

Development of the health-preserving competence of a physical education teacher on the basis of N. Bernstein's theory of movements construction using virtual reality technologies

Mykola B. Yevtuch¹, Vasyl M. Fedorets², Oksana V. Klochko³, Mariya P. Shyshkina⁴ and Alla V. Dobryden⁵

¹*Institute of Pedagogy of the NAES of Ukraine, 52-D Sychvykh Striltsiv, Kyiv, 04053, Ukraine*

²*Vinnitsia Academy of Continuing Education, 13 Hrushevskoho Str., Vinnytsia, 21050, Ukraine*

³*Vinnitsia Mykhailo Kotsiubynskyi State Pedagogical University, 32 Ostrozhskego Str., Vinnytsia, 21100, Ukraine*

⁴*Institute of Information Technologies and Learning Tools of the NAES of Ukraine, 9 M. Berlynskoho Str., Kyiv, 04060, Ukraine*

⁵*Pavlo Tychyna Uman State Pedagogical University, 2 Sadova Str., Uman, 20300, Ukraine*

Abstract

The article studies the results of the research aimed at the improvement of the methodology of development of the health-preserving competence of a Physical Education teacher in conditions of post-graduate education on the basis of Nikolai Bernstein's theory of movement construction using virtual reality technologies. Based on the use of AR/VR technologies a software application "Virtual Model Illustrating Nikolai Bernstein's Theory of Movement Construction" was developed. The stated model is one of the tools of the "Methodology of development of the health preserving competence of a Physical Education teacher on the basis of Nikolai Bernstein's theory of the levels of movement construction". The experimental study determines that the application of the virtual model within the stated methodology is an effective tool for the development of the health preserving competence of a Physical Education teacher. The application of the virtual model allows the actualization of the health preserving, conceptual, gnoseological, biomechanical, inclusive, corrective potentials of Nikolai Bernstein's theory of movement construction. The use of the virtual model presents the ways of targeted and meaningful use of Nikolai Bernstein's theory of the levels of movement construction by a Physical Education teacher and the improvement of physical and recreational technologies and concrete physical exercises and movement modes. Due to the application of virtual reality tools, health-preserving, preventative, corrective and developmental strategies are being formed among which the significant ones are: "Application of synergistic movements to adaptation to movement activity, and recreation", "Application of spatial movements for actualization of the orientation and search activities and development of spatial thinking", "Use of movements with a complicated algorithm for intellect development".

Keywords

health-preserving competence, Physical Education teacher, post-graduate education, virtual reality, N. Bernstein, biomechanics, methodology, pedagogy of health

1. Introduction

The application of digital technologies in education is a priority vector of innovative development, which gives the chance to disclose the potential of a personality and education [1, 2]. Burov et al. [1], Semerikov et al. [2] speak of the significance of digital technologies for education, "...integration of virtual reality technologies into the educational process would facilitate the increase of the quality of education". These scientists note that this would facilitate the achievement of the "flexibility of the educational process". The stated scientists emphasize that the use of modern digital technologies in the field of education can be viewed as an opportunity for improving education accessibility for children with disabilities as well as children with special educational needs [3, 4, 5]. An important idea of these authors is that "the described technologies will allow to minimize the link of the educational process to a certain place or time as well as enable the access to educational resources in a form that would suit the learner..." [1].

The stated digital technologies are significant for the development of a health preserving competence of a Physical Education teacher in conditions of post-gradual education [6, 7]. This is caused by the need of an educator to perceive a person in conditions of movement activity at a qualitatively new level. The demand for such a perception, apart from health preservation, is the importance for prevention of various disorders as well as the need in the improvement of the skills of a Physical Education teacher related to working with the movement sphere of a person [8]. We actualize the need to use digital technologies, particularly, of virtual reality technologies, to increase the qualification level of a Physical Education teacher in conditions of post-graduate education, first of all, for the study of complicated movements spatial and anthropological phenomena and theories, which they disclose.

Movement as a manifestation of human nature and a way of existence, personality formation and development and its corporality in the professional activity of a Physical Education teacher is a central phenomenon that he or she works with. Therefore, a person's health is also perceived and interpreted in the format of movement activity [8]. At the same time, the nature of movement activity, which includes the knowledge and the practically oriented perception of its in-depth, neurological and systemic mechanisms is currently not fully understood by a Physical Education teacher. Consequently, the knowledge about movement as the essence of human existence is not fully used in the professional activity, primarily, within the health preserving aspect. The insufficient understanding of the in-depth and systemic physiological, neuro-physiological and psychophysiological mechanisms of movement activity by a Physical

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✉ bruney333@yahoo.com (V.M. Fedorets); klochkoob@gmail.com (O.V. Klochko); shyshkina@iitlt.gov.ua

(M.P. Shyshkina); alladobruden@gmail.com (A.V. Dobryden)

🌐 http://esu.com.ua/search_articles.php?id=17432 (M.B. Yevtuch);

<https://scholar.google.com/citations?user=sfjR5w0AAAAJ> (V.M. Fedorets);

<https://sites.google.com/view/klochko-oksana-v> (O.V. Klochko);

<https://iitlt.gov.ua/eng/structure/departments/cloud/detail.php?ID=269> (M.P. Shyshkina);


<http://irbis-nbuv.gov.ua/ASUA/0038843> (A.V. Dobryden)

🆔 0000-0001-6116-4760 (M.B. Yevtuch); 0000-0001-9936-3458 (V.M. Fedorets); 0000-0002-6505-9455 (O.V. Klochko);

0000-0001-5569-2700 (M.P. Shyshkina); 0000-0002-6505-9455 (A.V. Dobryden)

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Education teacher is caused by a number of factors. Among the above mentioned factors, the following main ones can be singled out: the complexity and specificity of the issue; the insufficient understanding of its practical and technological significance; the need to study the neurological foundation of movement; domination of practical and technological training without proper consideration of the knowledge about the nature of movement; underestimation of the importance of the theoretical knowledge about the nature of movement for a professional and thus its insufficient operationalization (in the sense of transformation of theoretical concepts into practices and technologies) as well as targeted use in health preserving technologies and practices of physical education. The stated vector, which discloses the nature of movement activity, is primarily, even though incompletely, studied within the framework of formation and development of the professional competence.

In Ukraine, an important factor of insufficient actualization of knowledge about the nature of movement activity, were the limitations to studying biomechanics, which existed in the former Soviet Union. In the former Soviet Union, the foundations of biomechanics as a science that discloses the nature of movement were made by an outstanding scientist Nikolai Bernstein [8, 9, 10, 11, 12, 13, 14, 15] at the end of 1940-s. One of the focal points of biomechanics is the theory of the levels of movement construction developed by Nikolai Bernstein. In the 1950-s, Nikolai Bernstein and his movement theory were severely criticized and essentially forbidden, and the scientist was persecuted [8, 13, 15] because of the fact that sociocultural processes, including the educational ones, are somewhat inert, biomechanics as a science that discloses the nature of movement and is even currently insufficiently used in the training a Physical Education teacher and development of his health preserving competence. Accordingly, this also applies to the issues of insufficient application of biomechanics, namely, Nikolai Bernstein's classic theory of movement construction in the course of post graduate training of Physical Education teachers.

The current processes of European orientation and humanization of the Ukrainian education as well as the active use of the child-centric, inclusive [16, 17], competence based and innovative approaches, determine the new intellectualized and humane format of Physical Education [8, 18, 19, 20, 21, 22] as a diverse creative anthropological practice and as a variant of a "technology of self", improvement of both the movement sphere and corporality as well as self-realization and personal development and creativity. In this aspect the application of a personality-oriented approach is relevant as it includes the need to consider the personal and age biomechanical peculiarities of a child. One of the main aspects in setting this problem is the introduction of inclusive education. The inclusive paradigm determines the need for a Physical Education teacher to develop intellectual skills of taking into consideration the sensor and motor capabilities of children with special educational needs. Accordingly, in this aspect it is important that an educator gains knowledge and skills that make it possible to correct the sensor and motor disorders with Physical Education [16, 17].

The above mentioned tendencies determine professionalization and a central vector in post-graduate training of a teacher. This creates a need for a practice oriented disclosure of the nature of movement, both in the state of norm and pathology caused by certain motor disorders. An important aspect of actualization of the stated problem is also the issue of primary diagnostics of the state of the motor system, which includes the teacher's understanding of the peculiarities of its neurological foundations in order to personalize and optimize the motion activity at Physical

Education lessons [8]. Diagnosing of the peculiarities and the state of the motor system, based on the knowledge about its nature is significant for health preservation as it allows the teacher to design and organize movement activities of the pupils using a targeted, conceptual and nature corresponding approach as well as correct those activities in the course of the classes. In conditions of commercialization and competition it is important for a Physical Education teacher from the point of their professional and social adaptation and self-realization.

The peculiarity of Nikolai Bernstein's theory of the levels of movement construction [8, 9, 10, 11, 12, 14] is its systemic nature and the fact that it is rather difficult for perception as well as practical application. That is why, effective representation tools are needed in order to present this theory in conditions of post-graduate education and with the focus on its practical implementation. The possibility of using the augmented reality technologies is one of such effective tools. Apart from general tendencies towards digitalization of education, the determining reasons for choosing technologies of virtual and augmented reality include the possibility to work with spatial objects, which is important for biomechanics, which studies mostly spatial changes and movement of a human body; another important factor is the time factor – the need to cover complex scientific theories in the context of their practical application within a short period of time, which is always the case in conditions of post-graduate training; another significant factor is the representative and sense-forming potential of augmented and virtual reality.

The scientific pedagogical literature does not sufficiently cover the issue of strengthening the health-preserving competence of a Physical Education teacher in conditions of post-graduate training, using the knowledge about the nature of movement, which is disclosed in Nikolai Bernstein's theory of the levels of movement construction. The studies do not highlight the ways and methods of using virtual reality for a practically oriented representation of the stated theory in the course of post-graduate training of a Physical Education teacher. Together with the health preserving significance of Nikolai Bernstein's theory of the levels of movement construction, which is being disclosed using augmented reality, it is relevant for the development of the professional competence of a Physical Education teacher as well as for working with children with special educational needs. All these factors put together prove this study to be relevant.

Purpose. Improvement of the methodology of development of the health-preserving competence of a Physical Education teacher in conditions of post-graduate training on the basis of Nikolai Bernstein's theory of movement construction using technologies of virtual reality.

2. Selection of methods and diagnostics

The following approaches were used in the study: analysis of the scientific literature; competence based; systemic; morphological-functional; anthropological [23]; biomechanical [8, 9, 10, 12, 14, 20, 21, 22]; ontological, neurophysiological, pathopedagogical (Fedorets et al. [24], Yevtuch et al. [25]); hermeneutic, inclusive [8, 16, 17].

The following concepts were applied: knowledge transfer (Takeuchi and Nonaka [26]) and anthropologization (Ushinskii [27]).

Digital technologies. Digital technologies were used [1, 2, 3, 6, 7]. The study worked with the Internet resources of the technology of virtual reality, namely the software application

“Virtual Model Illustrating Nikolai Bernstein’s Theory of Movement Construction” [28, 29]. The CoSpaces Edu software was used to develop and view the virtual reality software application [29].

Methods of mathematical statistics. Wilcoxon’s T-test [30]. In order to confirm the statistical significance of the difference in the results of solving the control problems of physical education teachers before and after the experiment, we used Wilcoxon’s T-test. The criterion is used to compare the indicators of the same sample in two different conditions. In this case, the “typical” shift is considered to be a shift in the direction of increasing the values of the studied feature.

We formulate hypotheses:

H_0 : The values of the indicators after the experiment exceeds the values of the indicators before the experiment at the level of significance $p < \psi$.

H_1 : The values of indicators after the experiment are less than the values of indicators before the experiment at the level of significance $p < \psi$.

The calculation of the sum of the ranks of “atypical” shifts T_{emp} is carried out according to the formula

$$T_{emp} = \sum_{i=1}^k r_i, \quad (1)$$

where k is a number of atypical shifts, r_i is the ranks of atypical shifts ($i = 1..k$).

T_{cr} is found in the table for a given n (number of indicators) according to the level of significance ψ . ψ is determined in accordance with the problem 0.05 or 0.01, i.e. $p < 0.05$ or $p < 0.01$.

If $T_{emp} \leq T_{cr}$ at the level of significance $p < \psi$, the shift in the “typical” direction in intensity with high probability prevails, we accept hypothesis H_0 . If $T_{emp} > T_{cr}$, with an intensity with high probability is dominated by a shift in the “atypical” direction, we accept hypothesis H_1 at the level of significance $p < \psi$.

Our own methodological concepts. The developed “Virtual Model Illustrating Nikolai Bernstein’s Theory of Movement Construction” is the determining, conceptualizing and system organizing part of the study. The stated virtual model is a part of the “Methodology of development of the health preserving competence of a Physical Education teacher on the basis of Nikolai Bernstein’s theory of the levels of movement construction”. This methodology is formed on the basis of using pedagogical tasks, analysis of movements and movement modes as well as on the study of practically all significant situations, issues and biomechanical and anthropological phenomena in the normal and pathological states. A significant component of the methodology is the implementation of tasks aimed at the development and correlation analysis of physical exercises and movement modes based on the application of N. Bernstein’s theory of movement construction [8, 9, 10, 12, 14, 20, 21, 22]. The important approaches used within the framework of this methodology include problem based learning and flipped learning as well as game-based teaching methods and Socratic (maieutic) methods. The analysis and study of pedagogical, movement and sport experiences and practices of Physical Education teachers seems important.

Within the stated methodology, we use our own methodological technique “Wheels of problems and senses”. This technique represents a broadened and adapted to practical use

“version” of the hermeneutic circle. In the course of its development we used the holistic and systemic approaches as well as ideas of contextual learning. The developed “Virtual Model Illustrating Nikolai Bernstein’s Theory of Movement Construction” [28, 29] was used throughout the stated methodology and represents its “central” and sense-forming component.

Methodology of control over the efficiency of application “Virtual Model Illustrating Nikolai Bernstein’s Theory of Movement Construction” as a part of the methodology. The basis of the control methodology is presented by 10 interrelated questions. The questions are given in the form of a test. A Physical Education teacher needs to choose one correct answer of the four suggested options. This is done to form a systemic and practically oriented understanding of this issue in a teacher as well as to develop his skill of conceptualizing relevant issues of motor activity in a practical way with the focus on health-preservation. Here is the list of the question.

Question:

1. From the list of movements select those in which level A is the leading one.
2. From the list of movements select those in which level B is the leading one.
3. From the list of movements select those in which level C is the leading one.
4. From the list of movements select those in which level D is the leading one.
5. From the list of movements select those in which level E is the leading one.
6. Which movement level (choose from A, B, C, D, E) dominates in dancing or physical exercises that have a relatively complex algorithm or scenario? How can this be used at the lessons of Physical Education from the point of health-preservation and personality development?
7. At which level of movements (choose from A, B, C, D, E) the movements are implemented with minimal energy losses? How can this be used from the point of health-preservation in organization of workout process at Physical Education lessons?
8. Development of which level of movements (choose from A, B, C, D, E) is the basis of praxis? How can this be used at the lessons of Physical Education from the point of health-preservation and personality development?
9. At which movement level (choose from A, B, C, D, E) basic motor disorders are formed in conditions of infantile cerebral paralysis? Is it possible to consciously and arbitrarily influence this level?
10. Which of the levels of movements (choose from A, B, C, D, E) is associated with orientation and search activity, and can be fully realized thanks to the visual analyzer. The formation of which thinking is facilitated by the actualization of this level of movements? How can this be used at the lessons of Physical Education from the point of health-preservation and personality development?

3. Results and discussion

Improving the health-preserving competence of a physical education teacher in the conditions of postgraduate education is a defining and system-organizing educational precondition for the effective preservation of the health and life of children in the conditions of the educational process. Guided by the paradigm of competence approach and the ideas of inclusion, creativity,

child-centeredness and humanization, we define the *health-preserving competence of a physical education teacher* as an integrative professional and personal ability of a teacher aimed at preserving the life and health of students with typical development and special educational needs in the educational process by forming a healthy lifestyle, prevention and correction of disorders; by promoting the formation of children's competence in personal health-preserving, physical activity, corporeality, physical image, personal freedom, as well as the development of socially adapted, harmonious, ecophilic and life-creating personality through the use of physical culture means. A relevant component of improving the health-preserving competence of physical education teachers in postgraduate education is the use of virtual and augmented reality technologies to deepen and expand practical knowledge about motor activity as a manifestation of human nature and as a way to his or her health.

Let us consider the ways and peculiarities of using the virtual model ("Virtual Model Illustrating Nikolai Bernstein's Theory of Movement Construction") as a system organizing model within the "Methodology of development of the health preserving competence of a Physical Education teacher on the basis of Nikolai Bernstein's theory of the levels of movement construction". In this methodology, the virtual model is the central and sense-forming element, representing a spatial image-semiotic system. We formed the stated methodology on the basis of methodological idea of cyclic, repetitive, rhythmic, step-by-step development of knowledge and senses as well as on the "panoramic" and holistic perception of reality. Together with knowledge development, we actualize the formation of corresponding senses, values, intentions, reflections, interpretations and professional health preserving attitudes. Cyclicity and repetitiveness, being the determining structural and didactic ideas of knowledge representation and sense shaping, are initially defined by systemic nature and a "multi-dimensional" and diverse specifics of N. Bernstein's theory of movement construction [9, 12, 14]. Within the framework of this theory five levels of movements are defined – A, B, C, D, E. Being interrelated and interdependent, these levels represent a complex hierarchic system. It is relevant that every level of motor activity is relatively autonomous and specific and may be considered as a determining and defining for movements that are characterized by common features. At the same time, a certain level is presented as a necessary component or the basis for the next, "higher" level of movements. According to the above described understanding, movements activity may be presented either by all levels or by one, two (e.g. balancing movements), three (e.g. walking) or more (up to five) levels.

Highlighting the essence of N. Bernstein's theory, we characterize each level of movements in the relation to other levels and thus disclose the phenomenology of movements activity as a whole. At the same time, we highlight one key determining aspect (vector) and a few additional ones. These additional aspects facilitate a deeper, widened and interpretation oriented disclosure of the key aspect by supplementing its senses. In this pedagogical system the key aspects (vectors) are presented as *problem-conceptual lines*. These lines differ from the aspects (in a narrow sense) as they are clearly directed, aimed at problem setting, interpretation and constructing of new knowledge. The orientation towards knowledge and sense construction, transfer and transformation includes the actualization of an individual problem as well as the formation of complex and general understandings about movement perceiving the peculiarities of all five levels. Thus, the consideration of the issue of movements activity is being actualized through its consideration within the "individual-general" system, which is one of the central

correlations in hermeneutics [31]. The stated “individual-general” correlation is reflected in the concept of a hermeneutic circle. In our pedagogical system of didactic positions, the central and main differences between the problem-conceptual line and aspect lie in the fact that it is primarily viewed and formed as a certain epistemological, hermeneutic, value-conceptual and practically and technologically oriented subsystem with the corresponding orientations. The consideration of a certain problem-conceptual line (aspect) discloses the nature of all five levels of movement as a complex system and accentuates each of these levels as a particular “movement ontology”. By actualizing each next aspect as the previous one we “take it through” all A, B, C, D, E levels.

For instance, while disclosing the nature of movement through the representation of “Key manifestations of movement” and “Movement characteristics”, we analyze and illustrate it with the help of a virtual model. The movement is structured into subsystems represented by a certain level: A (tonic movements) – ensures muscle tonus, mimic movements, trembling from cold and stress, etc. (see figure 1); B (synergistic movements) – synergistic, economic, balancing, reciprocal (movements in which antagonist muscles contract and relax in turn), smooth, “round” movements etc. (e.g. body movements when a person stands, balances or does physical exercises without lifting the legs from the surface or changing his or her position) (see figure 2); C (level of spatial movements) – movements that ensure active spatial movements: jumps, walking, running, thrusts (see figure 3); D (level of concrete actions) – movements that ensure an effective and targeted work with objects, tools – praxis (see figure 4); E – intellectual movements: language movements and dances and “motion scenarios”, which have a complicated structure (see figure 5).

We briefly represent another important problem-conceptual line, which is a group of inter-related aspects – “Movement as a manifestation of existence, movement as a body scheme, movement as a spatial and orientation phenomenon”. Level A – level of tone – is a manifestation of existence as a given; is “discloses” the space of the body as a self-sufficient, self-referential and self-reflective system; the level of tone (A) essentially “forms” the “vital body” as a self-referential phenomenon both in the consciousness and in reality; this level ensures the formation of a “primary” scheme of the body; discloses the corporal “self” as the one that is in the body in general, actualizes it; existential of corporality; forms a certain orientation within one’s body, which is relatively independent from the environment. Level B – level of synergy – swaying, synergistic movements form: movement as such, which is characteristic of a body and the movement of body parts relatively to the body as well as swaying shifts (sways, bends etc.) of a body in space; discloses the corporal “self” as such exists in the body through synergistic movements; actualized the existential of space [32], the existential of corporality as the existential of movement [8] by shifting parts of the body (limbs and the body itself) relatively to it; discloses the existential of temporality through movements, which are repetitive and periodical, forming a “temporal-biochemical-swaying” process, which facilitates the perception of time; forms orientation within one’s body with regard to and depending on the movement of parts of the body (arms, legs) relatively to it and while making swaying movements, also taking gravitation into consideration; balancing movements give the realization of gravitation and thus form a close connection with the Earth as a planet and the foundation of life; these movements are a precondition for forming spatial metaphors, which represent the basis of the sensor-motoric thinking. Level of spatial movements – C: represents and “unveils” the space, landscape and the

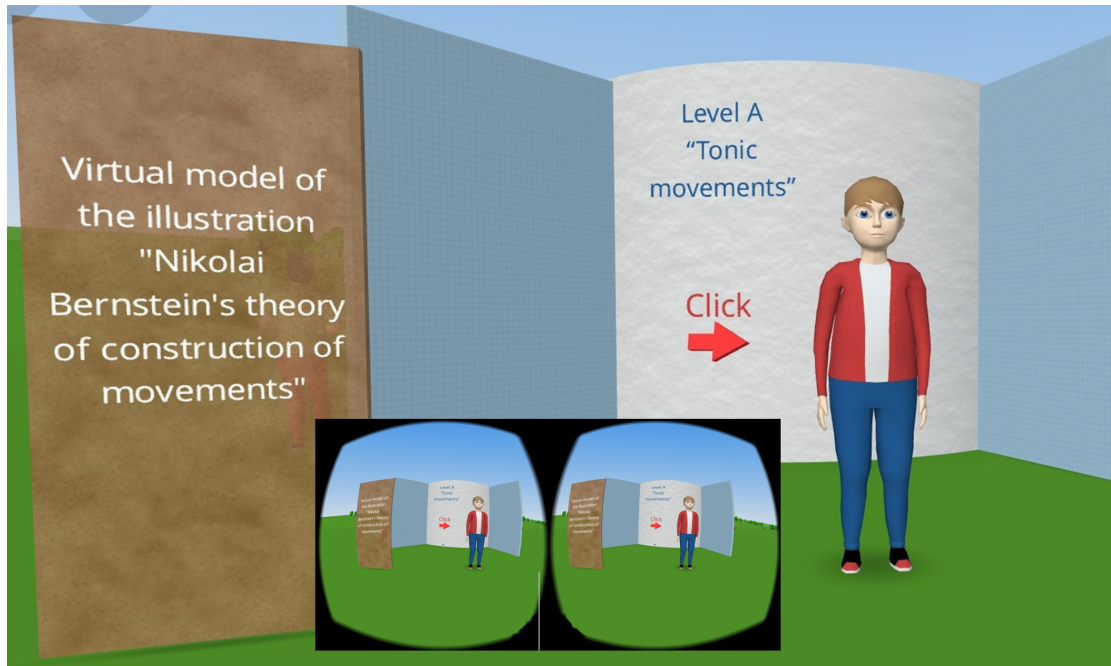


Figure 1: Level A – Tonic movements [28]. The figure shows a man standing. This is provided by the tonic level (A). A person can jump sharply. This is an example of changes in the tonic level – ballism. Movement: muscle tone, statotonic, coordination-tonic, facial expressions, trembling in the cold, grouping when falling. Level basis (is the “background level”) – B, C, D, E. Characteristic of movement: unconscious (automatic), the involvement of all muscles of the body, basic and background for all levels, associated with the subconscious. Attitude to space and orientation: own body.

Earth with the existing objects and perspectives; presents movement as a “spatial” existence through spatial movement; discloses the existential of spatiality and temporality; actualizes the existential of corporality and the existential of locomotion [8] through movement of the body in space; forms an orientation and goal setting in space; is a precondition of forming spatial metaphors as the basis of thinking and values [33]. Level of concrete actions – D; “forms” a “world of things” in the consciousness (the object domain); discloses the orientation within the objects and actions; “creates” praxis as an ability for targeted, creative and “transformational” work with objects, tools and the environment and to a certain extent as a “specific” interaction with people and animate objects (plants, animals). Level of intellectual movements – E: forms mental and corporal activity as a semiotic-conceptual and intentionally-targeted, in the formats of language and communication; discloses the language and dialogue as existence and a mental-communicative way of existing in it; determines the spaces and fields of concepts, senses and values; discloses intellectual activity as a human way of being; actualizes the existentials of love and health as a manifestation of human nature.

The presented brief overview of the three problem-conceptual lines (aspects) in the learning process discloses with the help of the “Virtual Model Illustrating Nikolai Bernstein’s Theory of Movement Construction” the essence of movements activity in a consecutive, “layer-by-layer”,

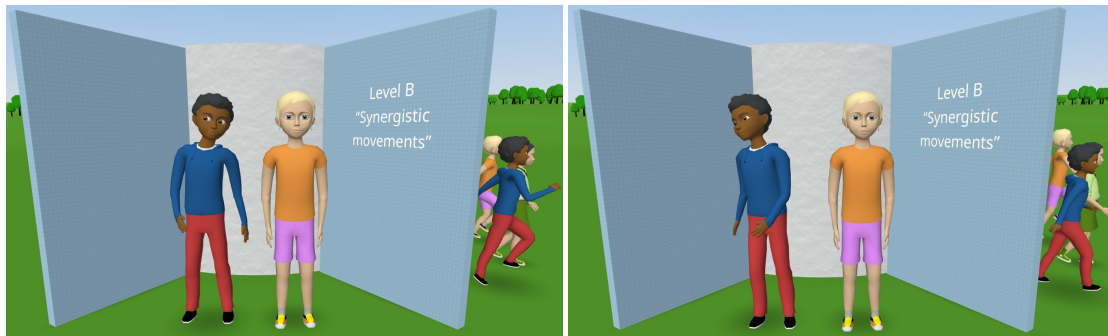


Figure 2: Level B – Synergistic movements [28]. Movement: base walking and dancing (rhythmic), maintaining balance and balancing, facial expressions. Level basis (is the “background level”) – C, D, E; rhythm of speech and intonation. Characteristic of movement: movements without taking into account the spatial structure of the environment, economical, balancing, stereotic, equilibrium, “pulsating”, rhythmic, repetitive, smooth and precise, partially automatic, the basis of walking, may be partially automatic and unconscious. Attitude to space and orientation: own body and the immediate surrounding space.

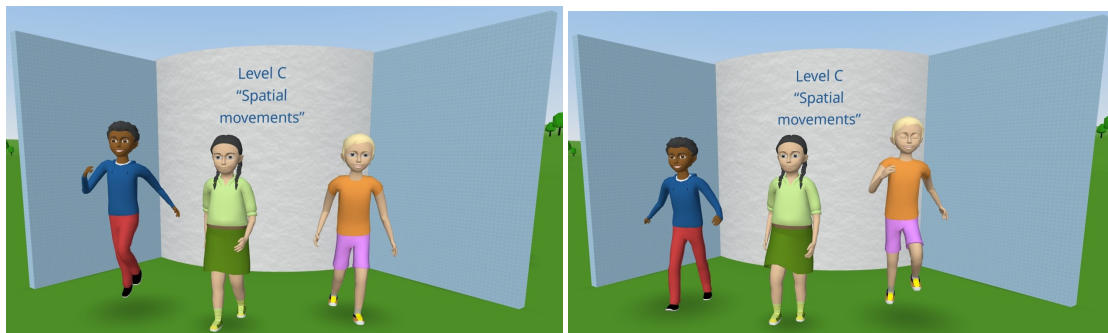


Figure 3: Level C – Spatial movements [28]. Movement: movement based on orientation in space, walking, running, throwing, jumping. Level basis (is the “background level”) – level D, E. Characteristic of movement: spatially oriented, differentiated, precise, conscious, conscious movements. Attitude to space and orientation: three-dimensional space.

cyclic way. In the course of this process the knowledge from various fields (knowledge transfer) is used, which is then naturally integrates into a certain epistemological system. Such a variety of knowledge facilitates the actualization of the hermeneutic potential of N. Bernstein’s theory, which accordingly launches the active formation of interpretations, reflections, understandings and senses. From the didactic point of view, the stated methodology of knowledge representation and perception allows to present the knowledge in various ways, not being limited to a fixed hierarchic model. Problem-conceptual lines may be represented in any order and combination. This creates a corresponding learning diversity, facilitates spontaneous manifestations and is a precondition for creativity and active dialogue-based interaction. Physical Education teachers can independently choose the aspect that needs to be analyzed in the context of N. Bernstein’s theory. This may further be used for a formal description of the methodology for

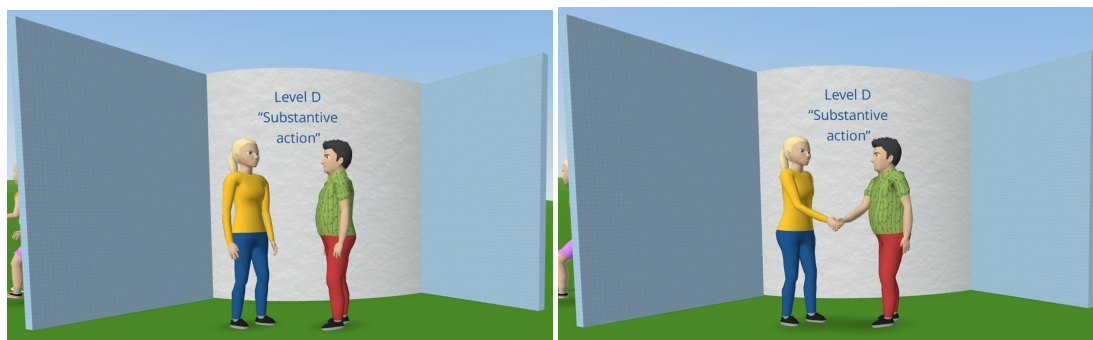


Figure 4: Level D – Substantive action [28]. The figure shows the idea of movement of level D – Substantive action. It is primarily formed through contact in the “man–man” system as a contact. In this case, the participation of level A (tonic movements) is relevant – which forms the possibility of contact with another person, and later (in the process of human development) with the object (tool). Movement: actions and work with objects, praxis. Level basis (is the “background level”) – level E. Characteristic of movement: has a complex algorithm, is targeted, subject-manipulative and meaningful, system-forming and meaning-forming factor is the goal and the result is focused on the action with the objects, this level is semantic and objective, conscious movements. Attitude to space and orientation: “space” of objects and tools that are in three-dimensional space.

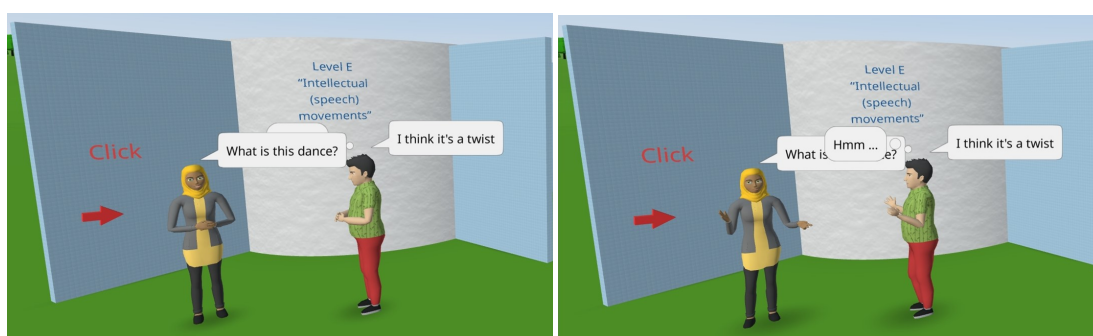


Figure 5: Level E – Intellectual (speech) movements [28]. Movement: intellectualized movements – sign language and partly body language and dance (understood as complex choreographic actions), reading, spoken and written language and reading. Characteristic of movement: characteristics related to speech, physical communication, complex dances and motor scenarios, conscious. Attitude to space and orientation: for language – space of objects and ideas, ideal (virtual) spaces of values, values; for dances and complex motor scenarios – three-dimensional space, space of speech, “space” of tools and objects, space of ideas, values and meanings.

the improvement this virtual reality model of the stated issue and creation of a corresponding interactive model.

Within this pedagogical system we present the repeated and multi-dimensional highlighting of the nature of movement, together with the actualization of its various aspects and with a corresponding subsequent formation of complex understanding of the movements field and a human being, as a methodology (methodological technique) of cyclic and layer-by-layer shaping of knowledge, values and senses, calling it the “Wheel of problems and senses”. The axis idea of

this methodology is the cyclic and repetitive knowledge formation, reproduction, transfer and transformation in various aspects, contexts, formats and in correlation with various problems and aims of movements activity and corporality. This, in turn, determines the hermeneutic and sense forming potentials of the methodology as well as the existence of knowledge in the form of a problem. Accordingly, in the course consideration of various aspects and their analysis in correlation with the nature of various levels of motor activity organization, knowledge is being constantly updated. The very existence of knowledge in the form of problematization, as a problem and as interpretations, facilitates its preservation, development, growth and widens the opportunities for a value based and practical orientation of creativity. Using the ideas expressed by S. Frank, we may characterize such knowledge as “living knowledge” [34]. Thus, thanks to its multi-dimensional, systemic, representative nature, N. Bernstein’s theory allows to disclose the phenomenology of movement using the “Wheel of problems and senses” methodology, which is a practical and targeted application of the idea of a hermeneutic circle and which, speaking metaphorically, forms new knowledge and senses in the course of its “movement” within the “knowledge space”.

The “Virtual Model Illustrating Nikolai Bernstein’s Theory of Movement Construction” forms the foundation of the above presented practical implementation of the ideas of a layer-by-layer and cyclic shaping of knowledge and senses about movement with the help of the “Wheel of problems and senses” methodology (methodological technique). The stated model contains anthropic images, typical situation (e.g. a person is running – level C, or talking – level E) and “motion spaces” in which the peculiarities of every level of movements is being disclosed. The virtual spaces of the stated model as well as the corresponding anthropic images are used to study the peculiarities of various levels of movements and are also subsequently used as sense-forming contexts to highlight and particularize the relevant issues of the motion sphere, health preservation and disclosure of the human phenomenon as a whole.

Thanks to the use of the “Virtual Model Illustrating Nikolai Bernstein’s Theory of Movement Construction”, the “Wheel of problems and senses” and the problem-conceptual lines, which form it to a great extent, motor activity is disclosed as a manifestation of the poly-ontological human nature [35]. Accordingly, the motor activity is represented as a particular “existential-vital-movements-activity-intellectual ontology”, and is not reduced (simplified) to mechanic movements. Motion is viewed as a continuum of anthropological phenomena – from purely “biological-corporal” ones (levels A, B) and “corporal-spatial” (level C) and “corporal-praxeological” to “gnoseological-linguistic” and spiritual ones (level E).

For a “dialogue-based” “immersion” of course participants into the “biomechanical essence of movement”, the initial demonstration of the virtual model includes the actualization of maieutic and interactive practices. The idea of this aspect is to disclose movement as a complex, multi-level anthropic system. In the virtual model, the five levels are demonstrated in the form of anthropic images and are a spatial formation. Such a presentation is essentially a “spatial” as well as “anthropic” metaphorization. It creates the effects and levels of movements are presented using real examples and in real situations, which are considered with the relation to and together with the use of the virtual model.

While focusing the attention of course participants on the phenomena of complexity and consistency as the determining ones in movement construction, we analyze when the stated complexity is distorted by considering the virtual model. Therefore, the fine interaction between

the levels of movements is also distorted. The fact that probable distortions really exist, can be modelled and thus “extracted” from N. Bernstein’s level theory poses a special methodological interest [8, 9, 10, 11, 9, 14]. We suggest that the course participants model probable distortions on the basis of knowledge about the nature of movement disclosed with the help of the virtual model. The stated aspect of decomposition with the subsequent “construction” of movement is possible even after the basic familiarization with N. Bernstein’s theory.

Using the virtual model and, consequently, the “layer-by-layer and periodic consideration”, we present various aspects of movement, each time quickly analyzing the peculiarity of all five levels. In the course of this process, the movements, sport, life and professional experiences of Physical Education teachers are being actualized. As an example, we will consider the problem of sense as a significant component of organizing movements activity by analyzing three levels (A, B, C) of N. Bernstein’s theory.

A – “The level of tone” – reflects the sense of corporal existence. In this aspect we focus on the existentiality of corporality, remembering classical ideas of L. Binswanger [32]. We consider the stated aspect in the spirit of existential pedagogics (Bollnow [36]). Thus, it is significant for the humanization of the educational process and the formation of a kind attitude of a teacher towards a child, which corresponds to the child-centric ideas of the “New Ukrainian School”. While analyzing the “A” level, we indicate that the main “purpose” of a child is the existential perception of self as a possibility and a reality – “I AM” and “BE”.

Senses of the next level B (“Synergistic movements”), which is well represented in the virtual model, is also characterized by human corporality. At the same time, relevant senses of human existence in the environment are added. This level is directly linked with the Earth, namely with gravity. Balancing movements are also included into this level. Thanks to this level, the essential initial contact with the Earth is created. In this aspect, we actualize the ideas of Embodied Cognitive Science within the framework of which the relevant aspect of intellectual activity is the body and human corporality, which are “inscribed” and interact with the environment.

Senses of level C (“Spatial movements”) are primarily disclosed through a possibility to shift the position in space, which is effectively presented in the model. Thus, through the realization of this level, the orientation and search activity, which is one of the preconditions of the intellect and a manifestation of the vitality and spatial nature of a person, is manifested and developed.

The main reason for actualizing the idea of senses of motor activity is for the teacher to understand the ways and possibilities for motivating the pupils to work out and lead a healthy lifestyle. For instance, at level A (tonic movements) the educator works with the senses of corporal being and being as such. This includes beauty, health, the sense of life [8, 32]. This is the “source” of motivation and not the fact that a child “must” workout.

Level B (“Synergistic movements”), just as the previous one, allows a person to understand himself in relation with “himself” and the “environment”, with the Earth. At this level, in order to form senses and influence a pupil, it is necessary to be congruent. In our opinion, this level is linked with a person’s perception of his/her body. To a certain extent, it may be called “corporal reflective”. It discloses the corporality dynamically, in synergistic movements and through rhythms (it is the basis of dances).

At level C (“Spatial movements”), it is important to use the informative-value and vital potential of the “Earth space” in order to form senses and motivations for motor activity and healthy lifestyle. A relevant point is the environmentally friendly application of landscape

pedagogics, spatial metaphors etc.

In the course of implementation of this virtual model, we consider the issue of inclusion (as one of the central problem-conceptual lines) in order to give the teacher an understanding of the ways of improving pedagogical interaction with as well as teaching the children with special educational needs [16, 17], and also to broaden the professional abilities of an educator in terms of correction of sensor-motoric and other disorders with the help of Physical Education tools.

Motor health-preserving strategies are formed on the basis of M. Bernstein's theory of construction of movements. Based on the practical and technological understanding of the features of biomechanics, psychology and neuronal foundations of different levels of movement revealed in M. Bernstein's theory and through the reception of pedagogical and sports experiences of physical education teachers the strategies are developed that are considered as health-preserving and prophylactic ones. The very same strategies are to some extent corrective and developmental. These strategies can be used for health-preserving improvement of existing physical culture and health technologies and practices as well as for the development of new ones. We will briefly present the main aspects of motor health-preserving strategies.

Motor health-preserving strategy "Application of synergistic movements to adaptation to movement activity, and recreation" is developed on the basis of practically oriented understanding of synergistic movements – level B. The feature of these movements is economical, adjusting, pulsating, repetitive, rhythmic, balancing and to some extent "recreational" nature (see figure 2). This strategy can be applied to the formation of new motor actions (in the sense of physical exercises), as well as used in the already existing ones with the actualization of the synergistic component. That is, already known exercises can be performed in a "synergistic mode". Such movements are balancing, rhythmic, repetitive and are realized with a sense of ease. The movements can also be performed partially in an automated mode, which creates the effect of rest, comfort of the movement itself, "comfortable" feeling of your body, as well as calming due to the actualization of the rhythmic component. The application of spatial and body-spatial motor metaphors is relevant, in which there is an orientation in the directions up/down, forward/backward, right/left, the movement around own axis. The application of this "synergistic strategy" is necessary for the "soft entry" into motor activity, which corresponds to human nature i.e. for warming-up and getting out of the load – for a hitch. "Entering" and "exiting" motor activity should be delicate and inconspicuously synchronize the work of the cardiovascular and respiratory systems and musculoskeletal system, taking the body to a qualitatively new level of functioning systematically, smoothly, rhythmically, not abruptly, quickly, "avalanche like" and not synergistically. Synergistic movements also play a setting and tuning role for a particular activity or other movements. Let's remember the soft, delicate, oscillating and rhythmic movements when a woman shakes a baby. In the same semantic series there are synergistic (rhythmic, oscillating) combat or "marriage" (expressed in animal dances) movements, both in humans and in animals that have a corresponding reflection in dances.

The motor health-preserving strategy "Application of spatial movements for actualization of orientation-search activity and development of spatial thinking" is formed on the basis of actualization of orientation-search activity which has expressive spatial character (see figure 3). In the implementation of this activity, visual and auditory analyzers are activated as the main ones that provide adaptation in space. The development and active functioning of the mentioned analyzers (visual, auditory) is a sensory prerequisite for the formation of spatial thinking,

orientation and imagination. To implement this strategy, we recommend using outdoor activities, the potential of landscape pedagogy and tourism, as well as the demonstration of landscapes and spatial objects and their discussion. It is important to use motor games with elements of orientation in space and complex-coordinated movements and movements on various including circular trajectories and their subsequent analysis and discussion. The application of spatial motor metaphors, elements of theatrical pedagogy, which includes reincarnation into various images in which the motor and spatial-motor components are expressive, is relevant.

The motor health-preserving strategy “Application of movements with a complex algorithm for the development of intellect” is formed on the basis of updating the intellectual potential of the level E – intellectual movements) (see figure 5). We recommend using relatively complex motor scenarios, including choreographic and those that can be performed both individually and collectively, as well as to teach to work with spatial images, routes and actions, thinking about their trajectory and method of implementation. An example is the performance of combat movements in martial arts combined into a special system (dance) – kata. The combat motor actions are integrated and transformed into a sequence of movements and a sequence of actions (if movements with objects or weapons) in kata. Motor actions are thus interconnected and “intercurrent” successive combat movements that are integrated into a system. They represent “motor-spatial algorithms” and a system of body-movements “tools” of influence and action. The spatial-temporal integration of motor actions is based on: principles and cultural traditions and experiences of combat, ideas about the enemy and the combat situation, modeling and reflexive understanding of the probable problem, concentration and meditation techniques, knowledge of biomechanics and human psychology. Thus, the kata from the standpoint of cognitivism can be considered as a “body – space – activity” semiotic system defining characteristic, which is cognition. It is interesting to use the representative potential of movements, which includes the ability to communicate through motor activity and demonstrate complex ideas, feelings, which is also considered in the framework of theater pedagogy. The use of music and the arts in general, including poetry, is important. The use of elements of play, carnival, imitation of life scenarios, as well as narrative and communicative skills of a teacher is important for the actualization of this level.

We recommend using augmented and virtual reality technologies in the implementation of all these motor health-preserving strategies, which will allow implementing them at a new quality level.

One of the significant results of contemporary European centric transformations of the Ukrainian education is the formation of intellectualized, axiologized, “human-centric”, psychology driven and “humanitized” physical culture [18, 22]. Such physical culture is considered as a relevant component of movements activity, development and existence of a child and not only as a school subject. Thus, it is represented as a system of personality-oriented and culture-corresponding techniques of the body, which we view in correlation with mental, spiritual and health preserving practices as well as, to a certain extent, their inseparable components. Judging from the anthropological-cultural and humanistic positions, it is important that the teacher perceives the cultural heritage and includes it into the value-conceptual contexts of the educational process, namely, for the organization of motor activity, development of corporality and the corporal image of the pupils.

In the light of such views, physical culture may be viewed not only as a corporal technique

and a motion practice of a particular culture, but first and foremost as a culture forming unit. We believe that corporal techniques make up the basis of preserving physical as well as psychological, existential and spiritual health.

N. Bernstein [8, 9, 10, 13, 14, 15] defined a person and his/her locomotor sphere as a set of super complex integratively functioning intentional systems, which have a certain potential for autonomy (in a modern auto-poetic understanding). This made his views radically different from the views of a simple person (lat. *Homo simplex*) and a reflex person, mechanic person, automated person. N. Bernstein's ideas are disclosed and have undergone value based comprehension with the help of virtual reality and they lead us to an idea that movement is a manifestation of the higher nature of human existence as well as to an understanding of metaphysical and ontological for mans of motor activity.

An experimental study. To analyze the efficiency of using the "Virtual Model Illustrating Nikolai Bernstein's Theory of Movement Construction" within the "Methodology of development of the health preserving competence of a Physical Education teacher on the basis of Nikolai Bernstein's theory of the levels of movement construction" in the Communal Higher Educational Institution "Vinnytsia Academy of Continuous Education" and study was conducted in 2019 among 165 Physical Education teachers, who were taking the professional growth training course. The experimental group was made up of 85 people.

Let us prove the statistical confidentiality of the obtained results. The number of tasks that had to be completed by the Physical Education teachers before and after the The results showing the number of correct answers of Physical Education teachers to the question before and after using the methodology of development of health-preserving competence of a physical education teacher in the conditions of postgraduate education on the basis of N. Bernstein's theory of construction of movements with the use of virtual reality technologies $n_1 = 10$ and $n_2 = 10$ (see figure 6).

Let us confirm the statistical significance of exceeding the values of the indicators of the results of solving control problems by physical education teachers after the experiment over the values of the corresponding indicators before the experiment using the Wilcoxon's T-test [30].

We find the difference between the values of the corresponding indicators of the results of solving control tasks by physical education teachers before and after the experiment (table 1).

We arrange the obtained absolute values of the differences in the indicators of the studied trait before and after the experiment in ascending order. Rank them in ascending order of absolute differences with using average ranks (because there are related ranks) from 1 to 10 (table 1).

Analysis of the table data showed that there are no "atypical" shifts. So, calculated by formula (1)

$$T_{emp} = \sum_{i=1}^k r_i = 0.$$

Find the critical value for the Wilcoxon's T-test for $n = 10$, using the data in table 1:

for $p < 0,05$ the $T_{cr} = 10$,

for $p < 0,01$ the $T_{cr} = 5$.

The empirical value $T_{emp} = 0 < T_{cr} = 5$ at the significance level $p < 0.01$.

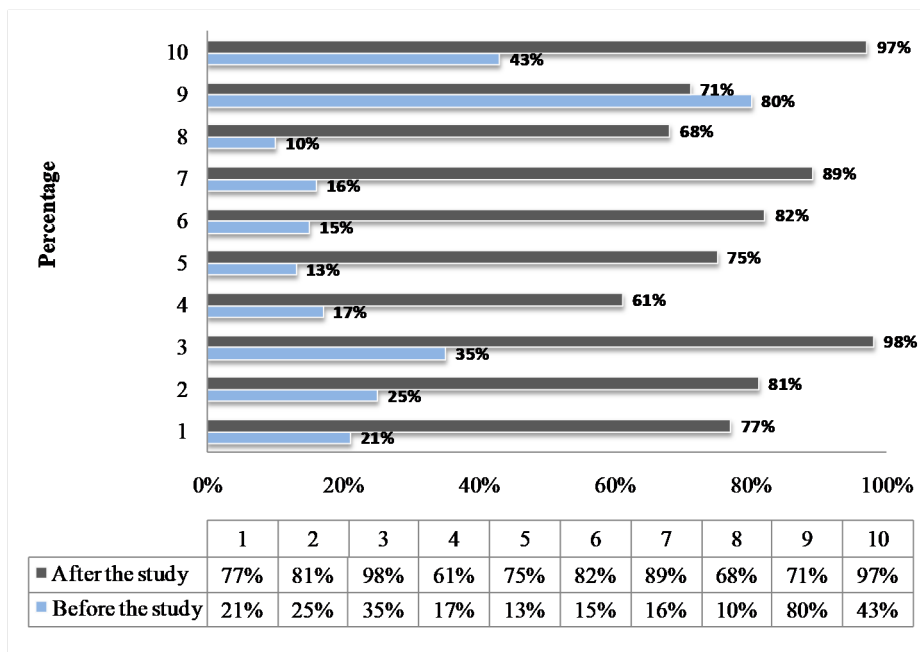


Figure 6: The results showing the number of correct answers of Physical Education teachers to the question before and after using the methodology of development of health-preserving competence of a physical education teacher in the conditions of postgraduate education on the basis of N. Bernstein’s theory of construction of movements with the use of virtual reality technologies.

Hypothesis H_0 is accepted. The values of the indicators of the results of solving control tasks by physical education teachers after the experiment statistically with a high probability exceed the values of the indicators before the experiment at the level of significance $p < 0.01$.

3.1. Conclusion

The application of virtual reality technologies for health and practically oriented perception of the phenomenology of movement activity, the essence of which is disclosed in Nikolai Bernstein’s theory of movement construction, is an important innovative tool for improvement of the health preserving competence of a Physical Education teacher in conditions of postgraduate education. Based on the use of AR/VR technologies a software application “Virtual Model Illustrating Nikolai Bernstein’s Theory of Movement Construction” was developed. This virtual model is an effective tool for the development of the stated competence.

The results of the analysis of the research aimed at the study of the efficiency of the virtual model within the “Methodology of development of the health-preserving competence of a Physical Education teacher on the basis of Nikolai Bernstein’s theory of the levels of movement construction” using the Wilcoxon’s T-test prove the statistical significance of the efficiency of application of the given methodology, namely, a statistically viable positive dynamics of the educational achievements of Physical Education teachers have been determined. With the help of the virtual model the health-preserving, intellectual, gnoseological, hermeneutic,

Table 1

The value of the corresponding indicators of the results of solving control tasks by physical education teachers before and after the experiment, their difference and ranks of absolute values of differences

Order number of the task, n	Before the experiment, x_{before} (%)	After the experiment, x_{after} (%)	Difference, $x_{after} - x_{before}$ (%)	The absolute value of difference (%), $ x_{after} - x_{before} $	Ranks of absolute values of differences, r_i
1	21	77	56	56	3.5
2	25	81	56	56	3.5
3	35	98	63	63	7.5
4	17	61	44	44	1
5	13	75	62	62	6
6	15	82	67	67	9
7	16	89	73	73	10
8	10	68	58	58	5
9	8	71	63	63	7,5
10	43	97	54	54	2
Sum total	-	-	-	-	55

representative, axiological, praxeological, technological and sense forming potentials of Nikolai Bernstein's theory are being disclosed. This facilitates the formation in a teacher of systemic views and structural-functional, holistic and value-conceptual understandings of movement as the basis of life and health as well as the "existential-vital-movement-activity-intellectual ontology".

Disclosing the theory of movement construction through the application of the virtual model and other tools as viewed as a gnoseological precondition of fundamentalization of the health-preserving knowledge and the corresponding competence and it is also a cognitive factor of the health-preserving oriented professionalization and axiologization of the work of a Physical Education teacher. The use of a virtual model for the representation of Nikolai Bernstein's theory in the methodology of the health-preserving competence of Physical Education teachers is a necessary condition for the development of the stated competence both in the context of its integration with the professional competence as well as to raise the scientific, fundamental and technological level. This also facilitates the effective practically oriented application of the state theory by a Physical Education teacher for the analysis and improvement of physical and recreational technologies as well as of concrete physical exercises and movement modes.

Accordingly, a Physical Education teacher gains professional opportunities for the application of Nikolai Bernstein's theory in the health preserving and correction-development work with children with special educational needs as well as in inclusive education practices. On the basis of the health-preservation oriented disclosure of the nature of movement, health-preserving, preventative, corrective and developmental strategies are being formed among which the significant ones are: "Application of synergistic movements to adaptation to movement activity, and recreation", "Application of spatial movements for actualization of the orientation and search activities and development of spatial thinking", "Use of movements with a complicated

algorithm for intellect development”.

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