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Review Article

The Meta-Problem in Scientific Research in Physical Education and Sport: Architecture and Pathways to Knowledge

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Abstract

Background. Contemporary scientific research increasingly faces not a shortage of data, but a shortage of an adequate level of generalization at which data can be transformed into knowledge. In many applied fields, including physical education and sport, technically correct studies often remain fragmented because they are not integrated into a broader explanatory framework.

Purpose. To systematize approaches to understanding the meta-problem and its operationalization in research on physical education and sport.

Materials and Methods. The study was conducted as a theoretical-methodological analysis with elements of retrospective empirical verification. The logic of the work was based on the assumption that productive research programs are formed not only around local hypotheses, but around higher-order concepts that determine research architecture, sequence of proof, and pathways to new knowledge. Conceptual analysis, comparative methodological synthesis, and retrospective examination of completed doctoral studies devoted to modeling learning, training, and motor development processes were applied.

Results. The meta-problem was interpreted as a higher-level conceptual construct preceding the formulation of topic, aim, hypothesis, and methods. It determines the framework within which these elements acquire coherence and scientific meaning. It was shown that in physical education and sport, learning, upbringing, and training may be interpreted as derivative forms of a unified process of detecting deviations from a functionally optimal mode and correcting them. The central contradiction of development lies in the need to change while preserving functional stability. Under conditions of local and limited positive factor effects, classical two-group designs have restricted explanatory value, whereas factorial designs, repeated measurements, and response-surface approaches are more productive for identifying optimal regimes.

Conclusions. The meta-problem should be considered as a methodological level organizing the critical path of scientific inquiry. Its practical value lies in improving research design, manuscript evaluation, and the production of cumulative scientific knowledge.

Keywords: meta-problem, scientific research, research design, methodology, knowledge generation, physical education, sport science, factorial experiment, adaptive processes, evidence synthesis.

Introduction

Contemporary scientific research increasingly faces not a shortage of data, but a shortage of the level of generalization at which data can be transformed into knowledge. The availability of statistically significant results, a large number of publications, or a wide range of methods does not in itself ensure scientific progress if there is no conceptual framework capable of integrating individual findings into a coherent explanatory logic (Wasserstein & Lazar, 2016; Chalmers & Glasziou, 2009; Sutton et al., 2009). Any new knowledge emerges as a result of resolving a contradiction identified within the object of study. If the object defines the boundaries of inquiry, the problem determines the direction of its development. From a methodological perspective, the formulation of the problem provides an integrated representation of the research subject, determines the system of essential relationships among its elements, and creates the foundation for hypothesis generation. Consequently, the productivity of research depends not only on the choice of

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methods but also on how adequately the central contradiction of the object is identified and formulated. In this context, the concept of the meta-problem becomes particularly important.

The meta-problem defines the conceptual framework of a study within which the topic, aim, hypothesis, and system of methods are formulated. While the topic delineates the subject area, the aim specifies the expected outcome, and the hypothesis proposes a testable assumption, the meta-problem establishes the framework within which these elements acquire meaning and mutual coherence (Kuhn, 1962; Lakatos, 1970; Popper, 2005). In different methodological traditions, this issue has been addressed through the concepts of scientific problems, anomalies, research programmes, or the conceptual core of a theory. Common to these approaches is the recognition that the development of knowledge is determined not by the accumulation of facts alone, but by the identification and resolution of internal contradictions in the explanation of the object. At the same time, the level of generalization at which such a contradiction can organize a coherent research programme remains insufficiently explored. The issue concerns not an individual research question, but a level of understanding at which the sources of change, limits of effects, criteria of evidence, and directions of inquiry become intelligible (Bertalanffy, 1968; Ioannidis, 2016).

In the field of physical education and sport, such a perspective is particularly important because the processes under investigation are characterized by multifactoriality, nonlinear dynamics, developmental phases, adaptive limits, and complex interactions among pedagogical, biological, and social factors (Impellizzeri & Marcora, 2009; Kiely, 2012; Balyi et al., 2013). Under these conditions, the study of isolated effects often produces fragmented conclusions, whereas both practical and scientific significance depend on understanding how to manage change without compromising the functional effectiveness of the system (Bishop et al., 2008; Halson, 2014).

The theoretical foundation of this approach is grounded in previous studies on programmed learning of motor actions, factorial experimentation, modeling of pedagogical processes, optimization of training regimes, and the analysis of residual effects of adaptation (Khudolii, 2019; Ivashchenko, 2020; Box & Wilson, 1951; Collins et al., 2009). These lines of inquiry demonstrate that new knowledge emerges not from a simple comparison of two groups or from merely recording differences between indicators, but from identifying regularities within the space of possible modes of system functioning (Kiely, 2012; Halson, 2014).

The meta-problem functions as a methodological core not only in experimental studies. It is also present in bibliographic reviews, narrative reviews, systematic reviews, and meta-analyses as the level that determines the logic of source identification, criteria for material selection, limits of generalization, and the admissibility of evidence synthesis (Grant & Booth, 2009; Page et al., 2021; Khudolii, 2026). In this sense, review-based and experimental studies represent different phases of a unified process of knowledge generation.

More broadly, every research project possesses a higher-order structure that organizes its critical path: the emergence of an idea, mapping of existing evidence, synthesis of knowledge, experimental verification, and refinement of explanatory models. It is precisely this organizing function that is performed by the meta-problem. In its absence, a study may remain technically correct while being conceptually weak (Chalmers & Glasziou, 2009).

Despite the practical importance of this perspective, the procedures for formulating a meta-problem and operationalizing it within the field of physical education and sport remain insufficiently systematized (Bishop et al., 2006; Kiely, 2012; Coutts et al., 2018). In most cases, attention is focused on specific methods, whereas the transition from the conceptual level to research design, variable systems, and evidence structures remains outside the scope of dedicated methodological analysis. Yet such an approach has substantial potential to enhance scientific validity, reproducibility of findings, and the practical effectiveness of research programmes (Collins et al., 2009; Glasziou et al., 2014; Khudolii, 2026).

In the present study, the meta-problem is considered as the central contradiction of the research object, formulated at a level of generalization that allows the integration of the topic, aim, system of hypotheses, experimental design, and procedures for interpreting results into a unified logic of knowledge generation. Therefore, the analysis of the meta-problem is associated not only with the formulation of research tasks but also with the architecture of the entire scientific inquiry.

The purpose of the study was to systematize approaches to understanding the meta-problem and its operationalization in research on physical education and sport.

Materials and Methods

The study was conducted as a theoretical–methodological analysis supplemented by elements of retrospective empirical verification. The logic of the investigation was based on the assumption that productive research programmes are formed not only around individual hypotheses or local experimental questions, but also around higher-order concepts that determine research architecture, the sequence of evidence generation, and pathways to new knowledge (Kuhn, 1962; Lakatos, 1970).

The methodological foundation of the study was the conceptualization of the meta-problem as a construct of a higher level of generalization. Within the framework of this work, the meta-problem was defined as an integrative research construct that unites individual questions, objectives, variables, and procedures into a coherent programme of scientific inquiry (Bertalanffy, 1968; Khudolii, 2026). Unlike a local problem, which is focused on identifying a specific effect, a meta-problem is directed toward revealing regularities that can be reused, modeled, generalized, and transferred across contexts.

The study was implemented in three stages.

At the first stage, a conceptual analysis of the defining characteristics of the meta-problem was conducted. Particular attention was given to its capacity to establish a long-term research logic, integrate theoretical and empirical components, determine criteria for method selection, and create conditions for the accumulation of cumulative scientific knowledge (Lakatos, 1970; Ioannidis, 2016).

At the second stage, an algorithm for the operationalization of the meta-problem in applied research was reconstructed. The transition from the conceptual to the operational level was analyzed through a sequence of procedures including the formulation of sub-problems, specification of research objectives, selection of influencing factors, identification of effectiveness indicators, construction of experimental designs, and selection of statistical and modeling tools for data interpretation (Box & Wilson, 1951; Collins et al., 2009).

At the third stage, retrospective empirical verification of the proposed approach was performed using completed doctoral research projects in the field of physical education and sport devoted to the modeling of learning processes, training systems, and motor skill development (Khudolii, 2019; Ivashchenko, 2020). The analysis focused on the internal structure of the research programmes, including the scope of the original problem, the logic of progression from theory to experimentation, the reproducibility of procedures, and the capacity of the obtained results for generalization and practical transfer.

The productivity of a meta-problem as the organizational core of research was evaluated according to the following criteria: (a) its ability to generate a series of interconnected experiments; (b) consistency between theoretical assumptions and research design; (c) the possibility of developing predictive or control-oriented models; and (d) the production of results extending beyond a single sample or specific empirical situation (Lakatos, 1970; Ioannidis, 2016).

A limitation of the study is the case-based nature of the empirical verification and its concentration on materials originating from a single scientific tradition. At the same time, this approach provides a high degree of comparability across cases and makes it possible to trace the mechanisms through which a conceptual idea is transformed into a reproducible scientific outcome.

Results

Theoretical Nature of the Meta-Problem

The analysis provides grounds for considering the meta-problem as the central contradiction of the research object that determines the architecture of scientific inquiry and integrates the topic, aim, hypothesis, and methods into a unified logic of knowledge generation. While the topic defines the subject area, the aim specifies the expected outcome, and the hypothesis formulates assumptions regarding relationships among variables, the meta-problem establishes the framework within which these elements acquire scientific meaning. In the domains of learning, education, and training, this framework is associated with the regularities that ensure effective system functioning under changing environmental demands (Table 1).

Table 1. Hierarchy of Research Organization Levels

Level of Organization	Primary Function	Type of Outcome
Research Topic	Delineation of the subject area	Boundaries of the research field
Research Aim	Definition of the expected outcome	Direction of inquiry
Hypothesis	Formulation of a testable assumption	Empirical verification of relationships
Research Objectives	Operationalization of research stages	Sequence of procedures
Research Methods	Data collection and analysis	Empirical findings
Meta-Problem	Integration of all levels into a coherent logic	Generation of new knowledge

The Meta-Problem and the Knowledge Generation Cycle

The findings indicate that a meta-problem acquires scientific value only when it is consistently examined through different forms of research. Theoretical, review-based, and experimental studies constitute a unified cycle of knowledge generation: idea → practical verification → analysis of secondary sources → experimental testing → model refinement → new idea. Without operationalization and empirical verification, a meta-problem remains merely a conceptual construct (Table 2).

Table 2. Algorithm for the Operationalization of a Meta-Problem

Stage	Content	Expected Outcome
1	Formulation of the meta-problem	Conceptual framework
2	Identification of sub-problems	Structure of inquiry
3	Specification of factors	Independent variables
4	Selection of indicators	Dependent variables
5	Design construction	Valid verification scheme
6	Selection of analytical models	Data-processing tools
7	Generalization	New model / new knowledge

Process-Based Interpretation of Learning, Education, and Training

The analysis demonstrates that learning, education, and training may be interpreted as derivative forms of a single process: the detection of deviations from a functionally appropriate mode of activity and their correction. Within this perspective, the primary issue is not the pedagogical intervention itself, but the necessity of restoring the system to a functionally effective state. Learning develops the system's ability to independently recover an appropriate mode of action when errors occur, whereas physical education and training strengthen the regulatory mechanisms that sustain effective motor performance under changing conditions.

The Central Contradiction of Development

It was found that developmental processes are fundamentally based on the contradiction between the necessity to change and the necessity to preserve functional stability. Insufficient change limits adaptation to new conditions, whereas excessive or uncontrolled change leads to system disorganization. Effective management of development therefore depends on selecting modes of influence that promote progress without compromising functional stability.

Residual Effects as a Mechanism of Change Accumulation

The results indicate that every effective influence leaves a residual effect—a temporary functional reorganization that may be reinforced by subsequent influences, lost because of excessive intervals, or distorted by excessive loading. The residual trace is not maintained when the recovery interval extends into a forgetting phase and is disrupted when a repeated influence is imposed during a state of pronounced functional fatigue. Consequently, the productivity of the process depends on the balance between preservation of the residual effect and the degree of system fatigue.

Formal Interpretation of the Central Contradiction

To describe controlled biological and pedagogical processes, a model may be used in which changes in the functional state, Y, depend on time or accumulated influence, X, and are determined by the simultaneous action of growth-promoting and self-limiting factors:

$$\frac{dY}{dX} = mY - rY^2$$

where mY represents the stimulating component of development, and rY^2 represents the internal inhibitory factor associated with resource depletion, system saturation, or increasing regulatory resistance.

The obtained expression demonstrates that any developmental process contains an inherent contradiction between the tendency toward growth and the mechanisms responsible for stabilization. It is precisely this interaction that gives rise to the nonlinear character of biological, learning, and adaptive processes..

Growth Models as a Manifestation of Contradiction Resolution

The analysis revealed that learning curves, training adaptations, and functional development trajectories may be interpreted as observable manifestations of the relationship between stimulation and internal inhibition. Rapid initial progress reflects the predominance of beneficial influences; deceleration indicates the strengthening of internal constraints; a plateau corresponds to a temporary equilibrium; and regression reflects the dominance of destabilizing factors. Consequently, growth models represent not merely changes in indicators over time but the process through which the central contradiction of the system is resolved.

Figure 1 illustrates the nonlinear nature of the learning process, in which an initial phase of accelerated improvement gradually transitions into a phase of deceleration and eventually reaches a plateau, reflecting the increasing influence of internal system constraints. The findings also demonstrate the substantial effect of functional state on the dynamics of motor skill acquisition. Under conditions of high work capacity, learning is characterized by a faster increase in the level of mastery and a shorter initial acquisition phase. In contrast, reduced work capacity prolongs the initial stage of learning and slows the accumulation of positive changes. Thus, the rate of skill development is determined not only by the number of repetitions but also by the functional state of the system, which defines the balance between stimulating and limiting factors. In this context, learning curves represent the process of resolving the central contradiction of development: the need to modify the functional state of the system while simultaneously preserving its stability (Table 3).

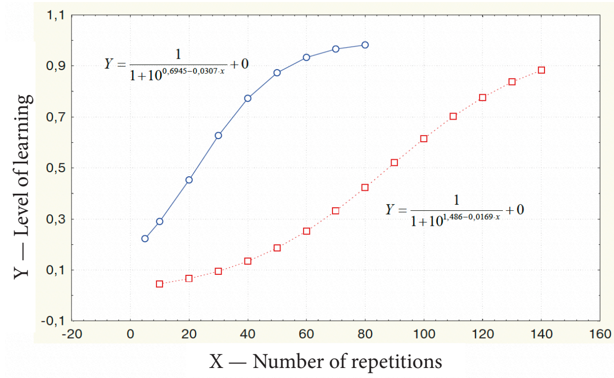

Fig. 1. Typical growth models of learning and adaptation processes (adapted from Khudolii, Doctoral Dissertation, p. 296, Fig. 5.3). Relationship between the level of mastery of the bent-arm headstand and the performance capacity of young gymnasts: (a) increase in the level of skill acquisition (Y) as a function of the number of repetitions under conditions of high work capacity; (b) increase in the level of skill acquisition (Y) as a function of the number of repetitions (X) under conditions of low work capacity.

The Meta-Problem and the Choice of Experimental Design

The analysis showed that when a factor exerts a local and limited positive influence, the central procedural task is not merely to verify the existence of an effect but to identify the region of influence within which the rate of beneficial change is maximized. Under such conditions, classical two-group designs based on comparisons between experimental and control groups provide only limited information, as they establish the presence of an average difference between two selected conditions. For the investigation of learning, training, and adaptation processes, multifactorial designs, repeated-measures approaches, longitudinal studies, and response-surface models are more appropriate (Table 4).

Table 4. Correspondence Between Research Objectives and Experimental Designs

Research Objective	Most Appropriate Design
Detection of an effect	Control–experimental group design
Identification of an optimum	Full factorial experiment
Analysis of temporal dynamics	Longitudinal design
Investigation of factor interactions	Multifactorial design
Classification of states	Discriminant analysis

Table 3. Interpretation of the Central Contradiction Across Different Processes

Process	Stimulating Component	Inhibitory Component	Outcome
Learning	Repetition, information	Forgetting, fatigue	Learning curve
Training	Training load	Resource depletion	Increase in training adaptation
Adaptation	Beneficial stress	Homeostatic limits	Nonlinear adaptation
Science	New data, new methods	Weak design	New knowledge

Methodology as a System of Knowledge Generation

The preceding findings make it possible to view research methodology not as a set of procedures applied after data collection, but as a coherent architecture for generating knowledge. The meta-problem determines the essential properties of the object of analysis and the set of relevant variables. The nature of the process under investigation defines the requirements for experimental planning, measurement structure, and design selection. Statistical methods should be anticipated during the design phase, while data structures should remain open to reanalysis and the application of more sophisticated multifactorial models (Box & Wilson, 1951; Collins et al., 2009; Ivashchenko et al., 2016; Ivashchenko et al., 2018; Ioannidis, 2016). Consequently, conceptual foundations, experimental design, analytical procedures, and data openness jointly ensure the transition from empirical observations to new knowledge (Table 5).

Table 5. Components of Methodology as a Knowledge Generation System

Component	Function
Methodological foundation	Explanation of the nature of the object
Meta-problem	Organization of the logic of inquiry
Design	Validity of verification
Statistics	Analysis of data structure
Data openness	Reproducibility and reanalysis
Generalization	Generation of new knowledge

Operationalization of a Meta-Problem: An Example from Physical Education and Sport

To illustrate the process of meta-problem operationalization, its implementation within a research programme devoted to the preparation of young gymnasts is considered (Khudolii, 2010, 2019). In this case, the meta-problem emerges as a contradiction between the need to improve athletic performance and the limited adaptive capacities of the organism. On the one hand, the achievement of high sporting results requires an increase in the volume and specificity of training interventions. On the other hand, excessive training loads lead to the depletion of functional reserves, reduced learning effectiveness, and an increased risk of maladaptation. Consequently, the central question concerns the identification of regularities governing the organization of the training process that enable performance improvement without compromising the functional stability of the system.

During the operationalization of this meta-problem, a series of interconnected sub-problems was identified, each reflecting a particular aspect of the central contradiction. These included the identification of informative indicators of functional and motor preparedness, the development of models describing age-related changes in preparedness, the investigation of immediate, delayed, and cumulative training effects, the identification of regularities in motor learning, the determination of optimal exercise–rest regimes, and the substantiation of training process structure and pedagogical control systems.

At the next stage, influencing factors and effectiveness indicators were specified. Independent variables included training load magnitude, work-to-rest regimes, the ratio of physical and technical training means, and the duration of training interventions. Dependent variables included indicators of functional state, levels of motor preparedness, effectiveness of learning gymnastic skills, and measures of athletic performance.

The resolution of the meta-problem required not a single experiment but a sequential system of interconnected studies. To achieve this, parametric modeling, 2^k factorial experiments, growth models, methods for analyzing immediate, delayed, and cumulative training effects, as well as procedures for forecasting and programming the training process were employed. This approach enabled the transition from isolated empirical observations to the identification of stable regularities governing the functioning of the young athlete preparation system.

As a result, a series of interconnected models was developed, including models of functional and motor preparedness in young gymnasts, models of training loads, models of motor learning processes, models of training process management, and methodological guidelines for programming long-term athlete development. These findings provided the foundation for the construction of an integrated concept of young gymnast preparation and enabled a transition from the description of isolated effects to the management of motor function development processes.

This example demonstrates that a meta-problem cannot be reduced to the formulation of a single research question. Rather, it functions as an organizational core that generates a system of interconnected studies, determines the logic of transition from theoretical conception to experimental verification, and ensures the accumulation of cumulative knowledge. It is precisely this capacity to generate a sequence of interrelated investigations that distinguishes a meta-problem from a local scientific problem. In physical education and sport, this is manifested as the search for regularities governing change in ways that promote development without loss of effectiveness (Khudolii, 2019; Ivashchenko, 2020; Ivashchenko et al., 2016; Ivashchenko et al., 2018). Thus, a meta-problem serves as a mechanism for transforming individual empirical observations into a research programme, and a research programme into new scientific knowledge.

Discussion

The findings of the present study support the view that the meta-problem should not be regarded as an auxiliary methodological term but rather as a distinct level of research organization that determines the relationship between conceptualization of the object, selection of an evidentiary strategy, and generation of new knowledge. From this perspective, scientific progress depends not merely on the accumulation of empirical findings but on the capacity to integrate those findings into a broader explanatory framework (Kuhn, 1962; Lakatos, 1970; Ioannidis, 2016). It is precisely this integrative function that is performed by the meta-problem.

The proposed approach refines the conventional understanding of research structure, in which the topic, hypothesis, and methods are often treated as the central components. The present analysis suggests that these elements acquire their full meaning only within a broader organizational framework. Without such a framework, a study may remain technically rigorous while being conceptually fragmented, testing an isolated effect without understanding its place within the structure of the process under investigation. Similar limitations have been repeatedly identified in methodological literature as one of the major causes of the low cumulative value of applied research (Glasziou et al., 2014; Wasserstein & Lazar, 2016).

The results further indicate that such reductionism is particularly problematic in physical education and sport. Learning, training, and adaptation processes are characterized by nonlinear dynamics, developmental phases, effect thresholds, and interactions among multiple factors (Kiely, 2012; Halson, 2014). Under these conditions, traditional two-group designs can reveal differences between selected conditions but often fail to answer more fundamental questions: Where does the beneficial effect begin? Within which range is the optimum achieved? When does a plateau emerge? Under what conditions do overload and regression occur? Consequently, multifactorial designs, repeated-measures approaches, and response-surface methodologies provide a more productive framework because they allow researchers to investigate the space of possible operating regimes rather than isolated comparisons. This conclusion is consistent with empirical studies on physical education, motor learning, and training adaptation (Box & Wilson, 1951; Collins et al., 2009; Ivashchenko et al., 2016; Ivashchenko et al., 2018).

An important outcome of the study is the process-oriented interpretation of learning, education, and training as forms of controlled correction of deviations from functionally appropriate modes of activity. Such an interpretation shifts the focus away from the transmission of information or mechanical repetition of exercises and toward the mechanisms of error detection, feedback, and restoration of effective action patterns. Within this framework, learning may be understood as the development of a system's capacity for self-correction, whereas training represents the enhancement of regulatory mechanisms that maintain effectiveness under changing conditions. This interpretation is consistent with contemporary theories of motor learning, in which feedback, error correction, and adaptive control occupy a central position.

The proposed interpretation is also consistent with the concept of the central contradiction of development. Every adaptive system must simultaneously change in response to new demands and preserve the stability of its essential functions. Excessive stability results in stagnation, whereas excessive change leads to disorganization. Therefore, the effectiveness of pedagogical and training interventions is determined not by the magnitude of the stimulus itself but by the ability to regulate the boundary between stimulation and disruption, adaptation and overload, renewal and preservation of structure. This logic corresponds closely to contemporary views of adaptation as a dynamic balance between stress and recovery (Kiely, 2012; Halson, 2014).

A further contribution of the study is the interpretation of residual effects as a mechanism through which change accumulates over time. If every productive intervention leaves a temporary functional trace, then the overall outcome depends on the relationship between the preservation of that trace and the level of system fatigue. Excessively long intervals shift the process toward forgetting, whereas excessively dense repetitions increase the risk of functional exhaustion. Consequently, the management of recovery intervals, training volume, and intervention structure becomes not merely a technical issue but a central component of developmental logic. Similar mechanisms have been described in studies of adaptation and training process planning.

The formal model proposed in this study, in which system dynamics are represented as an interaction between forces of stimulation and forces of regulation, is not intended to serve as a universal description of all biological and pedagogical processes. Its value lies primarily in its heuristic potential. The model provides a conceptual explanation for why development rarely follows a linear trajectory, why periods of rapid progress are often followed by plateaus, and why regression may occur despite continued intervention. From this perspective, growth models can be interpreted as observable manifestations of the interaction between stimulation and regulation within the system.

The findings also support the view that methodology should be understood not merely as a collection of technical procedures but as a system for generating knowledge. Within such a framework, statistical methods must be aligned with research design at the planning stage, while data structures should preserve opportunities for reanalysis, investigation of factor interactions, and application of more advanced analytical models. The use of factorial and discriminant analyses in pedagogical control and the study of motor skill development provides a practical example of this logic (Ivashchenko et al., 2016; Ivashchenko et al., 2018). This perspective is consistent with contemporary principles of reproducible research and open science (Ioannidis, 2016).

The practical significance of the proposed concept lies in its potential application as a tool for evaluating scientific studies. Any research project may be assessed according to whether it possesses a meta-level of organization: whether a conceptual core has been identified, whether the design corresponds to the nature of the process under investigation, and whether the collected data allow the identification of mechanisms rather than merely differences between mean values. For editorial and peer-review practice, this perspective provides an additional criterion for assessing the scientific quality of manuscripts.

The principal limitation of the present study is its theoretical and methodological nature, together with its reliance on a single scientific tradition for empirical verification. Nevertheless, this concentration of material made it possible to evaluate the proposed concept at the same level of generalization at which it was formulated, tracing the connection between conceptual foundations, experimental design, and reproducible outcomes across a series of interconnected research programmes. Future research may focus on interdisciplinary validation of the model in other fields of knowledge and on the development of formalized criteria for identifying meta-problems in contemporary scientific literature.

Conclusions

The meta-problem represents the central contradiction of the research object and serves as the methodological construct that determines the architecture of scientific inquiry, the logic of evidence generation, and the criteria for producing new knowledge. It functions as the organizing framework through which research questions, hypotheses, methods, and interpretations acquire coherence and scientific significance.

A meta-problem attains scientific value only when it is operationalized and subjected to empirical verification. Without translation into a system of variables, an experimental design, and an evidence-generating procedure, it remains a purely theoretical construct.

In the field of physical education and sport, learning, education, and training may be interpreted as derivative manifestations of a unified process involving the identification of deviations from functionally appropriate modes of activity and their subsequent correction. This perspective makes it possible to conceptualize human development as a controlled process aimed at maintaining effectiveness under changing environmental and functional conditions.

The central mechanism underlying development is the contradiction between the necessity for change and the necessity for preserving functional stability. The effectiveness of pedagogical and training interventions is therefore determined by the capacity to regulate the relationship among stimulation, adaptation, and system constraints.

When the positive influence of a factor is local and limited, traditional control–experimental group designs possess restricted explanatory value. More informative approaches for identifying optimal operating regimes include multifactorial experimental designs, repeated-measures strategies, longitudinal studies, and response-surface methodologies.

Research methodology should be regarded as an integrated system that combines knowledge about the nature of the object, experimental planning, embedded analytical procedures, and data openness that allows repeated multifactorial analysis. Such integration provides the foundation for transforming empirical observations into cumulative scientific knowledge.

The practical significance of the meta-problem concept lies in its potential application as a framework for research design, manuscript evaluation, and assessment of whether a study is capable of generating not only isolated findings but also cumulative and transferable scientific knowledge.

Ethics Approval

This study was conducted in accordance with the ethical principles of scientific research, standards of academic integrity, and the provisions of the Declaration of Helsinki relevant to analytical and theoretical investigations. The study was theoretical and methodological in nature and did not involve human participants, clinical interventions, collection of personal data, or the use of biological materials. Therefore, approval from an institutional ethics committee was not required.

Informed Consent

Informed consent was not required because the study did not involve human participants, surveys, interviews, observations, or the use of identifiable personal data.

Data Availability Statement

The data supporting the findings of this study are contained within the article. The study is based on the analysis of materials available in the public scientific domain and on the synthesis of findings reported in previously published research.

AI Transparency Statement

Artificial intelligence tools were used during manuscript preparation as supportive instruments for language editing, text refinement, content organization, and technical editorial assistance. All conceptual contributions, scientific interpretations, final formulations, and responsibility for the content of the article remain solely with the authors.

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Conflict of Interest Statement

The authors declares no actual or potential conflict of interest related to the publication of this study.

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Мета-проблема в науковому дослідженні у фізичному вихованні і спорті: архітектура і шляхи до знання

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 5 табл., 1 рис., 26 джерел.

Актуальність. Сучасне наукове дослідження дедалі частіше стикається не з нестачею даних, а з нестачею належного рівня узагальнення, на якому дані можуть бути перетворені на знання. У багатьох прикладних галузях, зокрема у фізичному вихованні і спорті, технічно коректні дослідження нерідко залишаються фрагментарними через відсутність ширшої пояснювальної рамки.

Мета. Систематизувати підходи до розуміння мета-проблеми та її операціоналізації у дослідженнях з фізичного виховання і спорту.

Матеріали і методи. Дослідження виконано у форматі теоретико-методологічного аналізу з елементами ретроспективної емпіричної верифікації. Логіка роботи ґрунтувалася на припущенні, що продуктивні дослідницькі програми формуються не лише навколо локальних гіпотез, а навколо концептів вищого рівня узагальнення, які визначають архітектуру дослідження, послідовність доказування та шляхи отримання нового знання. Використано концептуальний аналіз, порівняльний методологічний синтез і ретроспективний аналіз завершених докторських досліджень, присвячених моделюванню процесів навчання, тренування та розвитку рухових здібностей.

Результати. Мета-проблему інтерпретовано як концептуальну конструкцію вищого рівня, що передує формулюванню теми, мети, гіпотези та вибору методів. Вона визначає рамку, у межах якої ці елементи набувають змістової узгодженості та наукового сенсу. Показано, що у фізичному вихованні і спорті навчання, виховання і тренування можуть розглядатися як похідні форми єдиного процесу виявлення відхилень від функціонально доцільного режиму діяльності та їх корекції. Центральне протиріччя розвитку полягає у необхідності змінюватися при одночасному збереженні функціональної стійкості. За умов локального та обмеженого позитивного впливу фактора класичні двогрупові схеми мають обмежену пояснювальну цінність, тоді як факторні плани, серійні вимірювання та моделі поверхні відгуку є більш продуктивними для пошуку оптимальних режимів.

Висновки. Мета-проблему доцільно розглядати як методологічний рівень, що організує критичний шлях наукового пошуку. Її практичне значення полягає в удосконаленні дизайну досліджень, експертизи рукописів і продукуванні кумулятивного наукового знання.

Ключові слова: мета-проблема, наукове дослідження, дизайн дослідження, методологія, генерація знання, фізичне виховання, спортивна наука, факторний експеримент, адаптаційні процеси, синтез доказів.

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