SECTION «PHYSICAL EDUCATION AND SPORT»

MODERNIZATION OF THE INSTRUCTIONAL ENVIRONMENT: UTILIZING DYNAMIC NAVIGATIONAL MARKERS TO IMPROVE STUDENTS' PHYSICAL ACTIVITY

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Abstract. The digitalization of leisure time and the intensification of the educational process have led to a critical increase in sedentary behavior among schoolchildren. Systemic physical inactivity (hypodynamia) triggers musculoskeletal disorders and a decline in students' cognitive potential. In this context, there is an urgent need to develop innovative «active design» solutions for school spaces that integrate movement into the daily environment without specialized equipment. *The article aims* to provide theoretical substantiation and practical development of a model for modernizing the learning environment by implementing dynamic navigational markers (floor and wall decals) to stimulate spontaneous physical activity and overcome movement deficits during school breaks. To achieve this goal, the following objectives were identified: to substantiate the concept of "substitution" as a methodological basis for modifying passive school zones; to determine the ergonomic and pedagogical requirements for designing visual physical activity stimulators; to present an original typology of floor and wall markers along with algorithms for their application. *The research methodology* is based on general scientific methods of analysis and synthesis, induction and deduction, observation, and abstraction,

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which are applied to adapt international WHO physical activity protocols to the architectural and planning solutions of contemporary educational institutions and to study the mechanisms of sensorimotor integration. *The research results* showed that the use of dynamic markers transforms school corridors into an interactive ecosystem where movement becomes a natural consequence of occupying the space. It was established that unifying visual signals into coordination and balance tasks contributes not only to physical relief but also to the "calibration" of proprioception and to increased focus before subsequent lessons. The practical importance lies in the creation of a ready-to-implement methodological case study, which includes mock-ups of floor markers ("Islands of Agility", "Math Jump-drome") and wall markers ("Wall Reactor," "Finger Labyrinth"), as well as guides for teachers and parents. *Value/Originality.* For the first time, an all-encompassing approach to modernizing school recreational areas is presented through the lens of "stimulative architecture" and sensorimotor control. The universality of visual integration principles for the development of schoolchildren's coordination is substantiated, in accordance with the strategic aims of strengthening the nation's health.

Introduction

The evolution of digital technologies and the intensification of the educational process have led to a pronounced deficit in physical activity among schoolchildren. This trend is manifested in a chronic increase in static load due to extended sitting and unregulated "screen time". Systemic physical inactivity (hypodynamia) during childhood triggers complex functional disorders of the musculoskeletal and cardiovascular systems, requiring the immediate integration of innovative health-saving technologies into the architecture of the modern learning setting [1, p. 34-36].

An analysis of the "WHO 2020 guidelines on physical activity and sedentary behavior" has demonstrated the implementation of explicit recommendations that focus not only on physical activity levels but also on strict limits on sedentary behavior [2, pp. 1271-1282].

The WHO "Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age" provide a critical evidence-based framework that aligns seamlessly with the modernization of instructional environments through dynamic navigational markers. By establishing a global standard of at least 180 minutes of daily physical activity for preschoolers – including 60 minutes of moderate-to-vigorous intensity – the WHO necessitates a departure from static educational settings toward interactive spaces that inherently promote movement. Within the context of utilizing dynamic navigational markers, these guidelines serve as a fundamental justification for transforming physical spaces into active learning conduits that discourage prolonged sedentary behavior and excessive screen time. An expert translation of these principles into the instructional environment suggests that such markers function as both architectural stimuli and pedagogical tools, facilitating a synergy between cognitive engagement and physical exertion. Because early childhood is a formative period for preventing future non-communicable diseases and obesity, the integration of dynamic navigation systems represents a strategic implementation of WHO recommendations. This approach ensures that physical activity is not merely an isolated component of the daily schedule but is woven into the very fabric of the educational infrastructure, fostering intuitive play and habitual movement through intelligent environmental design [12].

Specifically, the authors recommended an average of at least 60 minutes of moderate-to-vigorous physical activity per day, with most of this time devoted to aerobic activity [4, pp. 1451-1462].

The article states that a significant proportion of adolescents worldwide fail to meet this minimum requirement due to the dominance of sedentary lifestyles inside educational institutions and at home.

The WHO guidelines identify digital activity as a distinct risk factor, showing a direct correlation between lengthy screen time (on handheld devices and televisions) and deteriorating obesity rates, reduced sleep quality, and impaired social-emotional health. For children and adolescents, the following recommendation has been established: "limit the amount of time spent being sedentary, particularly the amount of recreational screen time" [13; 14].

According to the expert community, prolonged sedentary behavior among schoolchildren correlates with metabolic risks (deterioration of glycemic control and lipid profiles), cardiovascular disorders (long-term increase in blood pressure), and mental health concerns, namely an increase in manifestations of anxiety and depressive states [7].

Research shows that replacing sedentary time with physical activity, even at low intensities (such as walking or light exercises during breaks), provides significant health benefits. The core message of the study is the thesis: "Doing some physical activity is better than doing none." The concept of "Substitution" is based on the principle of redistributing the daily time budget, in which even short periods of physical activity displace periods of static rest, leading to a cumulative positive effect on the student's metabolic and psycho-emotional state [6].

Thus, the problem of physical inactivity among modern schoolchildren is not only a lack of participation in sports but also excessive sedentary behavior. Since the WHO recommends replacing prolonged sitting with any form of activity, the "active design" case study directly implements international strategies to mitigate the harms of sedentary living.

A growing body of international, multidisciplinary research supports the embedding of physical activity in the school environment. Contemporary pedagogical thought is shifting from isolated physical education lessons toward the concept of "Whole-of-School" physical activity.

According to Khairuddin et al., the school's physical environment is a primary determinant of student behavior; "active design" serves as a structural nudge that promotes incidental physical activity [10].

Research in Environmental Psychology suggests that the school's "built environment" can either facilitate or inhibit movement. By utilizing dynamic navigational markers, educational institutions transition from a "factory model" of sedentary learning to a "Kinesthetic Classroom" model.

Furthermore, the work of Ratey and Hagerman spotlights the neurobiological benefits of such integration. They argue that movement is "Miracle-Gro for the brain", as physical activity triggers the release of brain-derived neurotrophic factor (BDNF), which is crucial for long-term potentiation and memory formation. This stresses the author's proposal that dynamic markers are not simply physical tools but cognitive stimulators [10].

The concept of Sensorimotor Integration, as explored by Ayres, provides an academic foundation for using floor and wall markers. In an era of "sensory deprivation" caused by digital screens, students require proprioceptive and vestibular input to maintain neurological arousal.

The use of "Islands of Agility" and "Curving Trails" directly meets this need, enabling the brain to "calibrate" the body in space, a process shown to improve executive functions such as impulse control and attention span [3].

In the context of the New Ukrainian School (NUS) reform, these findings correspond with the strategic goal of creating a "motivating space." Recent studies in Human Factors and Ergonomics (e.g., Pheasant) emphasize that environmental modifications must be anthropometrically scaled to the user. This validates the necessity of the author's developed pedagogical and ergonomic requirements for marker placement, ensuring that the modernization of the instructional environment is both empirically grounded and practically effective.

The article aims to provide theoretical substantiation and practical development of a model for modernizing the educational space of general secondary education institutions by implementing dynamic navigational markers (floor and wall decals) as an effective tool to overcome sedentary behavior and intensify schoolchildren's physical activity patterns.

To achieve this goal, the following objectives were identified:

– to define the pedagogical and ergonomic requirements for creating an active design of the instructional environment using visual stimulators of physical activity;

– to develop and systematize a typology of dynamic navigational markers, classifying them based on their effect on various muscle groups, coordination abilities, and mental functions of students;

– to substantiate practical recommendations for integrating active zones into school recreational spaces and to evaluate their potential in the context of increasing attention span and psycho-emotional relief for students.

The research methodology is based on general scientific methods of analysis and synthesis, induction and deduction, observation, and abstraction, which are applied for a comprehensive study of international WHO physical activity protocols and their adaptation to the architectural and planning solutions of current educational institutions.

The study was conducted in accordance with the research project of Yuriy Fedkovych Chernivtsi National University: "Active Nation: A Modern Model for Increasing the Level of Physical Activity of Schoolchildren as a

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1. Typology and Functional Purpose of Floor and Wall Markers for Physical Activity within the Structure of School Recreation Areas

In the context of physical education, the modern learning setting must transform from a passive waiting area into a dynamic network that stimulates spontaneous physical activity among students.

Within the framework of this scientific project, the architectural phase of the "Active Learning" practical case study has been completed, with a primary focus on adapting exercises to the limited space of school premises. The structure of the developed case study includes four key components:

Methodological Constructor – a set of 25 "active inserts" for natural sciences and mathematics lessons;

Dynamic Navigational Marker Palette – layouts of floor and wall decals designed for spontaneous physical activity in corridors;

Digital Dashboard – a prototype for tracking the collective physical activity of each class;

Parents' Guide – recommendations for incorporating physical activity into homework routines.

We examine the architectural integration of physical exercises through daily school life, where recreational zones, corridors, and stairwells are transformed into engaging platforms for sensorimotor development. Through visual stimulators, floor navigational markers, and wall-mounted training elements, such an environment encourages children to move without additional compulsion or external control. This approach helps overcome the rigid, sedentary structure of the school day, ensuring continuity of the physical activity regimen and preventing fatigue by naturally replacing static tension with dynamic, play-based interaction with the space.

Consequently, the educational space dictates the child's behavior; movement becomes a natural consequence of being in the corridor instead of an obligation. This facilitates the transformation of passive zones, as corridors cease to be mere "paths from point A to point B" and become active training tools.

The effectiveness of implementing dynamic navigational markers in general secondary education institutions depends directly on compliance with several requirements that ensure integration between a child’s physical development and their safety within the educational space.

An active space in an educational institution is a specially designed, functionally saturated environment based on the principles of "stimulative architecture," in which every interior element (both horizontal and vertical surfaces) is integrated into the student’s overall physical activity regime. In contrast to traditional sports zones, the active space of corridors and recreational areas is oriented toward spontaneous (incidental) physical activity triggered by visual cues and markers. It operates as a multifunctional zone that, through play-based interaction, provides sensorimotor stimulation and cognitive offloading, and transforms school transit areas into tools for developing students' health-saving competence.

Zoning school recreation areas with visual markers offers several important advantages, making this tool optimal for the modern school.

Securing Safety and Injury Prevention. Unlike bulky exercise machines or sports equipment, decals do not create physical obstacles in evacuation zones or transit routes. The use of specialized anti-slip coatings lowers the risk of falls, while clearly defined play zone boundaries separate flows between active students and those who prefer quiet rest.

The decal system implements the "equipment-free" concept, emphasizing resource efficiency and eliminating the need for inventory. All necessary stimulating material is already integrated into the surfaces of walls and floors, eliminating the need to store, issue, and regularly maintain small sports apparatus. This makes active breaks autonomous and accessible to students at any moment without the need for constant supervision by specialized staff.

A further advantage of this approach is aesthetic modernization and psychological comfort. Visual markers serve as contemporary art objects, transforming monotonous school corridors into bright, child-friendly spaces. The use of a harmonious color palette and geometric shapes helps reduce visual noise, creates clear semantic accents that structure the space, and lowers anxiety levels through the intuitive rules of the game embedded in the design itself.

Decal-based zoning allows easy reconfiguration of the active space without construction, enabling variation and adaptation of physical loads. This enables the teaching staff to update "activity routes" to match students' age-related needs (from primary to high school) or with thematic educational projects.

To facilitate sensorimotor stimulation, cognitive offloading, and the development of coordination and spatial cognition, floor markers were created, transforming an ordinary floor into an interactive trainer.

Examples of such markers include:

"Islands of Agility" – decals in the shape of multi-colored circles, "stones," or "lily pads," placed at varying distances from one another (from 30 to 60 cm). Description: An imitation of crossing a river or walking along safe points. Task: To get from one end of the corridor to the other by stepping only on the "islands" without touching the "water" (the floor). This trains distance perception and jumping skills.

"Winding Path" – a bright, solid balance line, 10 cm wide, and "footprint" inserts in challenging spots. Description: A long graphic line with sharp turns and loops. Task: To walk the entire distance by placing the foot precisely on the line (heel to toe) without losing balance. This helps the child calm down and focus after an active lesson.

"Math Jump-drome" or "Mathematical Hopscotch" – squares with numbers from 1 to 9, arranged in a 3x3 format (similar to a phone keypad or the game of hopscotch). Description: A grid with numbers or geometric shapes. Task: Tasks are differentiated by age. For younger students, this may involve jumping on numbers in ascending or descending order. For older students, it involves "jumping out" the answers to simple arithmetic problems provided by a peer (e.g., if the prompt is "2+3," the student must jump onto the number 5).

The use of wall zones within school recreation areas is an essential part of the case study, as it enables the use of vertical surfaces that typically serve only a static informational function.

The rationale for implementing active wall zones in the educational space includes verticalizing physical activity and decompressing the spine. Schoolchildren spend most of their study time with their heads tilted forward (a condition known as "text neck" caused by desk work and gadget use). Wall markers and associated tasks, such as "Touch the Star" or "Wall

Labyrinth," force the student to straighten their back, lift their head, and stretch their arms upward. This creates a natural spinal decompression effect and activates the extensor muscles, which tend to atrophy during prolonged sitting.

Furthermore, these zones stimulate proprioception and sensory integration. Utilizing wall space allows for the integration of eye-hand coordination exercises into breaks. Exercises like "finger labyrinths" or "color buttons" improve neural connections between the brain's hemispheres, directly impacting readiness to perceive abstract material in subsequent lessons (e.g., mathematics or languages).

Using walls also addresses the problem of "space deficit." In many educational institutions, corridors are narrow, making it impossible to install large-scale sports equipment or conduct running games. Consequently, wall decals utilize "dead zones" of the interior. They do not impede the main flow of students during transitions or evacuations but create localized nodes of activity. This enables the implementation of the concept of intensive recreation in an area of less than 0.5 m^2.

Prolonged contemplation of horizontal surfaces (notebooks, screens) leads to visual fatigue and a decline in dopamine levels. Switching one's gaze to vertical, vibrant graphic objects with a play-based subtext acts as a cognitive reset. Wall zones become hubs for micro-socialization, where students can compete to reach specific markers, thereby increasing motivation to move through elements of gamification.

Examples of vertical interactive zones include:

"Touch the Star" – bright stars or planets placed at varying heights on the wall. Description: Star-shaped decals with numerical values, positioned from shoulder level to the highest reachable point. Task: The objective is to touch the highest star possible by stretching or jumping.

"Finger Labyrinth" – a maze decal applied to the wall. Description: The decal features a textured or high-contrast labyrinth pattern. Task: Students must trace the path with their finger from start to finish without lifting it or crossing the boundaries. This exercise relieves stress and improves focus.

"Wall Reactor" – a marker featuring several multi-colored circular "buttons." Task: Students aim to touch them as quickly as possible in a predetermined sequence (e.g., "red, blue, yellow, green") or compete in pairs for reaction speed.

2. Pedagogical and Ergonomic Requirements for Designing an Active Pedagogical Environment

The design requirements for an active learning setting must be based on the principles of ergonomic safety, didactic expediency, and broad accessibility. This ensures the transformation of static school spaces into an interactive ecosystem that stimulates a child’s natural need for movement, facilitates sensorimotor correction, and minimizes the negative consequences of prolonged sedentary behavior through visual and motor stimulation.

Ergonomic requirements primarily encompass safety and usability. The ergonomic approach consists of adapting the environment to the anthropometric and biological characteristics of students across diverse age groups:

Wall decals (e.g., "Touch the Star") must be positioned according to anthropometric parameters, specifically student height. The stimulator's working zone should span from the level of a bent elbow (lower bound) to the maximum height of an extended arm, including a jump (upper bound).

Floor markers must be high-quality and feature a high coefficient of friction (anti-slip coating) to prevent injuries during fast movements or jumps. The material must be wear-resistant to resist intense mechanical impact and suitable for wet disinfection.

Visual ergonomics is achieved by using high-contrast colors (e.g., yellow on blue, white on green) to enhance marker visibility under varying corridor lighting conditions. Graphic elements should be clearly differentiated without overloading the visual system.

Pedagogical design of the active environment is based on the principles of awareness, accessibility, and continuity:

User-Friendly Design. Marker design should inherently suggest the action algorithm to the child without requiring additional instructions from a teacher. Visual codes (footprints, palms, arrows) must be universally intelligible.

Cognitive Integration. Markers should not serve as purely mechanical stimulators. A vital requirement is the inclusion of educational elements (numbers, letters, geometric shapes, and logical mazes), which promote the concept of "motor intelligence" and encourage cognitive switching during breaks.

Inclusion and Differentiation. Tasks must offer various levels of difficulty to ensure success for children with different physical fitness levels and motor development, including those with special educational needs. For instance, wall-mounted finger labyrinths are accessible to children for whom high-intensity jumping is contraindicated.

Zoning and Logic. Markers must be integrated into the space to avoid obstructing main transit traffic in corridors. Pedagogically, it is justified to create "activity routes" that lead from classrooms to rest areas or the cafeteria.

Psychophysiological alignment is a further critical requirement, requiring an effect of novelty and changeability. To prevent fast adaptation and loss of interest (habituation to the stimulus), the design project should incorporate modularity or allow for periodic updates and additions. Furthermore, the use of play-based themes (e.g., space exploration, natural landscapes) can effectively stimulate emotional release and reduce school anxiety and burnout.

Compliance with these requirements transforms the passive school environment into a "pedagogical tool" in which every interior element serves a health-saving strategy without jeopardizing the architectural integrity or security guidelines of the institution.

Recommendations for Wall Zone Design:

Anthropometric Alignment. Implementation across three marker levels: lower (chest level), middle (eye level), and dynamic (extended arm + 10–15 cm for a jump).

Tactile Diversity. Use of markers with varied textures (matte, glossy, or embossed) for additional stimulation of nerve endings in the fingertips. Materials should be anti-reflective to avoid visual strain under artificial lighting.

Recommendations for Floor Marker Design:

Biomechanical Correspondence. The distance between elements should be calculated using age-related anthropometric data; step and jump lengths should align with typical ranges (e.g., 40–50 cm for primary school; 60–80 cm for middle school) to prevent overexertion.

Traction and Safety. Utilization of particular materials with a high coefficient of friction (anti-slip lamination) to minimize injury risks.

Color Psychology. Use of saturated, harmonious shades that clearly differentiate the play zone from the general floor area without creating excessive visual noise.

Implementation and Planned Zoning:

The effectiveness of active markers directly depends on competent zoning. Priority locations include general recreation areas and primary school corridors. Special attention should be paid to transit zones near gymnasiums, where decals can serve as a "dynamic warm-up" or stations for circuit training.

Safety continues as the fundamental criterion. For floor markers, using certified materials that retain traction even when wet is critical. For wall zones, a thorough audit of architectural features is required. Markers must be placed at a safe distance from sharp corners, glass partitions, and door swing radii to prevent injuries. Additionally, wall elements must be securely fastened and free of small parts that could detach.

The presence of active zones in schools gives educators broad opportunities to modernize established teaching methods. Teachers can utilize these locations to conduct structured "active breaks," moving the class from the classroom to the corridor for a 3-minute intensive "reboot". This not only relieves static tension but also greatly boosts concentration levels for the subsequent stage of the lesson.

Furthermore, activity zones can become integral to interdisciplinary quests. For instance, solving mathematical problems can be combined with walking on a "balance beam" or looking for specific letters on wall markers. Such an approach transforms the school environment into a gamified learning space, where every kid's movement carries pedagogical value and contributes to their psychophysiological well-being.

Embedding active pauses into the homework process is a critical prerequisite for preserving students' cognitive resources. According to the principles of neuropedagogy, prolonged static load leads to the "dormancy" of subcortical brain structures accountable for attention and working memory.

Implementing the "Active Learning" (Movement Through Learning) concept in the home environment helps overcome this barrier: short intervals of physical activity intensify cerebral blood flow and stimulate the production of brain-derived neurotrophic factor (BDNF), which facilitates the formation of new neural connections.

Thus, movement during lesson preparation does not act as a distractor; instead, it functions as a biological catalyst that "switches on" the prefrontal cortex, allowing the child to assimilate complex material more quickly and effectively while minimizing the risks of academic fatigue and stress.

We have attempted to integrate the concept of "Active Learning" into the home setting. This guide is based on the principles of neuropedagogy: movement during learning does not distract but, on the contrary, "activates" the brain.

Below, we examine the parent guide titled "Active Homework" or "How to Transform Sitting at a Desk into Dynamic Intellectual Development?"

We have adopted the concept of the "dynamic workstation", as prolonged static sitting leads to congestion and a decline in concentration. Therefore, the first recommendation for parents is to shift the approach to space organization (see Fig. 1).

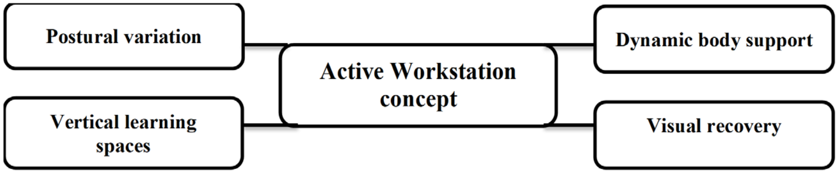

Figure 1. Components of the " Active Workstation" Concept

Posture alternation involves allowing the child to complete certain tasks (e.g., reading or watching a video lesson) while standing, lying on their stomach on a mat, or sitting on a stability ball (which engages the stabilizer muscles and helps maintain brain arousal).

Vertical surfaces are used to memorize information (e.g., vocabulary, formulas) by keeping it at eye level. Eye movement and shifting focus from a notebook to the wall stimulate visual memory. To fully implement the "dynamic workstation" concept in a home setting, two additional key elements must be integrated to complete the physiological and cognitive activity cycle.

Micromobility and active sitting involve using furniture or accessories that allow the body to perform micro-movements even during static tasks. Using balance cushions, saddle chairs, or stability balls activates the deep back and core muscles (stabilizer muscles) and maintains muscular tone without interrupting the learning process. This improves blood circulation and prevents the congestion typically caused by rigid s chool chairs.

Sensory offloading and the visual horizon serve to prevent digital fatigue and stimulate cognitive recovery by altering focal distance. The mechanism involves organizing the space so that every 20 minutes, the child can shift their gaze from a near object (e.g., a notebook or screen) to a distant one (e.g., a wall marker, window, or recreation zone). Eye exercises integrated into wall panels are particularly effective here. This prevents eye strain and "resets" the neural networks that process visual information, thereby increasing the overall duration of productive work.

Together, these components create an environment that does not exhaust the student's body but rather supports their natural biorhythms and work capacity.

The "Neuro-pause" or dynamic break method can be highly effective. Instead of resting with a phone in hand, every 25–30 minutes, the student is encouraged to perform an exercise to "reboot" neural connections. For example, cross-crawls –marching in place while touching the left elbow to the right knee and vice versa –activate brain hemisphere lateralization.

It is also beneficial to implement elements that have proven successful in schools, such as a "Home Wall Reactor" using colored stickers on the child's room walls.

Another key recommendation is Kinesthetic Learning, which integrates subject knowledge into physical actions. This involves solving problems while moving – for instance: "One step equals adding 2. What is 4+2+2?" Jumping in place while practicing multiplication tables helps consolidate results through muscle memory.

Using available household materials to create active zones similar to those in schools is highly relevant.

A balance line made of masking tape in a corridor encourages the child to walk along it whenever they move between rooms. This trains the vestibular apparatus, which is directly linked to speech and writing centers.

A "Touch the Star" marker on a door encourages stretching or jumping five times under specific conditions.

The implementation of the Substitution idea, based on the rule that "any movement is better than none," can transform the study of a paragraph or poem into a walk in the park rather than sitting in a chair. Another option is "active waiting": while a computer boots up or an online platform loads, the child can perform a favorite exercise, such as 10 squats or a "plank" [5, p. 239–252].

Finally, additional physical load should be presented as a "secret code" for completing homework faster. When the brain receives oxygen through movement, the time required for homework is reduced by an average of 20–30% [8, pp. 1044-54].

Conclusions

The synthesis of research results regarding the modernization of the educational environment through dynamic navigational markers leads to several conceptual conclusions:

Revision of the School Activity Paradigm. The evolution of the digital space and academic intensification have created conditions for systemic physical inactivity. The traditional physical education model is insufficient to compensate for 6–8 hours of static sitting. The primary risk is not just a lack of sports, but excessive "sedentary time". Therefore, the WHO-recommended Substitution concept is the only strategic path to minimizing metabolic and cardiovascular risks. Low-intensity physical activity integrated into the educational process has a cumulative health effect that far outweighs the effects of total passivity.

The Educational Environment as an Active Pedagogical Agent. Schools must stop viewing corridors as mere transit zones. Modernizing space through "active design" transforms walls and floors into functional trainers. Visual markers act as neuropsychological "nudges," provoking movement at a subconscious level. Thus, the school environment functions as a "hidden teacher," fostering health-saving behavior without external compulsion.

Scientific and Methodological Substantiation of the "Active Learning" Case Study: The developed typology of dynamic markers combines movement physiology, ergonomics, and cognitive psychology. Floor markers (Agility Islands, Winding Path, Math Jump-drome) develop gross motor skills and spatial thinking, while wall markers (Touch the Star, Finger Labyrinth, Wall Reactor) enhance flexibility, spinal health, and fine motor skills. Combining movement with cognitive tasks facilitates better retention of material by activating interhemispheric neural connections.

Ergonomic and Pedagogical Validity. The effectiveness of active design depends on ergonomic compliance (e.g., anti-slip coatings, anthropometric height) and pedagogical principles (e.g., intuitiveness, inclusivity, variability). The "equipment-free" system is resource-efficient, does not obstruct evacuation routes, and ensures high throughput during breaks.

Universality of Sensorimotor Integration. Developing proprioception is a critical factor for safety and health. While visual control of movement is often studied in rehabilitation, its application in pedagogy can preventatively address posture and coordination issues. Visual feedback allows the brain to accurately calibrate motor actions, providing a basis for injury prevention.

Socio-Pedagogical Effect. Implementing parent guides and digital dashboards creates a "school-family" health-saving vertical. Scaling the "Active Learning" case study nationwide within the New Ukrainian School (NUS) framework directly impacts the state's defense capability by fostering a healthy, physically prepared, and resilient young generation.

Future research should focus on longitudinal experiments to evaluate the impact of dynamic markers on academic performance and the reduction of musculoskeletal disorders throughout the school year. Transforming a "sitting" school into an "active" ecosystem is essential to the development of education in the digital age.

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