regulatory decisions. This structure is fundamentally similar to learning models used

Table 2. Key Constructs of the Physical Education Learning System and Their Operationalization

Construct	Conceptual Definition	Observable Indicators	Measurement Tools	Pedagogical Decisions
Learning goals	Planned learning outcomes	Level of motor skill acquisition	Tests, learning tasks	Task selection and progression
Learning tasks	Structured motor actions and exercises	Accuracy, coordination, stability	Observation, checklists	Modification and sequencing
Learning conditions	Organizational and load parameters	Intensity, volume, frequency	Load logs	Adjustment of regimes
Feedback	Information about learning progress	Error dynamics, progress	Formative assessment	Immediate/delayed correction
Regulatory decisions	Adaptation of the learning process	Task difficulty changes	Threshold rules	Instructional differentiation
Learning outcomes	Dynamic learning states	Retention, transfer	Repeated measurements	Revision of goals

in other educational domains and ensures the conceptual compatibility of physical education with learning theory (Reigeluth, 2013; Merrill, 2002).

Identifying these components makes it possible to conceptualize physical education as a coherent system in which changes in one element inevitably affect the functioning of others. This provides a foundation for systemic analysis and purposeful management of the learning process (Davis & Sumara, 2006).

This structure closely parallels learning models applied in other educational fields and ensures the conceptual alignment of physical education with learning theory (Table 2).

Modeling as a Core Mechanism of the Learning System

Within this system, modeling functions as both a theoretical and practical tool that enables the generalization of instructional experience, identification of regularities, and prediction of pedagogical effects. From a learning theory perspective, a model represents a simplified yet conceptually meaningful reflection of the real learning process that preserves its essential characteristics (Reigeluth, 2013).

In physical education, models make it possible to describe relationships between learning tasks and outcomes, determine optimal instructional load regimes, classify learner states for instructional differentiation, and support data-informed pedagogical decision-making. In this way, modeling serves as a bridge between learning theory and pedagogical practice, facilitating the transition from intuitive decision-making to evidence-based instructional design (Merrill, 2002; Biggs, 1996).

Feedback and Regulation of the Learning Process

One of the defining features of a learning system is the presence of effective feedback. In physical education, this function is implemented through pedagogical control, which allows educators to assess not only achieved outcomes but also the current state of learning. In terms of learning theory, pedagogical control corresponds to mechanisms of formative assessment that support real-time regulation of the instructional process (Black & Wiliam, 1998; Hattie & Timperley, 2007).

Feedback within the physical education learning system informs teachers about the alignment between instructional influences and learners' capabilities, enables the detection of deviations from planned learning trajectories, and creates conditions for individualized instruction. This highlights the fundamental distinction between learning-oriented and norm-oriented models of physical education (Sadler, 1989).

This logic is complemented by the concept of teaching styles in physical education, which conceptualizes the instructional process as a system of pedagogical decisions distributed between the teacher and the learner (Mosston & Ashworth, 2008). This approach reinforces the view of physical education as a controllable learning system, in which adaptivity is achieved through changes in decision structures and feedback mechanisms rather than solely through variation in exercise content.

Adaptivity and Controllability as Learning Principles

Interpreting physical education as a learning system presupposes its adaptivity—the capacity to modify instructional parameters in response to data on learner states and learning outcomes. In this respect, physical education aligns with contemporary models of adaptive learning that are actively explored in the learning sciences (Zimmerman, 2002; Nicol & Macfarlane-Dick, 2006).

Controllability of the learning system is achieved through the integration of modeling, feedback, and regulatory decisions. This enables a shift from standardized, one-size-fits-all programs toward flexible learning trajectories aligned with learners' actual capabilities, consistent with contemporary conceptions of effective instructional design (Merrill, 2002; Reigeluth, 2013).

Regional Perspective: Modeling and Pedagogical Control in Ukrainian Physical Education

The regional dimension of modeling in physical education has developed in response to specific educational and social challenges faced by the school system. In the Ukrainian context, these challenges are associated with the combination of high demands for learning outcomes, limited resources, and the need to work with student groups that are highly heterogeneous in terms of preparedness. These conditions have driven the development of approaches in

which physical education is viewed as a controllable learning system rather than as a set of standardized norms (Khudolii, 2019; Ivashchenko, 2016, 2020).

Educational Context and the Demand for Learning Controllability

For a long time, the Ukrainian system of physical education operated within a norm-oriented paradigm, focusing primarily on the fulfillment of curriculum requirements and attainment of prescribed performance indicators. However, empirical observations and results of pedagogical research have demonstrated the limited effectiveness of this approach under conditions of pronounced differentiation among students in health status, motor preparedness, and learning motivation. This has created a demand for tools capable of ensuring controllability and adaptability of the learning process, particularly through modeling instructional influences and systematic pedagogical control (Ivashchenko, Nosko et al., 2019; Iermakov et al., 2021; Mugurdinova & Iermakov, 2022).

Pedagogical Control as a System-Forming Element

Within the regional research tradition, pedagogical control is regarded as a key component of the learning system in physical education. Its function extends beyond outcome evaluation to include diagnosis of the current learning state, enabling evidence-informed pedagogical decisions. Control is integrated into the learning process and serves as a continuous feedback mechanism linking instructional influences with learning outcomes, thereby supporting the adjustment of instructional regimes and workloads (Ivashchenko et al., 2019; Ivashchenko et al., 2020; Iermakov et al., 2021).

This approach conceptually aligns physical education with principles of learning theory, in which formative assessment constitutes the foundation of adaptive learning. In practical terms, this implies a shift from episodic testing to systematic monitoring of students' motor and functional preparedness, allowing the dynamics of learning effects to be tracked over time (Ivashchenko, 2020; Khudolii, Kapkan et al., 2020).

Modeling the Learning Process in School Physical Education

In regional studies, modeling is used as a tool for describing, analyzing, and optimizing the learning process. Models make it possible to generalize the results of pedagogical experiments and translate them into decision-making rules that are understandable for practitioners. In particular, modeling is applied to determine optimal instructional load

regimes, sequences of motor skill formation, and conditions for the development of motor abilities (Khudolii, 2019; Ivashchenko, 2016; Ivashchenko et al., 2020).

From the perspective of learning theory, such models perform the function of instructional design, as they define the logic of learning organization and ensure alignment between instructional goals and learners' capabilities. Empirical evidence confirms that changes in instructional regimes and exercise structure lead to different immediate and delayed learning effects, which is fundamentally important for controlled learning (Ivashchenko et al., 2020; Khudolii, Iermakov, & Bartik, 2020; Iermakov et al., 2021).

Classification of Learning States and Instructional Differentiation

An important element of the regional approach is the use of classification models to identify states of motor and functional preparedness. From an instructional perspective, these states can be interpreted as levels of learning readiness that are directly relevant for instructional differentiation. The application of pattern recognition and classification methods allows students to be grouped in a theoretically grounded manner and instructional influences to be adapted to their current learning state (Ivashchenko, 2016; Ivashchenko et al., 2019; Iermakov et al., 2021).

Classification makes it possible to identify groups of learners with different instructional needs, adapt tasks and workloads, and prevent overload or insufficient stimulation. This strengthens the learning-oriented nature of physical education and reduces the risk of formal curriculum implementation without genuine acquisition of learning content (Ivashchenko, 2016; Khudolii et al., 2020).

Regional Experience as a Source of Conceptual Generalization

Although regional studies are often oriented toward solving local pedagogical problems, their content has considerable potential for theoretical generalization. Models of physical education developed in the Ukrainian context demonstrate how a learning system can be organized under conditions of limited resources and high variability in learner characteristics while maintaining controllability and predictability of learning outcomes (Ivashchenko, 2016, 2020; Khudolii, 2019).

In this sense, regional experience is not peripheral or secondary, but constitutes valuable material for the development of learning theory, as it illustrates the practical implementation of adaptive learning principles, feedback mechanisms, and instructional differentiation in real educational environments (Khudolii et al., 2020; Khudolii et al., 2025).

Table 3. Conceptual Mapping of Regional Approaches and Learning Theory

Regional Concept	Learning Theory Counterpart	Added Conceptual Value	Pedagogical Implications
Pedagogical control	Formative assessment	Learning regulation	Data-informed decisions
Process modeling	Instructional design	Learning structure	Reduced reliance on intuition
State classification	Levels of learning readiness	Adaptivity	Instructional differentiation
Load regulation	Adaptation parameters	Optimization	Overload prevention
Learning dynamics	Learning trajectories	Long-term control	Progress monitoring

International Perspective: Convergence with Learning Theory and Educational Research

The international scholarly discourse in learning theory and educational research increasingly conceptualizes learning as a systemic, adaptive, and controllable process in which feedback, regulation, and instructional design play a central role (How People Learn; The Cambridge Handbook of the Learning Sciences). Within this context, physical education is gradually being integrated into the broader field of learning sciences, where motor learning is considered alongside cognitive, procedural, and social learning. This integration provides a basis for comparing regional models of physical education with international theoretical frameworks.

Physical Education in International Learning Models

In contemporary international research, physical education is increasingly less likely to be treated as an autonomous discipline isolated from general educational theory. Instead, it is viewed as part of a learning environment in which motor competencies, self-regulation, lifelong learning capacity, and health-related practices are developed (OECD, 2019; United Nations Educational, Scientific and Cultural Organization, 2015). In this sense, physical education converges with other learning domains in which learning goals, feedback, and adaptation of instructional influences play a key role.

International learning-oriented approaches emphasize that learning effectiveness is determined not only by the content of tasks, but also by their organization, sequencing, level of difficulty, and alignment with learners' capabilities (Hattie, 2009; Black & William, 1998). These principles are conceptually consistent with the model-based approach to physical education, in which the learning process is described as a system of interrelated components.

Modeling as a Universal Methodological Language

One of the key points of convergence between regional and international approaches is the use of modeling as a universal methodological tool. In international educational research, models are employed to describe learning processes, analyze interactions between learners and learning environments, and predict learning outcomes (Instructional-Design Theories and Models).

Within this context, models of physical education developed in regional studies can be interpreted as part of a broader tradition of instructional modeling. They meet general requirements of learning theory in that they formalize the structure of the learning process, are grounded in empirical data, and support pedagogical decision-making aimed at optimizing learning outcomes (Complexity and Education).

Feedback and Formative Assessment in an International Context

In international learning theory, feedback is regarded as one of the core mechanisms of effective learning. Formative assessment and adaptation of the learning process are central concepts in contemporary learning sciences (Black & William, 1998; Hattie & Timperley, 2007). From this perspective, pedagogical control as applied in model-based approaches to physical education is conceptually aligned with international understandings of learning feedback.

Adaptive Learning and Motor Competence

International research on adaptive learning highlights the importance of accounting for individual differences among learners in pace, learning style, and outcomes (Zimmerman, 2002). In physical education, these differences are particularly pronounced due to variability in motor competence and functional readiness.

Studies of motor competence demonstrate that the level of motor skill development is closely associated with subsequent learning engagement and physical activity, strengthening the argument in favor of adaptive approaches to organizing physical education (Stodden et al., 2008; Barnett et al., 2016).

International Relevance of Regional Experience

Regional studies of physical education that focus on modeling and pedagogical control demonstrate a high degree of methodological compatibility with international educational research. Their value lies in providing empirically validated examples of learning system implementation in real educational contexts, thereby complementing international theoretical frameworks with concrete pedagogical content.

Conceptual Contribution to Learning Theory

Reconceptualizing physical education as a learning system is of fundamental importance for the development of contemporary learning theory. The materials synthesized in this narrative review demonstrate that physical education not only meets the basic criteria of a learning process but also provides unique opportunities for theoretical analysis of learning as a controlled, adaptive, and measurable system (Khudolii, 2019; Ivashchenko, 2020).

Physical Education as a Full-Fledged Domain of Learning Theory

In traditional educational models, learning theory has primarily focused on cognitive learning, while motor learning has often been treated as peripheral or purely applied. The analysis of model-based approaches to physical education indicates the need to reconsider this assumption. The formation of motor actions, the development of motor abilities, and functional readiness exhibit all key characteristics of learning, including goal-directedness, staged progression, dependence on prior experience, and sensitivity to feedback (Khudolii, 2019; Ivashchenko et al., 2019).

Within this context, physical education emerges as a domain in which learning outcomes are directly observable, measurable, and subject to regulation. This makes it particularly valuable for learning theory, as it enables the investigation of learning processes with a high degree of operationalization of variables and allows for real-time tracking of learning dynamics (Ivashchenko, 2020; Iermakov et al., 2021).

Modeling as a Mechanism for Conceptualizing Learning

One of the key contributions to learning theory discussed in this review is the interpretation of modeling not merely as an analytical tool, but as a mechanism for conceptualizing the learning process itself. In this approach, a model performs

a dual function: it serves simultaneously as a theoretical generalization and as a practical instrument for managing learning (Khudolii, 2019).

Models in physical education make it possible to formalize the structure of the learning process, identify critical parameters of instructional influence, describe relationships between learning conditions and outcomes, and predict learning dynamics. From the perspective of learning theory, this represents a shift from descriptive models toward controlled learning systems in which pedagogical decisions are grounded in theoretically justified and empirically verified relationships (Ivashchenko, 2020; Ivashchenko et al., 2020).

Feedback as a Central Mechanism of Learning

Of particular conceptual significance is the interpretation of pedagogical control as a mechanism of learning feedback. Within the model-based approach, control is integrated into the learning process and used to regulate instructional influences rather than to perform formal evaluation of achievements (Ivashchenko et al., 2019; Iermakov et al., 2021).

In terms of learning theory, this corresponds to contemporary conceptions of formative assessment, in which information about learning outcomes serves as the basis for adapting instructional design. Such an approach makes it possible to maintain an optimal level of task difficulty, avoid both overload and underlearning, and support individualized learning trajectories. In this sense, physical education functions as an example of a learning system with clearly implemented cycles of “action – feedback – adjustment” (Khudolii et al., 2020).

Classification of Learning States and Adaptive Learning

The use of classification models to identify states of motor and functional readiness is directly related to theories of adaptive learning. In an instructional interpretation, such states can be regarded as levels of learning readiness that determine the feasibility and appropriateness of specific instructional interventions (Ivashchenko et al., 2019; Iermakov et al., 2021).

This approach enables the integration of physical education into general models of adaptive learning, in which instructional decisions depend on diagnostic data, learning trajectories remain flexible, and the system responds dynamically to changes in the learner’s state. Consequently, physical education emerges as a natural laboratory for studying adaptive learning systems, which is of significant conceptual value for learning sciences (Khudolii et al., 2020).

Contribution to Interdisciplinary Learning Theory

Reconceptualizing physical education as a learning system contributes to the expansion of learning theory by integrating the motor domain into its conceptual scope. This integration helps reduce the gap between cognitive and procedural learning, connects pedagogical, psychological, and physiological dimensions of learning within a unified framework, and supports the interpretation of learning as a universal process independent of specific subject matter (Khudolii et al., 2020; Khudolii et al., 2025).

This constitutes the key conceptual contribution of the proposed approach: physical education ceases to be viewed as

a “special case” and acquires the status of a full-fledged object of learning theory, capable of enriching general understandings of the structure, mechanisms, and controllability of learning processes.

Discussion

This review contributes to contemporary discussions in the learning sciences by offering a conceptually oriented reinterpretation of physical education as a learning process. Drawing on established constructs from learning theory—such as feedback, formative assessment, adaptive regulation, and learning trajectories—it demonstrates how physical education can be systematically analyzed without reducing learning to normative performance indicators or isolated instructional techniques. By prioritizing conceptual integration and theoretical alignment, the review seeks to facilitate cumulative dialogue between physical education research and broader frameworks of learning theory.

The discussion of the results of this narrative review should begin with a synthesis of its central argument: physical education can be conceptualized as a learning system that operates according to general principles of learning theory. This perspective makes it possible to integrate regional models of physical education into the international discourse of learning sciences and to overcome the traditional opposition between motor and cognitive learning (Sfard, 1998; Khudolii, 2019; Khudolii et al., 2020).

It is important to emphasize that the interpretation of physical education as a learning system proposed in this article is not based solely on theoretical considerations. Rather, it has emerged from long-term pedagogical research in which modeling of the learning process, pedagogical control, and classification of learning states were operationalized and empirically tested in school settings.

Within these studies, learning outcomes were conceptualized not as isolated summative indicators but as dynamic learning states that change under the influence of regulatory pedagogical decisions. Models developed using discriminant and regression analysis made it possible to describe and predict the dynamics of motor skill formation and to optimize instructional influences with consideration of individual learner characteristics.

Thus, the concept of a learning system in physical education reflects an empirically verified logic of instructional organization in which feedback and regulation play a central role. In this sense, physical education can be regarded as an example of an adaptive learning system with direct relevance for the development of contemporary learning theory.

Physical Education Between Applied Practice and Learning Theory

One of the key points of discussion concerns the status of physical education within educational sciences. In many international publications, physical education is treated primarily as an applied field oriented toward health or physical activity outcomes, while its learning potential remains insufficiently conceptualized (Kirk, 2010; Bailey, 2006). The materials analyzed in this review indicate that such a reduction is methodologically limiting.

The model-based approach demonstrates that physical education includes all core elements of a learning process: learning goals, structured instructional content, feedback mechanisms, and regulation of instructional influences. This makes it possible to view physical education not as a supplementary discipline but as a full-fledged learning domain capable of contributing to the development of learning theory (Biggs, 1996; Ivashchenko, 2016; Khudolii, 2019).

Interpreting Regional Models in an International Context

An important aspect of the discussion concerns the translational value of regional research. The Ukrainian tradition of modeling physical education emerged in response to specific educational constraints and practical needs. However, the analysis shows that these models exhibit a high degree of methodological alignment with international approaches in learning theory (Hattie & Timperley, 2007; Ivashchenko, 2020).

In particular, the emphasis on pedagogical control as a feedback mechanism and the use of state classification for instructional differentiation fully correspond to contemporary conceptions of adaptive learning and formative assessment. This allows regional models to be interpreted not as local cases but as empirically grounded examples of learning system implementation in real educational contexts (Black & Wiliam, 1998; Iermakov et al., 2021).

Modeling and the Limits of Generalization

At the same time, the model-based approach has limitations that require critical reflection. First, any model represents a simplification of the real learning process and cannot fully capture the complexity of individual and social factors in learning. Second, models developed within a specific educational context require careful adaptation when transferred to other educational systems (Reigeluth, 2013).

In this regard, it is important to emphasize that the value of models lies not in their universality but in their heuristic capacity. Models help structure the learning process, identify critical parameters, and support evidence-informed pedagogical decision-making. From the perspective of learning theory, this is consistent with the understanding of models as tools for thinking rather than rigid instructional prescriptions (Davis & Sumara, 2006; Khudolii, 2019; Ivashchenko, 2020).

Pedagogical Control: Between Assessment and Learning

A separate issue concerns the interpretation of pedagogical control. In traditional pedagogical practice, control is often associated with summative assessment or selection. In the model-based approach analyzed in this article, control serves a fundamentally different function: it operates as a mechanism for regulating the learning process (Ivashchenko et al., 2019; Ivashchenko, 2020).

This brings physical education closer to contemporary theories of formative assessment, in which data on learning outcomes are used to adapt instructional design. From a discussion perspective, this raises the issue of revising traditional assessment practices in physical education and aligning them with learning goals (Hattie & Timperley, 2007; Khudolii et al., 2020).

Although the concept of teaching styles in physical education proposed in Teaching Physical Education convincingly demonstrates how the distribution of pedagogical decisions influences students' autonomy, the classical model remains largely descriptive with respect to feedback mechanisms. In particular, it provides limited tools for operationalizing learning states and learning data required for adaptive regulation of instruction. Combining the spectrum of teaching styles with model-oriented approaches to pedagogical control enables a shift from stylistic typologies to managed adaptive learning systems.

Contribution of Motor Learning to Learning Sciences

The results of the review also allow discussion of a broader issue—the role of motor learning in the development of learning sciences. Physical education, due to the high observability and measurability of learning outcomes, provides unique conditions for studying learning processes, feedback, and adaptation (Schmidt & Lee, 2019; Ivashchenko, 2020).

In this sense, motor learning can be regarded not as a peripheral field but as an important source of empirical and theoretical insights for general learning theory. This opens perspectives for interdisciplinary research integrating physical education, cognitive psychology, pedagogy, and educational measurement (Khudolii et al., 2025).

Transferability and Boundary Conditions

The applicability of the proposed learning system model depends on a number of conditions. Effective implementation requires access to basic assessment tools, sufficient time for instructional regulation based on feedback, and teachers' readiness to interpret learning data. In educational contexts where systematic measurement or instructional autonomy is lacking, the model performs primarily a heuristic rather than a fully operational function. This underscores the need to align learning systems with available resources and institutional conditions.

Directions for Further Reflection

The discussion also outlines directions for further research. In particular, the following areas require development:

- integrated models combining motor and cognitive learning outcomes;
- empirical studies of adaptive learning systems in physical education;
- comparative studies examining the applicability of model-based approaches across different educational contexts.

Such directions will not only deepen theoretical understanding of learning but also strengthen the position of physical education within the interdisciplinary field of learning sciences (OECD, 2019; UNESCO, 2015).

Conclusions and Implications for Learning Research

In this narrative review, physical education has been reconceptualized as a learning system that operates according

to general principles of learning theory. The analysis of regional and international approaches to modeling the learning process demonstrates that physical education is not a peripheral or auxiliary domain of education but constitutes a legitimate field within the learning sciences, characterized by its own learning goals, regulatory mechanisms, and measurable learning outcomes.

A central conclusion of the review is that modeling provides a conceptual framework for integrating diverse components of physical education—learning content, instructional conditions, individual learner characteristics, and pedagogical control—into a single controllable system. Within such a system, learning outcomes are interpreted as dynamic states of learning, and pedagogical decisions are grounded in feedback data rather than intuitive or purely normative assumptions.

The regional experience of modeling physical education developed within the Ukrainian pedagogical tradition illustrates how learning systems can function effectively under conditions of limited resources and high variability in learner characteristics. At the same time, analysis of the international scholarly discourse reveals a high degree of methodological compatibility between this experience and contemporary approaches in learning theory, particularly adaptive learning, formative assessment, and evidence-based instructional design. This compatibility supports the feasibility and value of integrating regional developments into the global theoretical context.

From the perspective of learning theory, particular significance lies in interpreting pedagogical control as a mechanism of learning feedback. This approach strengthens the learning-oriented nature of physical education, enhances the adaptivity of the instructional process, and creates conditions for the individualization of learning trajectories. The use of classification models to identify states of learning readiness further highlights the potential of physical education as a laboratory for investigating controllable learning systems.

For learning theory, the findings of this review have several important implications. First, they expand the scope of the learning sciences by incorporating the motor domain, thereby reducing the conceptual divide between cognitive, procedural, and physical learning. Second, they demonstrate that learning systems with a high level of operationalized variables can serve as an effective basis for testing theoretical assumptions about feedback, adaptation, and instructional control. Third, they underscore the importance of an interdisciplinary approach that integrates pedagogy, learning psychology, and educational measurement.

Future research should focus on the development of integrated learning models that combine motor, cognitive, and social outcomes, as well as on the empirical validation of adaptive learning systems across diverse educational contexts. In this process, physical education may play a key role as a domain in which learning processes are directly observable, measurable, and controllable.

Ethics Approval

Ethical approval was not required for this study because it was based exclusively on secondary or fully anonymized data.

Informed Consent

Not applicable.

Data Availability Statement

Data availability is not applicable to this article as no new data were created or analyzed.

Declaration on the Use of Artificial Intelligence

During the preparation of this article, artificial intelligence tools were used as auxiliary means for language editing, stylistic refinement, and text structuring. Artificial intelligence was not used for generating scientific data, analyzing empirical results, or formulating scientific conclusions. All conceptual positions, interpretations, and conclusions are the result of the authors' intellectual work, and the authors bear full responsibility for the content of the publication.

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Conflict of Interest

The authors declare no conflicts of interest.

References

- Bransford, J.D., Brown, A.L., & Cocking, R.R. (Eds.). (2000). *How People Learn: Brain, Mind, Experience, and School*. National Academies Press.
- Sawyer, R.K. (Ed.). (2014). *The Cambridge Handbook of the Learning Sciences* (2nd ed.). Cambridge University Press.
- Schmidt, R.A., & Lee, T.D. (2019). *Motor Learning and Performance: From Principles to Application* (6th ed.). Human Kinetics.
- Bailey, R. (2006). Physical Education and Sport in Schools: A Review of Benefits and Outcomes. *Journal of School Health*, 76(8), 397-401. <https://doi.org/10.1111/j.1746-1561.2006.00132.x>
- Kirk, D. (2010). *Physical Education Futures*. Routledge. <https://doi.org/10.4324/9780203874622>
- World Health Organization. (2020). *WHO Guidelines on Physical Activity and Sedentary Behaviour*. WHO.
- van Sluijs, E.M. F., Ekelund, U., Crochemore-Silva, I., et al. (2021). Physical Activity Behaviours in Adolescence: Current Evidence and Opportunities for Intervention. *The Lancet Child & Adolescent Health*, 5(7), 451-460.
- OECD. (2019). *Making Physical Education Dynamic and Inclusive for 2030: International Curriculum Analysis*. OECD Publishing.
- Biggs, J. (1996). Enhancing Teaching Through Constructive Alignment. *Higher Education*, 32(3), 347-364. <https://doi.org/10.1007/BF00138871>
- Reigeluth, C.M. (Ed.). (2013). *Instructional-Design Theories and Models: A New Paradigm of Instructional Theory* (Vol. 2). Routledge.
- Sfard, A. (1998). On Two Metaphors for Learning and the Dangers of Choosing Just One. *Educational Researcher*, 27(2), 4-13. <https://doi.org/10.3102/0013189X027002004>

- Greeno, J.G. (1998). The Situativity of Knowing, Learning, and Research. *American Psychologist*, 53(1), 5-26. <https://doi.org/10.1037/0003-066X.53.1.5>
- Black, P., & Wiliam, D. (1998). Assessment and Classroom Learning. *Assessment in Education: Principles, Policy & Practice*, 5(1), 7-74. <https://doi.org/10.1080/0969595980050102>
- Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research*, 77(1), 81-112. <https://doi.org/10.3102/003465430298487>
- Illeris, K. (Ed.). (2018). *Contemporary Theories of Learning: Learning Theorists ... in Their Own Words* (2nd ed.). Routledge.
- Merrill, M.D. (2002). First Principles of Instruction. *Educational Technology Research and Development*, 50(3), 43-59. <https://doi.org/10.1007/BF02505024>
- Baumeister, R.F., & Leary, M.R. (1997). Writing Narrative Literature Reviews. *Review of General Psychology*, 1(3), 311-320. <https://doi.org/10.1037/1089-2680.1.3.311>
- Grant, M.J., & Booth, A. (2009). A Typology of Reviews: An Analysis of 14 Review Types and Associated Methodologies. *Health Information & Libraries Journal*, 26(2), 91-108. <https://doi.org/10.1111/j.1471-1842.2009.00848.x>
- Green, B.N., Johnson, C.D., & Adams, A. (2006). Writing Narrative Literature Reviews for Peer-Reviewed Journals: Secrets of the Trade. *Journal of Chiropractic Medicine*, 5(3), 101-117.
- Davis, B., & Sumara, D. (2006). *Complexity and Education: Inquiries Into Learning, Teaching, and Research*. Lawrence Erlbaum.
- Sadler, D.R. (1989). Formative Assessment and the Design of Instructional Systems. *Instructional Science*, 18(2), 119-144. <https://doi.org/10.1007/BF00117714>
- Mosston, M., & Ashworth, S. (2008). *Teaching Physical Education* (6th ed.). Pearson.
- Zimmerman, B.J. (2002). Becoming a Self-Regulated Learner: An Overview. *Theory Into Practice*, 41(2), 64-70. https://doi.org/10.1207/s15430421tip4102_2
- Nicol, D.J., & Macfarlane-Dick, D. (2006). Formative Assessment and Self-Regulated Learning: A Model and Seven Principles of Good Feedback Practice. *Studies in Higher Education*, 31(2), 199-218. <https://doi.org/10.1080/03075070600572090>
- Khudolii, O.M. (2019). Research Program: Modeling of Young Gymnasts' Training Process. *Physical Education Theory and Methodology*, 19(4), 168-178. <https://doi.org/10.17309/tmfv.2019.4.02>
- Ivashchenko, O.V. (2016). *Modeling the process of physical education of schoolchildren (Modeliuvannia protsesu fizychnoho vykhovannia shkoliariv)*. Kharkiv, Ukraine: OVS.
- Ivashchenko, O. (2020). Research Program: Modeling of Motor Abilities Development and Teaching of Schoolchildren. *Physical Education Theory and Methodology*, 20(1), 32-41. <https://doi.org/10.17309/tmfv.2020.1.05>
- Ivashchenko, O.V., Nosko, M.O., Nosko, Y.M., & Chernenko, S.O. (2019). Pattern Recognition: Description of Modes of Teaching Boys Aged 7 Throwing a Small Ball at a Vertical Target. *Physical Education Theory and Methodology*, 19(3), 130-138. <https://doi.org/10.17309/tmfv.2019.3.04>
- Iermakov, S., Khudolii, O., & Chupikhin, D. (2021). Discriminant Analysis: Impact of the Number of Repetitions on the Effectiveness of Teaching Boys Aged 7 Throwing a Small Ball. *Journal of Learning Theory and Methodology*, 2(2), 75-81. <https://doi.org/10.17309/jltm.2021.2.04>
- Mugurdinova, I., & Iermakov, S. (2022). Pattern Recognition: Effectiveness of Teaching Boys Aged 14 the Press Headstand and Handstand. *Journal of Learning Theory and Methodology*, 3(1), 11-17. <https://doi.org/10.17309/jltm.2022.1.02>
- Khudolii, O., Kapkan, O., Harkusha, S., Marchenko, S., & Veremeenko, V. (2020). Motor Skills Development: Optimization of Teaching Boys Aged 15 Press Headstand and Handstand. *Physical Education Theory and Methodology*, 20(1), 42-48. <https://doi.org/10.17309/tmfv.2020.1.06>
- Khudolii, O., Iermakov, S., & Bartik, P. (2020). Didactics: Methodological Basis of Motor Learning in Children and Adolescents. *Journal of Learning Theory and Methodology*, 1(1), 5-13. <https://doi.org/10.17309/jltm.2020.1.01>
- Khudolii, M., Ivashchenko, O., & Khudolii, O. (2025). Fundamental Movement Skills Development in Children Aged 5-12: Theory, Evidence, and Pedagogical Models. *Physical Education Theory and Methodology*, 25(6), 1456-1470. <https://doi.org/10.17309/tmfv.2025.6.16>
- UNESCO. (2015). *Quality Physical Education (QPE): Guidelines for Policy-Makers*. UNESCO.
- Hattie, J. (2008). *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*. Routledge. <https://doi.org/10.4324/9780203887332>
- Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Robertson, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *Quest*, 60(2), 290-306. <https://doi.org/10.1080/00336297.2008.10483582>
- Barnett, L.M., Lai, S.K., Veldman, S.L. C., Hardy, L.L., Cliff, D.P., Morgan, P.J., Zask, A., Lubans, D.R., & Rush, E. (2016). Correlates of Gross Motor Competence in Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Medicine*, 46(11), 1663-1688. <https://doi.org/10.1007/s40279-016-0495-z>
- Ivashchenko, O., Khudolii, O., Prusik, K., & Giovanis, V. (2020). Strength Abilities: Immediate and Delayed Training Effects of Orthogonal Modes of Strength Training in Boys Aged 8 Years. *Physical Education Theory and Methodology*, 20(2), 109-116. <https://doi.org/10.17309/tmfv.2020.2.07>

Моделювання фізичного виховання як навчальної системи: регіональний та міжнародний виміри

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 11 с., 3 табл., 38 джерел.

Обґрунтування. У сучасних дослідженнях навчання освітні процеси дедалі частіше концептуалізуються як керовані, адаптивні та зворотно пов'язані системи. Попри це, фізичне виховання нерідко розглядається як концептуально відокремлене від загальної теорії навчання й переважно трактується як прикладна або нормативно орієнтована діяльність. Така редукція обмежує можливості системного аналізу, інструкційного дизайну та інтеграції механізмів формувального оцінювання.

Мета. Метою статті є концептуальне переосмислення фізичного виховання як навчальної системи з позицій теорії навчання, а також аналіз регіональних і міжнародних підходів до моделювання навчальних процесів і педагогічної регуляції навчальних результатів.

Матеріали і методи. Дослідження виконано у форматі нарративного огляду. Його методологічну основу становить концептуальний аналіз монографічних праць і публікацій у рецензованих наукових журналах, присвячених моделюванню навчального процесу, педагогічному контролю, адаптивному навчанню та інструкційному дизайну у фізичному вихованні. Відбір джерел здійснювався за концептуально орієнтованою стратегією з метою виявлення теоретично й емпірично обґрунтованих моделей навчальних систем.

Результати. Показано, що фізичне виховання може бути інтерпретоване як структурована навчальна система, яка включає навчальні цілі, операціоналізовані результати, механізми зворотного зв'язку та регуляторні педагогічні рішення. Навчальні результати концептуалізуються як динамічні стани навчання, що змінюються залежно від організації навчального процесу. Регіональні моделі ілюструють, як педагогічний контроль і класифікація станів навчання можуть використовуватися для адаптації педагогічних впливів за умов гетерогенності учнів.

Висновки. Фізичне виховання може розглядатися як легітимна галузь теорії навчання, здатна надавати концептуально узгоджені та емпірично обґрунтовані приклади керованих і адаптивних навчальних систем. Інтеграція моторного навчання у сферу learning sciences розширює можливості міждисциплінарного аналізу навчальних процесів і сприяє подоланню розриву між когнітивними, процедурними та фізичними доменами навчання.

Ключові слова: фізичне виховання, навчальна система, теорія навчання, моделювання, педагогічний контроль, адаптивне навчання, інструкційний дизайн.

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