Educational Technology Quarterly, Vol. **2022**, Iss. 4, pp. 276-306 https://doi.org/10.55056/etq.431

Using immersive reality technologies to increase a physical education teacher's health-preserving competency

Oksana V. Klochko[1], *Vasyl M.* Fedorets[2]

[1]*Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University, 32 Ostrozhskogo Str., Vinnytsia, 21100, Ukraine*
[2]*Vinnytsia Academy of Continuing Education, 13 Hrushevskoho Str., Vinnytsia, 21050, Ukraine*

Abstract. The article discusses the findings of study targeted at enhancing the methodology of augmented reality use for the development of a physical education teacher's competence in health preservation under post-graduate educational settings. According to Umwelt phenomenology, augmented reality is distinguished by its cognitive, metaphorical, varied, interactive, and anthropomorphic characteristics. The article examines the potential applications of augmented reality in a physical education teacher's line of work, notably in the area of health promotion. The software that could be implemented for this function has been described. The research determined that physical education teachers had a favorable attitude toward using immersive reality to protect students' health and foster the growth of their motor skills, intelligence, and creativity. The survey's findings indicate that the majority of teachers had a favorable response to the notion of using augmented reality in their professional work. However, in certain instances, there was a lack of a completely developed knowledge of this issue. The introduction of augmented technology techniques into the post-graduate education process, taking into account the anthropological, ethical, and cultural settings as well as instructor involvement in the mentioned process, could be one way to solve the problem as described. The software application "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" has been developed based on the usage of immersive reality technologies and comprises of 5 models. Specifically, the anthropological-spatial systems that simulate joints and are utilized to help teachers grasp the dangers to the locomotor apparatus. The positive dynamics of physical education teachers' educational outcomes are characterized as a consequence of study into the effectiveness of applying virtual models as a component of a technique for developing the health-preserving competence of physical education teachers.[1]

Keywords: health-preserving competence, Physical Education teacher, post-graduate education, augmented reality, virtual reality, Umwelt, pedagogy of health, preventive pedagogy, health risks, methodology, digital technologies

1. Introduction

The need to use immersive reality in education [21] and, first and foremost, in practices and technologies of Physical Education is caused by its "congruence" to the "human reality", particularly

[1]This is an extended and revised version of the paper presented at the 1st Symposium on Advances in Educational Technology [20].

klochkoob@gmail.com (O. V. Klochko); bruney333@yahoo.com (V. M. Fedorets)
https://sites.google.com/view/klochko-oksana-v (O. V. Klochko);
https://scholar.google.com/citations?user=sfjR5w0AAAAJ (V. M. Fedorets)
0000-0002-6505-9455 (O. V. Klochko); 0000-0001-9936-3458 (V. M. Fedorets)

its correspondence to the peculiarities of a pupil's motor activity and the multi-dimensional, adaptable and diverse spectrum of tools that can be used within it. The use of augmented reality in the educational process correlated with the disclosure of the value of human existence and the anthropological-value reflection of life-world (Germ. Lebenswelt) [15] of a person may form developing, intellectual and synergistic effects, which are the manifestation of digital transformation of education and its shift to a new quality level. At the same time, the issue of using augmented reality in the professional work of a Physical Education teacher, namely, for health preservation, is an actively developed topic [9, 14, 19, 21]. We view the problem of development of a methodology for using augmented reality for the development of a health-preserving competence of a Physical Education teacher in conditions of post-graduate education and on the basis of anthropological [4, 10, 24], ontological [1] and value paradigms, which includes the need to consider the phenomenology of a person, his/her multidimensionality and the peculiarities of this field of education (of physical culture and sport), creativity and potential of a personality.

Considering the introduction of the augmented reality in an educational process, the necessity of use of ontology-oriented comprehension of a person and his/her motion activity is actualized. In the semantic framework of ontological understanding of a person, he/she is represented as a multidimensional and polyontological creature. Experimental data received by Nosov [31] and then used by him as the foundation for the development of the virtual psychology, prove the polyontological nature of a person, view the person as place for integration of many realities. Therefore, it is necessary to examine the augmented reality not only traditionally from the "instrumental and technological" point of view but also from ontological positions. In such a case, the augmented reality is considered as a relevant component of person's ontology.

Accordingly, the methodological perception of the possibilities of using augmented reality is carried out with the application of relevant from the point of biosemiotics Umwelt ("the surrounding world") concept [23, 39, 42]. This concept provides a holistically oriented reflection of a special world or a specific reality of a living organism. The stated reality (Germ. Umwelt), according to von Uexküll [42] is manifested through integration of the world of perception (Germ. Merkwelt) and the world of action (Germ. Wirkwelt) [42]. Thus, in the course of its existence, the body forms a "relevant zone", which is that very fragment of reality, which seems to be vitally significant for its perception and activity.

The application of Umwelt conception for the improvement of the use of the augmented reality is a methodologically determined way of ontologization of Homo Educandus (A Person who studies) and humanization of an educational process. Accordingly, the use of an Umwelt idea can extend methodological and technological possibilities of application of the augmented reality by the selection of the special "transitional reality" between a person's reality and the world. Therefore, we suggest to perfect the methodology of use of the augmented reality in professional activity of a Physical Education teacher in the ontology oriented direction, which considerably extends and anthropologizes traditional methodologies and technologies in particular.

In addition, in order to broaden the possibilities of implementation of the existing potentials of the motor and mental spheres of a person, an integrated "external" reality is needed. In this respect, there occurs a need to integrate "corporal", "motor" and "intellectual" realities and "ontologies" (in the sense of reality) of health through the use of an external integrating factor (a

"special" reality), which a priori must itself be intelligent. Such an "external reality" within the framework of methodological comprehension presents itself as Umwelt and as the augmented reality.

Accordingly, such an "external" reality must form an intellectualized, dialogic, activity based and intentional (in the sense of targeted) anthropo-technical medium, capable of self-development. A natural pre-condition of the indicated "corporal and intellectual" integration is the phenomenon of Umwelt, and an artificial one is the augmented reality. Nowadays, such a "new" and "integrating" reality may be formed using digital technologies [19, 21], namely, in the form of augmented reality. The example of the indicated "corporal and intellectual" integration is the use of the augmented reality for the development of emotional intellect of children with disorders of autism spectrum [7]. In the work of Chen, Lee and Lin [7]. the augmented reality was used to teach to recognize mimic patterns. Accordingly, in the indicated cases [7], while forming mimic characters there will be present integration of corporal, emotional, intellectual components and an "external" component as the augmented reality.

Thus, we determine the need to use augmented reality in the course of training a Physical Education teacher, particularly, for improving his health-preserving competence [10], as a nature-corresponding way of a person's development, which correlates with a person's transcendent and polyontological essence. Augmented reality is a way of integrating the realities already existing in a person (mental, corporal, motor) as well as a way of their improvement. Thus, the application of augmented reality is an end-to-end anthropological project [1, 21, 32], which corresponds to human nature and his/her motor being, and not a "local improvement". Accordingly, in this aspect, the concept of Umwelt can be applied.

Despite a considerable number of studies dedicated to the use of digital technologies and, first of all, of augmented reality in the educational physical culture practices and technologies, the problem of using augmented reality for the development of the health-preserving competence of a Physical Education teacher in conditions of post-graduate education has not been sufficiently studied yet. Particularly, the methodological, pedagogical, anthropological, prognostic and psychological aspects of the stated problem haven't been thoroughly studied. In the methodology of use of the augmented reality, the presence of a "transitional zone" between a person and the world (Umwelt) is not sufficiently taken into account.

Taking into consideration the digital trend of education development and perceiving the practical demand for raising the effectiveness of pupils' health preservation during motor activity, as well as actualizing the issue of education professionalization, pedagogization, digitalization and technologization, the stated research is defined as relevant.

From the point of applying the understanding of a person's Umwelt, an innovation-oriented and integrative use of an image of a person, as well as of specialized biological and medical-biological knowledge, particularly, the comprehension of a locomotor apparatus, is a relevant vector of research. The stated integration may be implemented on the basis of application of the immersive reality technologies. The application of the stated digital technologies on a new innovative level would facilitate the disclosure of the representative, axiological, health-preserving and intellectual potential of the special knowledge about a person. Such an approach that includes the application of the immersive reality technologies is aimed at the development of the health-preserving competence of an educator through actualization of value, motivation and technology oriented aspects, linked to a certain system of problems that are of practical

significance. Thus, according to the competence paradigm of education, is practically and technologically oriented.

Purpose of the research: the use if the immersive reality technologies to improve the health-preserving competence of a Physical Education teacher in the course of post-graduate training, which is implemented on the basis of the Umwelt concept, the anthropological paradigm and virtual models of the locomotor apparatus.

2. Selection of methods and diagnostics

For the purpose of methodological perception and conceptualization of the possibility and practices of introduction of AR/VR technologies for the improvement of a health-preserving competence of a Physical Education teacher using the Umwelt concept and the anthropological paradigm, the following approaches and concepts, methods and technologies are used: ontological; hermeneutical; axiological; pathopedagogical [11]; health-preserving [19, 21]; phenomenological [15]; life-world (Germ. Lebenswelt) of Husserl [15]; biosemiotic [30]; anthropological [4, 10, 24]; anthropological practices and "technologies of self" (Foucault [13]); Umwelt (von Uexküll [42]) [23, 39, 42]; of contact boundary developed in gestalt psychology; of sense making (C. Lorenz) [23]; autopoiesis (Maturana Romesín and Varela [28]); of embodied mind (Lakoff and Johnson [25]); of cultural-historical theory of psychic development (Vygotski [43]); of C. Jung's Self (Germ. Selbst) [17]; virtual reality technologies, digital modeling, in particular, 3D modeling [5]; methods of mathematical statistics [40]. We also used visions and methodological approaches developed in the system of embodied cognitive science [35], enactivism [22] and virtual psychology & virtual science [31].

For the methodological perception, the following Ancient Greek concepts were used: "human nature" (Ancient Greek $\phi\upsilon\sigma\iota\zeta\ \tau\omicron\upsilon\ \alpha\nu\theta\rho\omega\pi\omicron\upsilon$) [16]; "harmony" or "mixing" (Ancient Greek $\kappa\rho\alpha\sigma\iota\zeta$) [16]; "self-perception" (the Delphian principle "Perceive yourself" – gnothi sautou) and "care of self" (epimelēsthai sautou) described by Foucault [13].

To develop the "Methodology of development of the health-preserving competence of a Physical Education teacher based on the knowledge of the nature of the locomotor apparatus in the normal and pathological state" and, accordingly, the pedagogical problems and the above mentioned virtual model we used a complex of approaches: problematic with the help of which we formed the problematic-sensible field and determined the scope of the problem (we determined the area of the unknown as well as the relevant area of cognition) and outlined a system of practically significant problems, situations and phenomena; targeted – defines and specifies the problem and knowledge; competence is aimed at the development of corresponding competences and is reflected in the methodological system; knowledge transfer is used for a selective inclusion into the methodological system (and problems) of medical-biological, anthropological, psychological and other knowledge. Hermeneutic is aimed at the formation of an ability of a teacher to interpret and understand the problematics of health. Axiological approach facilitated the formation of the value component in the pedagogical problems (as well as in the methodology in general) and a relative development of the hierarchal value-conceptual system as a component of the personality-existential component of the health-preserving competence of a Physical Education teacher. The phenomenological [15] approach is aimed at the selection

and consideration of normative and pathological phenomena as well as at the development of a health-preserving intentionality of an educator's consciousness. The ontological approach actualizes the consideration of the issue of health as a manifestation of existence, the corporal ontology manifested in motor activity and body comfort. The anthropological [4, 10, 24] approach is used with the purpose of anthopologization, which includes a holistic and value oriented understanding of a person as an anthropological-cultural as well as a biological phenomenon. The pathopedagogical approach [11] is formed on the basis of transfer of medical-biological knowledge aimed at concretization and practical orientation of knowledge through the disclosure of reasons, mechanisms and consequences of ligament and tendon stretching. The holistic approach is aimed at the formation of a complex understanding of a person, namely, in the virtual model we use the anthropic image and not only study concrete problems of joints and tendons. The psychological approach [17, 31] is used in order to psychologize and psychologically perceive the health of the locomotor apparatus and corporality. Systemic, anthropological, pathopedagogical, hermeneutic and axiological approaches are the determining ones for forming the virtual model and problems.

Proceeding from the methodological understanding of peculiarities of the augmented reality as well as Umwelt, we can point out that they are the phenomena that contribute to the formation of meanings, semantic contexts, values, patterns of action, images of health, and semantic images. Therefore, for the expansion of the education-oriented understanding of the augmented reality, we determine the attitude of teachers to the necessity of using the augmented reality for preserving health, development of creativity, intelligence, etc.

In order to determine the attitude of Physical Education teachers towards the idea of using augmented reality in the educational process with the purpose of preserving pupils' health and development of their motor skills, intellect and creativity, we developed a questionnaire that consisted of 6 questions.

The questions of the questionnaire were developed with the prevailing application of the anthropological [4, 10, 24] and psychological [17, 31] approaches. Considering health as an ability to create and a precondition for the disclosure of the intellectual potential of the personality, the questionnaire actualizes the significance of the creative, intellectual, environmental, anticipatory (ability to form forecasts) and other aspects. The questions of the questionnaire cognition, which is presented as an important aspect of health, was viewed from the point of a system of "corporal-cognitive" oriented concepts: the mind-body problem; embodied mind of Lakoff and Johnson [25]; cultural-historical theory of psychic development of Vygotski [43] and the methodological approaches developed within the system of the embodied cognitive science [35]. Thus, in the questions of the questionnaire the motor activity was contextually represented as a component of cognition, which may be actualized at a qualitatively new level thanks to the use of AR/VR technologies.

The respondents were asked to choose one of the three possible answers – "Yes", "No", "Cannot decide". The survey contained 6 questions:

1. Does the use of augmented reality facilitate the development of critical thinking and forecasting (anticipation) skills in pupils aimed at trauma prevention during lessons? ("Yes", "No", "Cannot decide")
2. Can the use of augmented reality facilitate the development of corporality, aesthetic and

ethic orientation of a pupil as well as of the competence of self-health preservation? ("Yes", "No", "Cannot decide")

3. Can the use of augmented reality facilitate the formation of ergonomic lessons and the creation of a comfortable, safe and health-preserving environment? ("Yes", "No", "Cannot decide")
4. Can the use of augmented reality facilitate the development of harmonious relations with the environment, eco-consciousness, implementation of the sustainable development concept and health preservation? ("Yes", "No", "Cannot decide")
5. Can the use of augmented reality facilitate the development of motor skills, creativity, existence and reflection in pupils? ("Yes", "No", "Cannot decide")
6. Can the use of augmented reality facilitate the development of digital and learning competences and intellect (motor intellect, in particular) in pupils? ("Yes", "No", "Cannot decide")

The study used AR/VR technologies to develop a software application "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" [12], which consists of 5 models. To develop and view AR/VR applications, specialized software CoSpaces Edu [27] is used, which can also be used in the educational process. Software application CoSpaces Edu can be viewed both with the technical equipment for viewing AR/VR applications and in the browser [27].

To determine the efficiency of the "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching", which is an important component of the "Methodology of development of the health-preserving competence of a Physical Education teacher based on the knowledge of the nature of the locomotor apparatus in the normal and pathological state", we used tests consisting of two problems and four questions. In a somewhat extended form, the stated tasks and questions were also used in the educational process in order to consider the issue of ligament and tendon stretching and tear prevention.

Problems

1. On stretching the ligamentous apparatus.
2. On the significance of flexibility developing exercises.

Questions

1. About the stretching of the spine.
2. About the risks of deforming osteoarthritis development.
3. About mechanical energy accumulation in ligamentous and tendons.
4. About the structural organization of a joint.

The size of the sample n (1) is determined with the help of Student's t-test [40].

$$n = \frac{t^2\sigma^2 N}{\Delta^2 N + t^2\sigma^2}, \tag{1}$$

where:

N is a size of general population;
Δ – the sampling margin of error (permissible deviation from the mean)

$$\Delta = tM;$$

t – the critical value of Student's t-test, taking into account the number of degrees of freedom $df = N - 1$;
M – the representation error:

$$M = \frac{\sigma}{\sqrt{\sum_{i=1}^{3} n_i - 1}};$$

n_i – the number of answers to the i-th question;
σ – the standard deviation is calculated by the following formula

$$\sigma = \sqrt{\frac{\sum_{i=1}^{3}(x_i - \bar{X})^2 n_i}{\sum_{i=1}^{3} n_i}};$$

$\bar{X}$ – the expected value (arithmetic mean):

$$\bar{X} = \frac{\sum_{i=1}^{3} x_i n_i}{\sum_{i=1}^{3} n_i};$$

x_i – the answer option, $(i = 1, 2, 3)$ ($x_1 = 1$ (no), $x_2 = 2$ (cannot decide), $x_3 = 3$ (yes)).

3. Results and discussion

The methodological search was carried out based on the ideas and intentions of integrity, anthropologization [4, 10, 24] and humanization. Thus, the peculiarities of using augmented reality with the aim of improving and implementing the health-preserving competence of the Physical Education teacher in conditions of post-graduate education were studied using the anthropological and biosemiotics approaches [30].

As of today, augmented reality has become an effective digital learning technology based on the achievements in the sphere of artificial intelligence [33]; a way of reflection and effective innovative methodology of actualizing emotional intelligence [7], intellect, storytelling activities and creativity [44], 21st century skills [19], inclusive education [2], interaction of parents with children [6] and potential of a personality.

The issue of using augmented reality in physical culture and sports has been studied by many researchers [9, 14].

While studying the use of augmented reality, we develop the methodological constructs based on the idea of unconditional value of intellect development, creativity and motor activity, which are being implemented due to physical culture. It is based on the fact that it helps the pupil to unveil his/her corporality as well as the mental sphere in the form of a special motor being, as well as through actualization of vitality, life-creativity and sense-creation. Thus, physical culture is a particular motor reality, which corresponds with human nature. Movement and motor being are interrelated with health, which is viewed as an authentic and anthropologically specific way of human existence.

Corporal and motion reality are also the basis of the psychic and mental spheres of a person. According to Vygotski [43] (the cultural-historical psychic concept), consciousness is the result of interiorization (in the sense of shifting to the center, into the psychic reality) of the "history" of a person's interaction with the environment. Motor activity occupies the central role in this interaction. At the same time, motor activity lies at the basis of the intellect, both during its formation in ontogenesis (individual development) and during a person's mental activity, as it is in fact a specific motor reality and existence of a human being.

From methodological positions, following the ontological approach, accordingly, we present health, motion and corporealness of a person as special realities. Therefore, they can be purposefully perfected by cooperation with the augmented reality. Meaningful in this aspect is sense-forming and intellectual dimensions of such cooperation. The use of the augmented reality in health-preserving practices of physical culture is the way of opening of motion activity in the formats of intellectual existence.

For the anthropological-value perception of the phenomenon of an intellect as an anthropologically specific reality and ontology (being) it is important to understand that its beginnings and currently relative components lie in the body, corporality and motor activity. This is described by Lakoff and Johnson [25] in their classical work "Metaphors We Live By". In his embodied cognitive science, Lakoff and Johnson [25] points out that the notion and metaphors, as system-organizing "elements" of the intellect are primarily formed as corporal phenomena. Currently, embodied cognitive science is developed on the basis of the idea about a close and interdependent connection between the mind, the body and the environment [39].

Schematically, the stated above ideas can be depicted as a sequence of a mutually determined and mutually dependent phenomena, namely: body, motor activity and interaction with the environment – intellect – adaptation, creativity, development. Thus, a person may be viewed as a human being that consists of various ontologies (beings) and realities [31]. And the "way" they are organized into a unity makes the very phenomenon of a person. The stated unity is first and foremost carried out "from within" as this is determined by human nature. According to Jung [17], such unity is perceived by a person as Self, which predominantly is perceived by a personality as the highest harmony of the "internal" God. The idea of a polyontological character of a person is the basis of virtual psychology worked out by Nosov [31].

Within the framework of the indicated approaches, as well as following the idea of integrity of an organism and the environment and their dynamic cooperation we actualize the question of the use of the conception of Umwelt [23, 39, 42] for the improvement of the methodology of use of the augmented reality for the development of health-preserving competence of a physical culture teacher. Umwelt is a special "perception and activity reality" of a living organism.

Thus, the reality is being "fragmented" and "channeled" into a countless number of "parallel"

Umwelts "in" which certain biological species live and which they "carry around" with them. This means that the existing reality is multi-dimensional and multi-aspect due to the formation of specific individualized "perception-activity" worlds – Umwelts.

Thus, every biological species generates, masters, sees and somehow understands and interprets the specific and significant for him/her personally spectrum of phenomena, which together form Umwelts. According to Husserl [15], we comprehend being through perception of relevant phenomena, which together reflect the reality in one's consciousness. That's why, in the context relevant to our problematics, we may speak about the peculiarities of the living world (Germ. Lebenswelt) [15], which is formed through a person's unveiling, perceiving and using the significant for him/her phenomena. In comparison we should note that apart from Human, other biological species have quite a limited number of phenomena that form their worlds and are presented and "narrowly" specific. These are the worlds of perception, action, being, which primarily define the mode of existence. Quite strictly determined combinations of specific phenomena form the Umwelts of biological species. Thus, all the biological species except for humans are maximally adapted to "their" Umwelts.

Limitation in space and time of animals' Umwelt is pointed out by Stella and Kleisner [39]. At the same time, when an animal is transferred to a different environment the stated adaptation possibilities drastically decrease and it is not always possible to for "new" Umwelts, even when resources are available. In essence, living organisms form, support and "carry around" a certain fragment of the reality, which is desired and to a considerable extent set for them. Thanks to the use of the Umwelt concept, subjectivity and personalized differences are actualized alongside with the significance of species peculiarities [23]. Every biological species, including man, has their own Umwelt.

Analyzing the Umwelt concept, Knyazeva [23] singles out some aspects that are significant for our methodology: active influence on the environment; feedback between the environment and the creature; selectivity of perception and action; sense making; existence of a dynamic boundary between a creature and the environment; interactive unity of the environment and the organism.

Clarifying the importance of the formative specificity of the Umwelt [23] as a manifestation of life that is related to the semantic potential of augmented reality. Umwelt as well as augmented reality can thus be regarded as environments (or worlds) of forming meanings and ways of using them.

Concerning Umwelt, this is analyzed by the ethologist Conrad Lorenz [23]. That is, through the mind-body, the living organism acquires meaning (living is sense making) [23], which can be modified and enhanced or weakened by the use of augmented reality. The semantic sphere of man, in turn, is connected with life, existence, images and symbolic reality. Therefore, the Umwelt is the living condition or "transient" fragment of reality that contextually integrates or correlates (according to the concept of autopoiesis by Maturana Romesín and Varela [28]) life is represented as existence, as a given and semiotic-symbolic systems [22]. On the other hand, semiotic systems are formed and exist precisely because of the specific formation of the Umwelt, which is a transition zone or a contact boundary between man and environment. These effects can to some extent be achieved through the use of augmented reality, which we consider as a component of the mind of the modern man or as a way to compensate for disturbed natural connections with the environment and by forming new ones. Similar understandings of the

significance of boundary phenomena exist in Gestalt psychology in a system that is considered by the psyche as the contact line between a person and a significant problem. Therefore, one can say, metaphorically: whoever controls the Umwelt shapes meaning and influences life. To a large extent, such an impact can be realized through the use of augmented reality.

Human Umwelts are qualitatively different from other living beings. Man, in the course of its development has created a special environment that at this stage of its existence and development becomes cognitive and cognitive-semantic. The Umwelt created by man actively interacts with it, forming communicative-semantic and cognitive contexts and essentially "communicates" with it. No wonder some creative people point out that the environment "speaks" to them and they take ideas and forces from it. As a specific feature of a person, we distinguish his ability to form "cognitively oriented" Umwelts. In this context it can be stated that by means of professionally made advertising it is possible to form a "digistic Umwelt" through which it is possible to "easily" gain 10 kg of body weight. Accordingly, through the use of physical culture and augmented reality, which will form the "Umwelt of movement", this process can be reversed.

Let us present the methodologically and technologically significant characteristics of the human Umwelt: historicism; cognitive, that is, it is an environment in which data is partially processed and information and knowledge are contained; aesthetism (even the presence of anti-aesthetic tendencies is the antithesis of illuminating aesthetism); ethics (or anti-ethics); value character (in animals we can mostly talk about the hierarchy of needs and importance); dynamism; anthropomorphism; ergonomics; comfort; interpretability; speech characteristic; anticipation (predictive) nature and predictability; ecology (nowadays); promoting sustainable development (at this stage of humanity's existence); harmony; educational; semiotic; digital (currently); health-saving; humorous (only human inherent humor); existential – as open, independent and self-sufficient being; multidimensionality; developmental and creative character; polyontological character; psychologically significant; technological and technical; characterization of relative autonomy. Our understanding of the human Umwelt is close to the concept of the life-world (Germ. Lebenswelt) by Husserl [15]. That is, we do not reduce a human's Umwelt to a perceptual-activity phenomenon, but understand it a little more broadly – based on the allocation of relatively autonomous other components or spheres. For example, training, technology, creativity and more. This understanding of the human Umwelt is also based on an understanding of the as yet undiscovered potential of using augmented reality and digital technologies in general. Based on a methodologically and technologically oriented understanding of the phenomenology of the human Umwelt, we interpret it as a significant multidimensional cognitive and meaningful human reality that has a degree of autonomy and significant contextual impact on humans. Based on the selected characteristics of the human Umwelt, a questionnaire was developed for physical education teachers.

We consider it expedient to use purposefully or at least take into account the phenomenology of human Umwelt when designing and implementing augmented reality technologies. That is, the construction of augmented reality can be carried out not only on the basis of effective target, needy, technological methodological installations, but also taking into account the "transition zone" between man and the world – Umwelt. Digital technologies and approaches that take into account the phenomenology of Umwelt, we call Umwelt oriented. Accordingly, augmented reality can be shaped as Umwelt-oriented. The peculiarity of such technologies will be pri-

marily the use of non-direct influences, cognitive, metaphorical, contextual, spatial, temporal, variability, interactivity, anthropomorphism, individual orientation and other characteristics that reflect the specificity of a person and his mind. This approach is contextually existent and is still being implemented mostly intuitively. In order to maintain health and improve motor activity, the importance of this Umwelt oriented approach is relevant because movement and health are, in so far as they are, contextual values. Movement and health are completely shifted to the actual area of consciousness when a person has certain problems, risks and threats.

Augmented reality allows you to "delicately" create "mental health", "mental movement", "mental health and comfort" and more. Thanks to the use of the augmented reality, we can create "tactfully" the "Umwelt of health", "Umwelt of motion", "Umwelt of safety and comfort", etc.

The indicated Umwelts are a special-purpose transformation or one of possible variants of a person's Umwelt. The purposeful Umwelt formation with desired qualities is a human specific that, first of all, can be exposed due to the use of the augmented reality.

Considering the "multichannel" of human perception, it can be noted that the actual component of "human Umwelts" that can be formed on the basis of augmented reality is their "ability" to synthesize different sensory modalities, namely, sound, visual, tactile, motor. We represent this as a "cognitive-environment synthesis" that facilitates the discovery of humans as beings of "cognitive-motor", intellectual, creative and polypotent. Similar synthesis occurs in associative areas of the cerebral cortex. Artists dreamed of such a synthesis, namely of union, music, light, visual images, movement, movements, odors, touches [18]. This is partly embodied in contemporary art. Thus, augmented reality opens up new and special possibilities for a "new cognitive synthesis". For physical culture, the use of augmented reality, considered in relation to the preservation of health, opens up innovative perspectives, which are first and foremost related to the intellectualization of motor activity and to the ergonomic and natural disclosure of the potentials of man, in particular motor, physical, cognitive, creative.

The actual contemporary direction that gives the opportunity to consider augmented reality and Umwelt as an "active" "cognitive-activity" reality is the concept of autopoiesis by Maturana Romesín and Varela [28]. Within the semantic sense of this concept, the phenomenon of life, including the interaction of the organism with the environment, is presented as an active autopoiesis and cognitive process. Also significant is the trend of enactivism [22], in which the mind-body problem [22, 23]. The body and consciousness in this system of ideas are understood in a holistic way. Defining in this aspect are also the ideas of Embodied Cognitive Science [35]. In the system of this direction, cognitive is represented as a phenomenon that is formed by the interaction of consciousness, body and environment. The notion of cognition as a physical and environmental phenomenon is significant for the professional activity of a physical education teacher, because it works primarily with interdependent phenomena – movement, body, health, which exist in a particular reality and form it. The above ideas about Umwelt and the concepts of autopoiesis, enactivism and embodied cognitivism are considered as aspects that contribute to the introduction of augmented reality, defining the latest understanding of physical culture and sports as "body-cognitive-environmental" and "health-protective" not only as a traditional development of strength, endurance, or other qualities. The key in these cognitively oriented interpretations of motor activity is the phenomenon of augmented reality as one of the "paths" of the autopoiesis of a person. Similar notions of bodily, motor, and mental perfection existed

Figure 1: Organizing specialized online training using SGM SPORTS [34].

in the system of the Hellenistic tradition of the paidae (Greek $\Pi\alpha\iota\delta\epsilon\iota\alpha$) [16] and were realized through "taking care of themselves" [13] and "self-knowledge" [13]. Thus, through the use of augmented reality, we actualize the development of physical culture as a "body-cognitive" and health-saving anthropopractic and promote intellectual activity of motor activity.

Here are some avenues of using augmented reality for the purpose of developing health-preserving and professional competences for physical education teachers:

1. To watch sports on video or visit the stadium. For example, overlaying content with real-time commentary or recording of a given sport or team player, in particular using face recognition technology and more (figure 1).
2. View matches and training while recording. Here, it is possible to overlay video comments, discussions, graphics, graphic analysis on video; such as displaying trajectories, etc.
3. For training and sports, rehabilitation, inclusion. For example, analysis of data on individual stages of training, displaying the strengths and weaknesses of students in this process, overlay training videos, graphics, comments, realistic 3D simulations, organizing discussions in real time, evaluation of the training session, etc. (figure 2).
4. Development of training videos using augmented reality: commenting on individual stages of training, monitoring the functioning of individual body systems during appropriate physical activities, graphical analysis, discussions, displaying trajectories, etc.
5. Educational marketing. For example, advertising an educational institution, developing links to your own training courses and training sessions, site pages, programs, and links to other pages of academics, coaches, athletes, clubs, and more.

Figure 2: Organization of individual training using SGM SPORTS [26].

6. Techno sport. The combination of augmented reality and the physical movement of a player, such as competing with a virtual sport tool (this use is less traumatic than real competition).
7. Simulation of sports competitions: conducting competitions and trainings, graphical analysis, discussions, help, comments, etc.

The use of augmented reality increases the motivation of physical culture teachers to master the complex of professional knowledge, promotes the humanization of the educational process, develops intellectual, emotional and volitional spheres, improves critical thinking, promotes professional reflection of practical experience. It is also aimed at the development of professional subjectivity, the discovery of sports talents, the improvement of sports equipment, the regulation of the volume and intensity of physical activity according to the state of health, etc. Considering all the advantages of this technology, it should be noted that it cannot completely replace the traditional technologies of organization of the educational process and will be the most effective in combination with them.

Consider software that implements augmented reality technologies that can be used in physical education. That software contributes to the formation of "human Umwelt". The specificity of "human Umwelt" is the preservation of health, in particular, through physical activity. Opportunities for augmented reality make it possible to build a trajectory of learning according to individual requirements and needs, and immersion in the audiovisual space makes the theoretical learning experience interesting, engaging and motivating students.

SGM SPORTS by SGM Solutions & Global Media GmbH is designed to organize specialized online training [34] (figures 1, 2). The basic idea behind this product is learning to generate sports strategies through augmented reality experiences. One of the company's products is a prototype ARVolley volleyball strategy that can be downloaded for free and used on Android and iOS platforms. The program demonstrates and explains the attack numbering system. With

it, you can place a virtual interactive playground on the table. These tools are implemented using virtual and augmented environments experience from brainshuttle™.experience [26]. Immersing students in the augmented reality environment of brainshuttle™.experience with realistic simulations, activates them in the learning process, exploring their own opportunities at an individual pace. Depending on the actions, students' situations and outcomes change dynamically, supporting the student to actively engage and achieve learning outcomes. With realistic simulation, the student perceives and performs the task at any level. Playing situations of realistic simulations can teach students some maneuvers, understanding of complex games, which can also help prevent injury.

brainshuttle™.experience augmented reality environments are created using 3D video, 360 degree video, Combined 3D and 360 degree video, 3D animation, Virtual environments, Game environments, Augmented environments (3D video, 360 degree video, Combined 3D and 360 Degree Video, 3D Animation, Virtual Environments, Game Environments, Enhanced Environments) [26].

DribbleUp offers software based on Augmented Reality Basketball (Smart Basketball), Soccer (Smart Soccer Ball), Health Gymnastics with a Ball (Smart Medicine Ball) [29, 36–38] (figures 3, 4, 5): DribbleUp add-ons are designed for both phone and tablet. DribbleUp products provide the ability to work with a virtual trainer, track the accuracy of the exercises performed, train muscle memory, track workouts over time. DribbleUp Smart Ball allows you to combine different cardio-strength exercises.

Figure 3: DribbleUp: Smart Basketball [36].

For techno sports (a new HADO sport format that combines augmented reality with players' physical movement) from Japanese company Meleap Inc. developed hardware and software

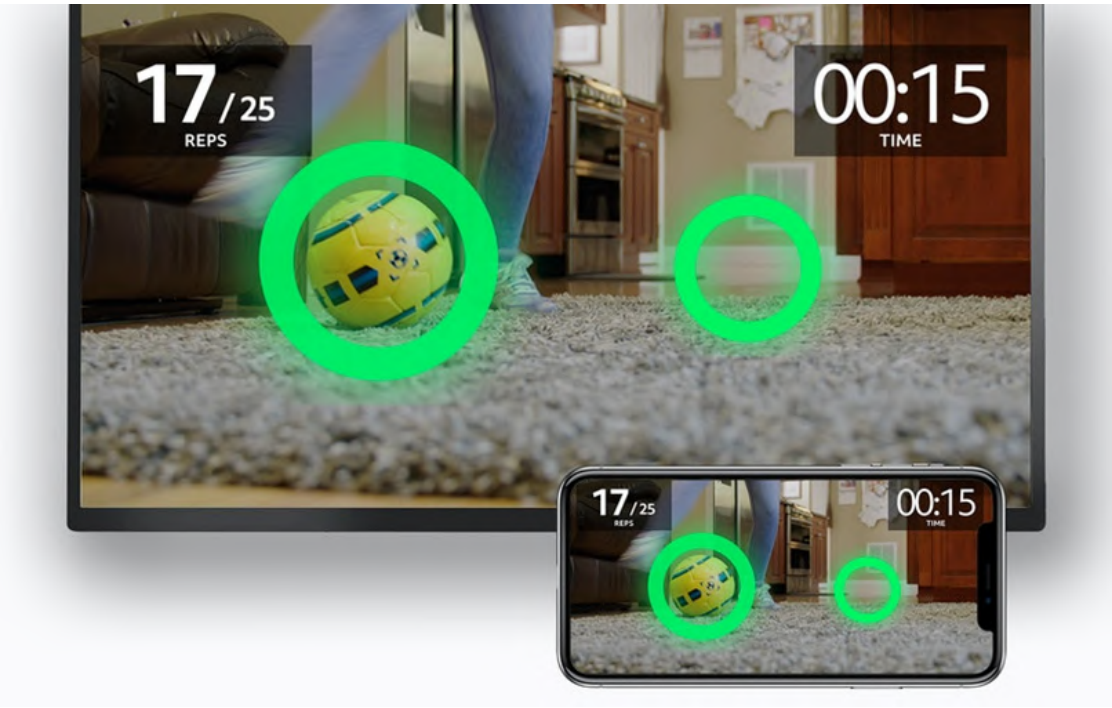


Figure 4: DribbleUp: Smart Soccer Ball [37].

based on augmented reality [29] (figure 6). To play the game, players must also wear a motion sensor and specially designed HMD to track virtual balls and other players. This integration of augmented reality into sports adds magical effects in a normal game, is health-friendly and prevents injury.

In order to determine the attitude of physical culture teachers to the use of augmented reality in the educational process, a survey was conducted by 36 Physical Education teachers. The research was conducted in 2017–2018 at Drohobych Ivan Franko Pedagogical University, Sumy Institute of Postgraduate Pedagogical Education, Mykolayiv Institute of Postgraduate Pedagogical Education. The results obtained are presented in figure 7 and figure 8.

Having analyzed the results of the survey we can note that the majority of teachers (57%) have a positive attitude towards this issue, 18% of the teachers demonstrate negative perception of the idea and 25% were not able to provide a definite answer. Such response distribution within the survey may be caused by the fact that the teachers are not sufficiently informed about the potential possibilities, opened by the use of augmented reality in the educational process.

The analysis of the structure of the answers, provided by Physical Education teachers in the questionnaires shows that so far, the teachers do not fully understand the possibilities of augmented reality in forming ethical attitudes of the health-preserving environment, eco-consciousness, comfort. This means that Physical Education teachers do not fully understand the sense-forming, contextual and environmental influences of augmented reality.

The ways of solving the stated problem may include the inclusion of augmented reality technologies into the process of post-graduate education taking into consideration the anthro-

Figure 5: DribbleUp: Smart Strength Ball [38].

Figure 6: HADO Game Using Means by Meleap Inc. [29].

pological, ethical, cultural contexts and using the competence based and personally-oriented paradigms; the involvement of Physical Education teachers to the development of educational software applications using augmented reality technologies in the role of consultants, coaches, experts etc.; improving the knowledge and skills of Physical Education teachers on concrete issues and phenomena related to health preservation; involvement of Physical Education teachers

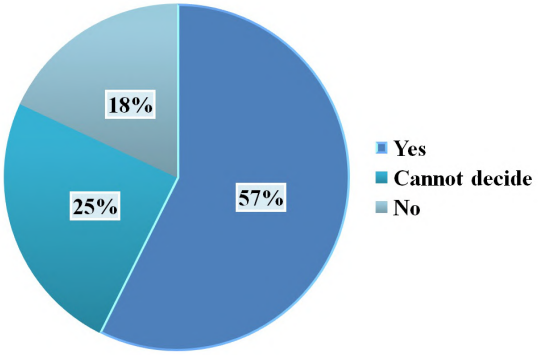
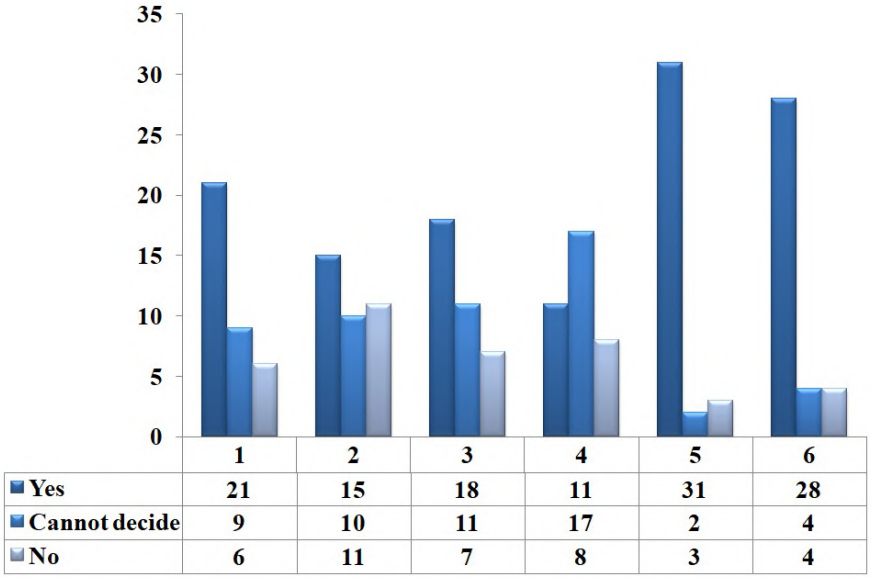


Figure 7: Percentage distribution of responses of physical education teachers by the criterion of their attitude to the use of augmented reality in the educational process to preserve the health of students and develop their motor skills, intelligence and creativity.



	1	2	3	4	5	6
Yes	21	15	18	11	31	28
Cannot decide	9	10	11	17	2	4
No	6	11	7	8	3	4

Figure 8: Visualization of the structure of physical education teachers, responses to the questionnaire aimed at determining attitudes toward the use of augmented reality in the educational process to preserve students, health and develop their motor skills, intelligence and creativity (see questionnaire in "Selection of methods and diagnostics").

into the project work on introduction of the software that includes augmented reality.

Let us consider the example of applying virtual reality in order to develop a Physical Education teacher's practically oriented knowledge about the structure (morphology) and functioning (physiology) of the locomotor apparatus and the cognitive schemes, intentions (aspirations of consciousness) and technological values that are formed afterwards. When interiorized (in the sense of transferring to the inside), the stated knowledge, cognitive schemes and values facilitate the development of competence oriented "instrumental" intellectual capabilities of a Physical

Education teacher. We believe that such intellectual-value capabilities include conceptualization, understanding, interpretation, reflection and creative health oriented perception of certain pedagogical situations, motion activities and mobility modes based on specialized knowledge about human nature (in this case, an comprehension of syndesmology, the science of bone connections). Together, the stated mental phenomena form a health-preserving way of thinking, which is a significant and system-organizing component of the intellectual-value (cognitive) component of the health-preserving competence of a Physical Education teacher.

According to the global "ideology" of professionalization, in order to effectively preserve pupils' health during motor activities, a teacher should understand the fine, "intimate" mechanisms of the locomotor apparatus functioning. First of all, it concerns the system of connections between the bones, which is represented by joints, semi-joints and other anatomical structures. The central professional-value orientation, aimed at helping an educator master the above mentioned knowledge and interpretation of the joints' phenomenology, is the problem of preserving the health of the locomotor apparatus due to teacher's understanding of the morphological and physiological risk factors and restrictions that need to be taken into consideration while planning motion activity. If the educator does not take into consideration the peculiarities of human morphology and physiology, which are represented as risk factors for pathology development, this may lead to pupil trauma and decrease of the efficiency of the training process.

This pedagogical system studies and analyses in detail the peculiarities of the locomotor apparatus in the normal state as well as in the state of possible pathology, which may occur due to non-physiological (in the sense of being unnatural) functioning of the joints during motor activity.

In this pedagogical system the developed "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" was used as a teaching method. This model is also a part of the set of tools of the "Methodology of development of the health-preserving competence of a Physical Education teacher based on the knowledge of the nature of the locomotor apparatus in the normal and pathological state". The basis of the stated methodology is the use of pedagogical problems and discussion of practically significant situations, issues and anthropological phenomena, which disclose the nature of the locomotor apparatus in the normal and pathological state as well as presents the possibilities for risk management in order to ensure the health of this system. The stated virtual model is applied while solving the problems for the analysis of the relevant issues and situations.

According to the developed "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" software application, which in its turn consists of 5 models, which disclose the phenomenology of a joint in a normal as well as pathological state. The conceptual-methodological basis of this model were formed by the ideas of Maturana Romesín and Varela [28], who believed that life is a cognitive autopoetic process, as well as theory about the functional systems by Anokhin [3] [41], by syndesmology – is the science of ligaments, the pathopedagogical [11] and propedeutic approaches. Within the framework of this model, a person is viewed simultaneously as semiotic-symbolic system as well as a complex image, which integratively form the corresponding field of senses. At the same time, we believe that the sense-forming potential of a complex human image is determining and primary. We know this from life experience, self-reflection – bight images of familiar people "live" in the consciousness of every person.

In order to increase the efficiency of health preservation in conditions of an educational process, primarily, in diagnostic and preventative aspects, we actualize the issue of using human images. It is through actualization of a human image that the cognitive nature of human Umwelt is disclosed. The define Umwelt as a multi-dimensional structure. One of the dimensions of Umwelt is presented by a system of human images, which disclose human nature in its various aspects in a complex, emotionally full, informationally exhaustive and, what's most important, quick way. Observation over professionals indicate that in addition to the ability to use logic and cognitive schemes they are also able to identify and understand a certain problem "in a flash of a lightning", demonstrating the correct result almost right away. In our opinion, this effect is achieved due to a formed ability to perceive and understand human images as an idea of "Plato's eidos" as well as a complex Gestalt (in the sense of a fragment of reality). Let us particularize that the concept of "eidos" (Ancient Greek $\epsilon\iota\delta o\zeta$ – view, image), which was understood as "visible", as a primary image of a person, was primarily formed in the Elin medical tradition. That means that a person in the professional intellectual tradition of Elin medicine was perceived as a system of images or eidoses – normative ad pathological. Such traditional concepts as "Norma" and "Patos" came to us from Ancient Greece. They respectively reflect the idealized human images.

Taking into consideration the professional health-preserving significance and sense-forming potential of human images, which we view as part of a person's Umwelt, we actualize the need of their systemic application in post-graduate education in the course of post-graduate training of a Physical Education teacher. Projected onto the semantic reality, the images form an "unparalleled" and unique "Umwelt of senses". Thus, we determine (as it was stated above) the presence of an image dimension in human Umwelt. This dimension is formed by a system of images, more particularly, by a reality that consists of images. First and foremost, the images reflect the phenomenology of a complexity of human existence and psychic. That is why we view images as a part of the cognitive sphere as well as of value, emotional and existential spheres. To some extent, they are present in human consciousness and Umwelt. That is why, the work with anthropomorphic images, created within the framework of virtual reality, are used in the educational process.

Let us study this on the example of forming practically oriented health-preserving knowledge, cognitive schemes, thinking, attitudes, intentions in a Physical Education teacher. The formation of the stated "competence toolkit" is based on the knowledge about the prevention of development of typical locomotor disorders. In this example, we view the disorders, which may occur due to "excessive" and non-physiological (in the sense of being unnatural) stretching of ligaments and, to a lesser extent, of tendons. The risk of occurrence of such ligament stretching is primarily linked with professional institutions and "fashion" (namely, doing yoga) that are focused on the development of excessive flexibility without proper consideration of morpho-functional and biomechanical basis of joints' functioning, of individual peculiarities of a body as well as of the appropriateness and necessity of this activity.

Thus, taking into consideration the fact that VR/AR technologies are rapidly developing, as well as taking into consideration the epidemiological situation, we were given the task to prepare a report on the possibility of development of VR/AR applications online. Let us start with a simpler system, which is available to the teachers as well as pupils (of elementary, secondary and specialized secondary schools). In the future, we are planning to conduct training sessions

using more complex VR/AR technologies. So, les us start.

In this paper, to develop the "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" we used [27] by Delightex [8] – a technological start-up, Munich, Germany, which was founded in 2012 by Yevhen Beliayev, the co-founder of JetBrains. CoSpaces Edu have free plans, a free plan may have some limitation of user options (a set of objects and tools, physical properties of an object, the extended language of scripts, etc.). CoSpaces Edu have also created libraries of readymade VR/AR applications to help the user, teacher, pupil.

It has a wide range of options to be used in education, some of them are [8, 27]: construction of 3D objects with the help of the given toolkit, the creation of interaction elements with the help of either block coding or an extended language of scripts, study of objects in virtual and supplemented realities, use during classes, organization of cooperation between pupils and for viewing together in the real-time mode.

The "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" software application is formed of five separate components, which contain the following 5 models [12]: Model 1 – "Virtual Normative Model of a Joint"; Model 2 – "Anthropic-Spatial Model of Risks for a Joint"; Model 3 – "Virtual Model of the Pathological Mobility of a Joint"; Model 4 – "Virtual Model of a Joint Space Narrowing", Model 5 – "Anthropic-Spatial Model of Risk Distribution for the Ligament System of Joints".

Using the "Virtual Normative Model of a Joint" (Model 1) (figure 9) [12], we present a joint as a biomechanical system, in which the spatial dimension is important. In this system, the main structural factor, which puts the boned forming joint together, is the ligaments (or a ligament system, to be more exact). The model focuses the attention on ligaments and on the joint space, which in the normal condition is relatively insufficient in size thus ensuring the optimal contact of bones with one another.

"Virtual Normative Model of a Joint" in "combination" with an image of a person transform into the "Anthropic-Spatial Model of Risks for a Joint" (Model 2) (figure 10) [12]. In this model, the image of a person is demonstrated, in which the joints are represented not as anatomic structures (joints), but as relevant and professionally significant "professional" spatial zones that are "put over" the anthropomorphic image of a person (figure 10). Thus, by integrating the human image and specialized knowledge about the joints, we transform the stated knowledge into technological values, intentions, attitudes as well as develop their spatial and motion sense. The corresponding sum of human joints is represented as a spatially organized system of risks. At the same time, the stated system of risks is the sum of technological values that form the basis for organizing motion activity.

Like any other professional a teacher in his professional activity relies on technological values. Quite often, they exist not in the actual, but rather in a "contextual-conceptual" format. Such a contextual format of technological values, as well as of the related intentions and attitudes, does not always make it possible to apply them directly and formally in the educational practices and health preservation techniques. That is why, the methodological idea is to actualize certain knowledge by shifting it from the contextual to the actual form. This is done through representation of this knowledge using the complex image of a person. We call this methodological technique the *"anthropological-graphic technological and value oriented transformation of specialized knowledge"*. With time, the stated technique may be presented as a

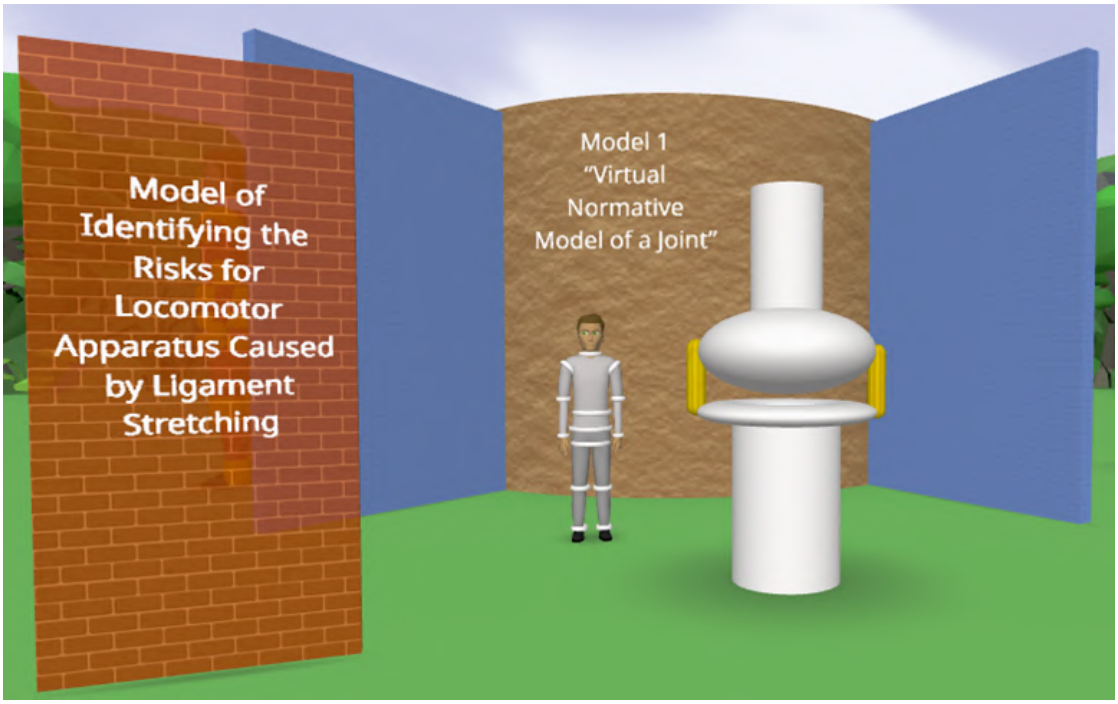


Figure 9: "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching": Model 1 – "Virtual Normative Model of a Joint" [12].

specific "pedagogical-epistemological technique" aim at increasing the efficiency of forming competences related to the phenomenon of a person. In this particular methodological system, this methodological technique, when specialized knowledge gains an "anthropic image", is first of all aimed at forming the health-preserving intentionality (vector) of an educator, at the development of corresponding visions and technological values. One of the central technological values in this case is a healthy joint in which the ligament system is "preserved" and not overstretched. The stated intentions and values, which determine professional strategies and peculiarities of application of health preserving technologies in the course of organizing motion activity, may compete with the currently fashionable idea of the more flexible the child is, the healthier and fit he or she is.

In order to effectively include the specialized knowledge about the nature of joints in the normal and pathological state into the structure of the cognitive component of the health-preserving competence, we use a comparative approach, which has a significant methodological and graphic potential. That is why, in order to compare with the norm, which is presented in (figure 9), we demonstrate the "Virtual Model of the Pathological Mobility of a Joint" (Model 3) (figure 11) [12]. In this case, the bones of a joint are at a considerable distance from one another, which is a precondition for development of pathologies and state preceding it. The model demonstrated a joint in a pathological condition with stretched and thinned (graphically depicted) ligaments can be formed very "simply", by an inappropriate, excessive and most often determined stretching of ligaments and tendons in the course of workout sessions. While

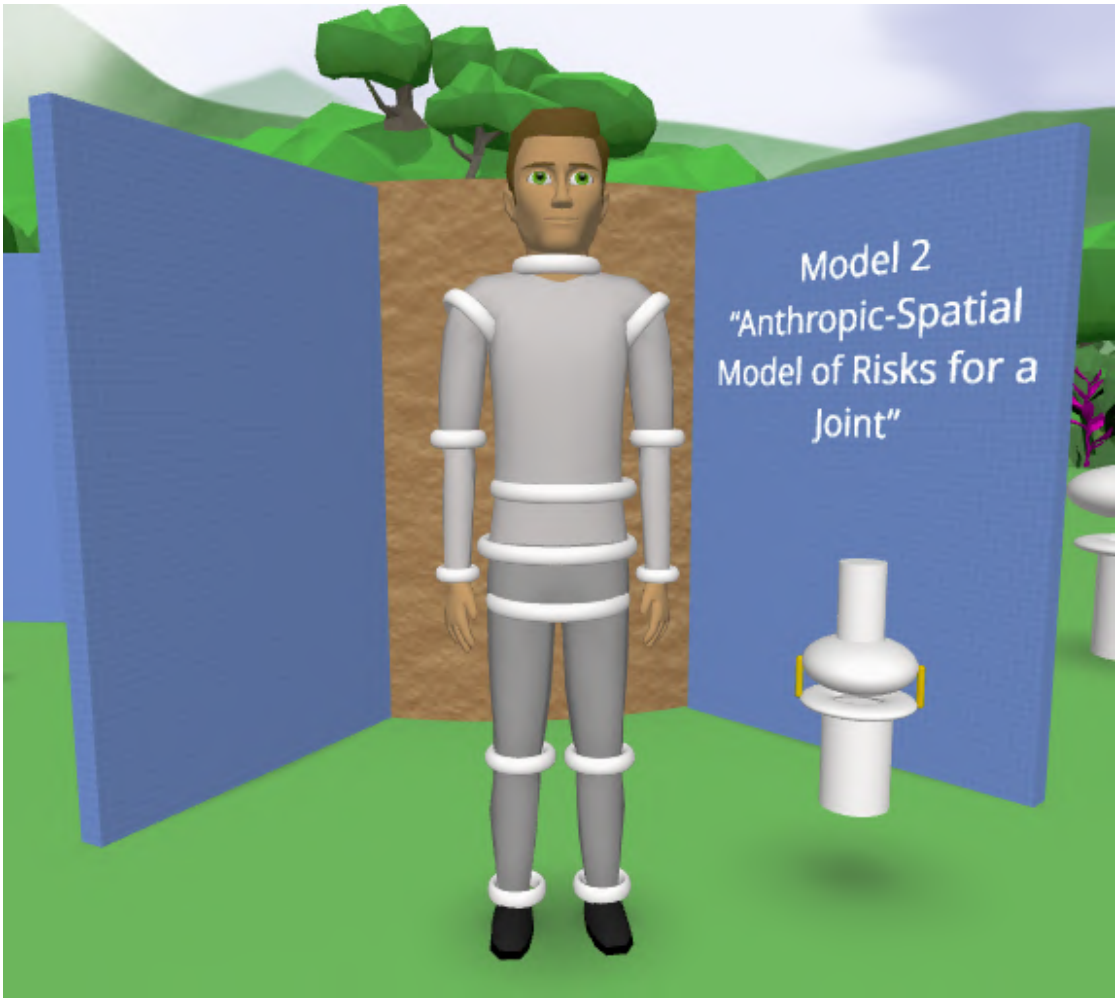


Figure 10: "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching": Model 2 – "Anthropic-Spatial Model of Risks for a Joint" [12].

analyzing this model we indicate that in conditions of significantly widened joint gap and of stretched ligaments, the normative biomechanics undergoes pathological changes. First of all, this is manifested in motor disorders, while doing the ballistic components of movements, under static load and in motor actions with objects. The reason for this is that in order to effectively perform movements that have a ballistic component, a relatively hard fixation in the joints is required. In addition, the increased mobility of the joints and the absence of sufficient fixation of joint bones is the artificially created "anatomic and physiological precondition" for development of such a pathology of joints as deforming osteoarthritis and other disorders at a relatively young age.

We also demonstrate another extreme variant, which is opposite to Model 3 – the "Virtual Model of a Joint Space Narrowing" (Model 4) (figure 12) [12]. In this model, the joint space is narrowed. Under typical (normative) human development this variant does not occur. It

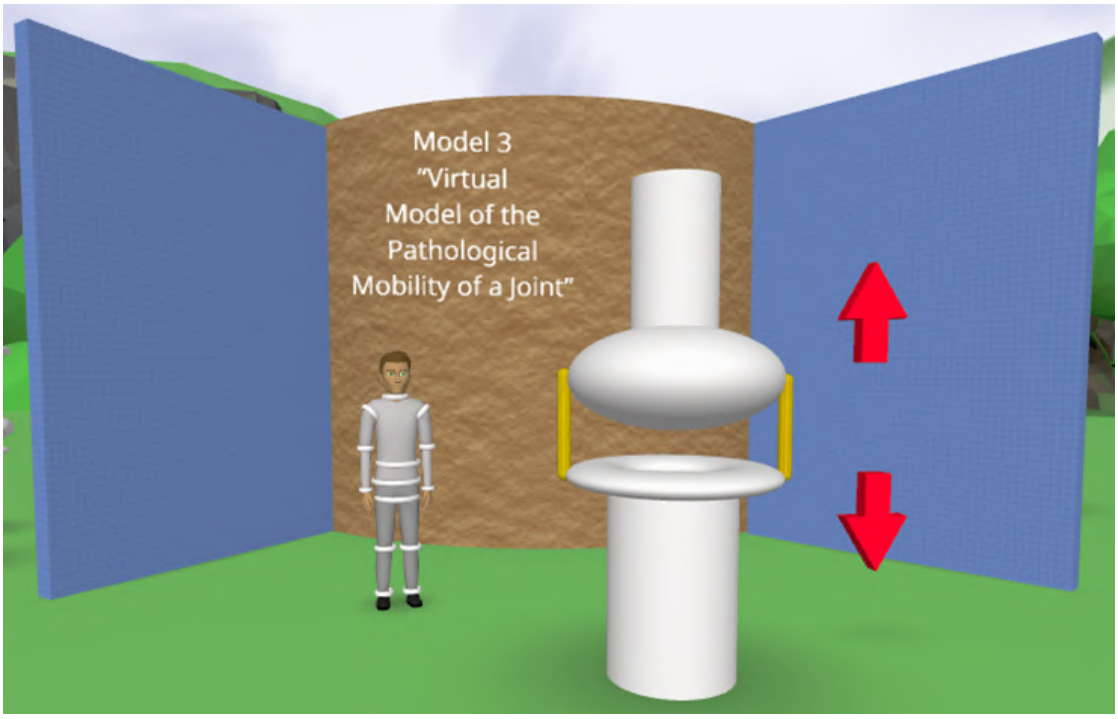


Figure 11: "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching": Model 3 – "Virtual Model of the Pathological Mobility of a Joint" [12].

can develop, strange as it may seem, by stretching the ligaments (figure 11), as one of non-physiological positions of a joint characterized by the absence of the physiologically acceptable and optimal fixation of joint bones.

The next important knowledge aspect of the studied above models oriented at health-preservation is the demonstration (with the help of these models) of ways of optimizing motion strategies on the basis of Anokhin [3] studies about functional systems. One of the basic practically oriented conclusions of the study about functional systems is that the locomotor apparatus adapts and "tunes" to different motion activities and workout modes inertially. This determined the strategies for forming the recreational physical training systems not arbitrarily, but rather taking into consideration of inertiality of the locomotor apparatus. Different motion activities functionally determine a different size of a joint space as well as different stretching of ligaments and tendons. Metaphorically speaking, this looks like tuning the strings of a violin for different tunes. That is why, if the inertiality factor is not taken into consideration, other competing strategies may occur. The example may be playing the violin and lifting heavy objects. Thus, a teacher needs to shape motion strategies with the consideration of the inertiality factor, which presupposes readjustment of the body from one motion mode and activity to another.

In the "Anthropic-Spatial Model of Risk Distribution for the Ligament System of Joints" (Model 5) (figure 13) [12] two images of a person are presented, which visualize and broaden the understanding of risk zones for the locomotor apparatus. In this case the risk zones actualize the significance of not only true joints, as is the case in Model 2 (figure 10). Presenting the risks

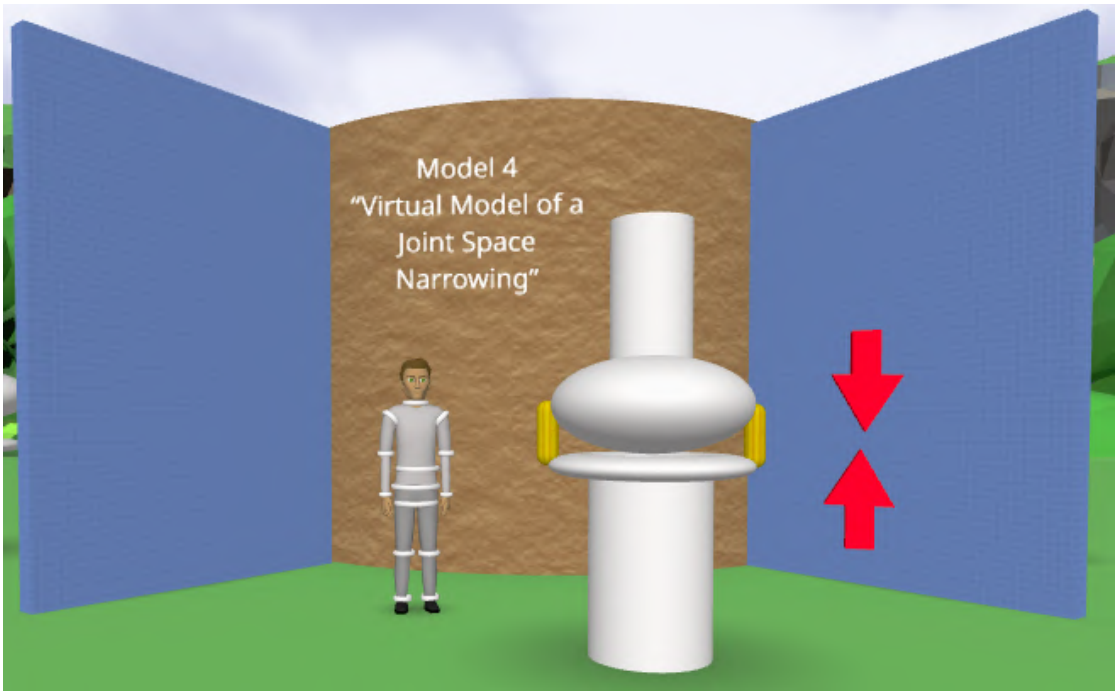


Figure 12: "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching": Model 4 – "Virtual Model of a Joint Space Narrowing" [12].

in an anthropomorphic, spatial and graphic way discloses the value and significance of the ligament system in relation to locomotor apparatus.

The "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" is first of all conceptual, it's application allows to disclose the essence of many normative and pathological phenomena. The clarity, visual presentation and meaning-forming potential make this model valuable. In conditions of limited time of advanced training courses it allows to relatively quickly disclose the essence of many practical problems and situations that a Physical Education teacher works with.

This model is used in correlation with the idea of self-perception [13, 16] and were realized through "taking care of themselves" (Foucault [13]), which is aimed at making a teacher comprehend the peculiarities of biomechanics of certain motion activities through their own motion experience. In order to do this, the bio-mechanic, and, in some cases, also the possible pathological processes and risks of motor activities, are disclosed o through a virtual model and illustrations and a teacher is offered a chance to self-test their influence.

To disclose the stated problematics of preserving the health of a locomotor apparatus, tasks in the form of questions are used:

1. Among the physical exercise known to you, find those which have a clear aspect of non-physiological joint functioning.
2. Analyze the biomechanical peculiarities of the non-physiological physical exercises using the virtual model.

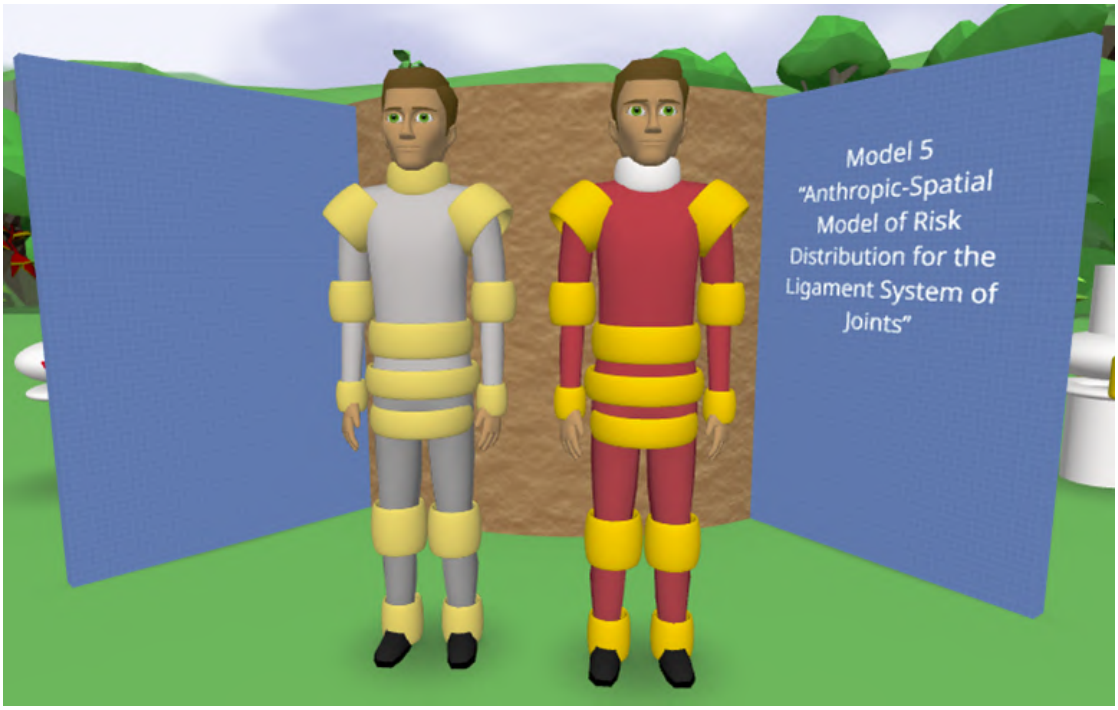


Figure 13: "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching": Model 5 – "Anthropic-Spatial Model of Risk Distribution for the Ligament System of Joints" [12].

3. Present you pedagogical experience of using the stated exercises.

In most cases, the issue is discussed at the class after Physical Education teachers have worked with it on their own.

In order to determine the efficiency of the teaching in accordance with the "Methodology of development of the health-preserving competence of a Physical Education teacher based on the knowledge of the nature of the locomotor apparatus in the normal and pathological state" we used a system of problems and questions. Accordingly, within the framework of the analysis of the influence of the above mentioned methodology we also assess the efficiency of the "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching", which is a part of the stated methodology.

Experimental study. We studied the efficiency of the application the "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" as a component of the "Methodology of development of the health-preserving competence of a Physical Education teacher based on the knowledge of the nature of the locomotor apparatus in the normal and pathological state". The research was conducted in 2019 in Public higher educational establishment «Vinnytsia academy of continuing education».

Based on the results of studying these characteristics in a trial study (figure 8, figure 7), in which 36 Physical Education teachers took part, we determine the size of the sample. In 2019 it was planned to teach the "Preserving the Health of the Locomotor Apparatus" course to 62

Physical Education teachers.

The size of the sample n is determined with the help of Student's t-test by formula (1). $N = 62$ is the size of general population.

The value o Student'st-test for the probability of $0,95$ (95%) $t \approx 2$ [40]. We calculate the size of the sampling using formula (1). $n \approx 48$.

In the course of preparation to conducting a research on the use of the developed "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" software app, taking into consideration the theoretical knowledge on the given topic that the Physical Education teachers were supposed to study, we have outlined questions the risks for locomotor apparatus caused by ligament stretching, that have to be mastered. For example, "On stretching the ligamentous apparatus" etc (table 1).

Table 1
The data received before and after the implementation of the methodology with the use of the "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" software app.

Tasks	Before	After	Deviation (+/-)
Problems			
1. On stretching the ligamentous apparatus	35%	87%	+52%
2. On the significance of flexibility developing exercises	41%	82%	+41%
Questions			
1. About the stretching of the spine	23%	67%	+44%
2. About the risks of deforming osteoarthritis development	15%	71%	+56%
3. About mechanical energy accumulation in ligamentous and tendons	9%	82%	+73%
4. About the structural organization of a joint	57%	86%	+29%

The data received before and after the implementation of the methodology with the use of the "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" software app gave the results shown in table 1 (figure 14).

As can be seen from table 1 and figure 14, the results of answers to problems and questions are increased significantly after the experiment than before of the application the "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" as a component of the "Methodology of development of the health-preserving competence of a Physical Education teacher based on the knowledge of the nature of the locomotor apparatus in the normal and pathological state". The most effective application of this methodology was for the problem "1. On stretching the ligamentous apparatus" (+52%) and the questions "2. About the risks of deforming osteoarthritis development" (+56%), "3. About mechanical energy accumulation in ligamentous and tendons" (+73%). Because the implementation on the basis of the Umwelt concept, the anthropological paradigm and virtual models of the Locomotor apparatus, provides an opportunity to implement indirect and contextual influences, cognitive, interactive, anthropomorphic, image-based and personalized nature as well as others characteristics of Umwelt oriented technologies of AR/VR.

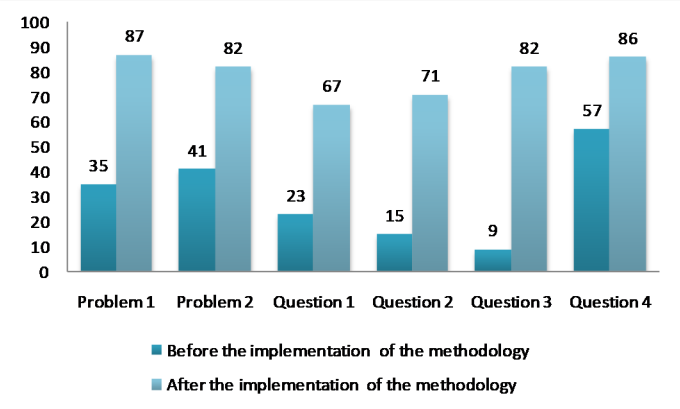


Figure 14: Visualization of data received before and after the implementation of the methodology with the use of the "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" software app.

4. Conclusion

The use of AR/VR technologies is an effective innovative technologies of development of a health-preserving competence of a Physical Education teacher under conditions of post-graduate education. Improving the methodology of use of the AR/VR technologies for the development of health-preserving competence of a Physical Education teacher under conditions of post-graduate education was carried out on the basis of the anthropological paradigm and the concept of Umwelt. Umwelt represents a "perceptive-acting" world of a person. A person's Umwelt has a sense-forming potential. Such features as correspondence to nature, indirect and contextual influences, cognitive, metaphoric, diverse, interactive, anthropomorphic, image-based and personalized nature as well as other characteristics, which take into consideration the anthropological and personalized peculiarities should be characteristic of Umwelt oriented technologies of AR/VR.

The relevant forms of AR/VR representation with the purpose of improving the health-preserving competence of a Physical Education teacher include the combination of the content with real time or recorded comments, graphic images, graphic analysis; realistic 3D simulations, assessment of the training session, etc. the important vectors of using augmented reality with this purpose is the development of study videos, techno sport, simulation and watching sports competitions and workout sessions, educational marketing etc. As for a Physical Education teacher the application of AR/VR in the educational process facilitates professionalization, technologization, axiologization and humanization of his/her professional activity, including its health-preserving component, technologies into the educational process in order to conduct Physical Education lessons, workout sessions, sports competitions, rehabilitation activities etc.

Based on the analysis of the currently available areas of use of the AR/VR technologies, as well as through its methodological understanding, we point to the significant innovative, educational potential of this digital technology. From a methodological point of view, the use of the augmented reality correlates with the application of the concept of Umwelt, contributes

to the formation of meanings, semantic contexts, values, patterns of action, images, semantic images, motor images, and images of health. This determines possibilities for extended and innovative use of the augmented reality for the development of a health-preserving competence of a Physical Education teacher in particular.

A survey was conducted to reveal the understanding of a value potential of the augmented reality. The attitude of Physical Education teachers to the use of the augmented reality in an educational process to preserve their students' health and develop their motion skills, intellect and creativity was determined. Analysis of the results of the questionnaire was performed, the aim of which was to determine the attitude of Physical Education teachers to the use of the augmented reality in an educational process for preserving their students' health and development of their motion skills, intellect and creativity. It is determined that most teachers (57%) treat positively this problem, 18% – negatively and 25% were not sure about this question. We can explain such a division of answers by not sufficient awareness of Physical Education teachers of an educational potential of the augmented reality.

Umwelt of a person is viewed as a multi-dimensional phenomenon. A system of images of a person is presented as a relevant dimension of a person's Umwelt, as they disclose the anthropic essence of a person in a value oriented, informationally exhaustive and emotionally filled way. The study uses the representation of special knowledge using a complete image of a person. The use of anthropomorphic images created with the help of the AR/VR technologies is actualized.

In order to improve the health-preserving competence of a Physical Education teacher in the course of post-graduate training the "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" software application has been developed. The developed virtual model "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" in the system of tools "Methodology of development of the health-preserving competence of a Physical Education teacher based on the knowledge of the nature of the locomotor apparatus in the normal and pathological state" was used for solving and analyzing pedagogical problems and questions, analysis of anthropological phenomena. As a result of the conducted experiment the positive dynamics of results of training of the physical education teachers on the basis of the given methodology with use of virtual model is defined.

The "Virtual Model of Identifying the Risks for Locomotor Apparatus Caused by Ligament Stretching" consists of 5 models: Virtual Normative Model of a Joint, Anthropic-Spatial Model of Risks for a Joint, Virtual Model of the Pathological Mobility of a Joint, Virtual Model of a Joint Space Narrowing, Anthropic-Spatial Model of Risk Distribution for the Ligament System of Joints. The stated model discloses the phenomenology of a joint both in the normal and pathological state in a representative and practically oriented way. Thanks to this model, a teacher forms the understanding of risks for the locomotor apparatus as well as of the anthropic-spatial system. On the basis of the innovative and practically-oriented disclosure of special knowledge about the locomotor apparatus, the virtual model facilitates the development of health oriented mental tools of an educator, i.e. of knowledge, thinking, visions, orientation, technological values, which, together with other components, form the health-preserving competence of a teacher.

The ways of effective introduction of AR/VR technologies in health-preserving activity of a Physical Education teacher are more active bringing specialists to the development of software additions of the AR/VR technologies as well as its introduction into an educational

process. Important in this aspect is the use of the anthropology oriented approaches that assist humanization of an educational process and technological adaptation of the AR/VR technologies to the nature of a person.

References

[1] Aleksandrova, L., 2014. Opyt filosofskogo osmysleniya "dopolnennoy realnosti" v ontologicheskom kontinuume "virtualnost - realnost" [The experience of philosophical understanding of "augmented reality" in the ontological continuum "virtuality - reality"]. *Vestnik Chelyabinskoy gosudarstvennoy akademii kultury i iskusstv*, 4(401), pp.59–63.

[2] Alhamdi, M.M.H., Salih, S.B. and Abd, M.A.A., 2019. The Impact of Learning Technology on Some Motor Skills of Deaf and Mute Students in Comparison with Healthy Students. *Indian Journal of Public Health Research & Development*, 10(10), pp.828–831. Available from: https://doi.org/10.37506/ijphrd.v10i10.5453.

[3] Anokhin, P.K., 1968. *Biologiya i neyrofiziologiya uslovnogo refleksa [Biology and neurophysiology of the conditioned reflex].* Meditsina.

[4] Bollnow, O.F., 1971. *Pädagogik in anthropologischer sicht.* Tokyo: Tamagawa University Press.

[5] Burov, O., 2021. Design features of the synthetic learning environment. *Educational Technology Quarterly*, 2021(4), p.689–700. Available from: https://doi.org/10.55056/etq.43.

[6] Cascales, A., Pérez López, D.C. and Contero, M., 2013. Study on Parents' Acceptance of the Augmented Reality Use for Preschool Education. *Procedia Computer Science*, 25, pp.420–427. Available from: https://doi.org/10.1016/j.procs.2013.11.053.

[7] Chen, C.H., Lee, I.J. and Lin, L.Y., 2015. Augmented reality-based self-facial modeling to promote the emotional expression and social skills of adolescents with autism spectrum disorders. *Research in developmental disabilities*, 36, pp.396–403. Available from: https://doi.org/10.1016/j.ridd.2014.10.015.

[8] Delightex GmbH, 2022. Well, hello there! Available from: https://delightex.com/.

[9] Enright, E., Robinson, J., Hogan, A., Stylianou, M., Hay, J., Smith, F. and Ball, A., 2016. Jarrod: The promise and messy realities of digital technology in physical education. *Digital Technologies and Learning in Physical Education.* Routledge, pp.173–190. Available from: https://doi.org/10.4324/9781315670164-11.

[10] Fedorets, V., 2017. Conceptualization of the anthropological model of the health preserving competence of a physical education teacher. *Visnyk pisliadyplomnoi osvity*, 5(34), pp.137–178.

[11] Fedorets, V.M., 2018. Rozvitok zdorov'yazberezhuvalnoyi kompetentnosti vchitelya fizichnoyi kulturi: patopedagogichniy aspekt [Development of the health preserving competence of a physical education teacher: pathopedagogical aspect]. *Bulletin of postgraduate education: Educational sciences series*, 6, pp.176–216.

[12] "Fedorets VM, Klochko OV: Model of Identifying the Risks for Muscular-Skeletal Apparatus Caused by Ligament Strain", 2021. Available from: https://edu.cospaces.io/HCC-WNR.

[13] Foucault, M., 1988. *Technologies of the Self: Lectures at University of Vermont Oct. 1982.* University of Massachusets Press, Cambridge. Available from: https://foucault.info/documents/

foucault.technologiesOfSelf.en/.

[14] Hsiao, K.F., 2013. Using augmented reality for students health-case of combining educational learning with standard fitness. *Multimedia tools and applications*, 64(2), pp.407–421. Available from: https://doi.org/10.1007/s11042-011-0985-9.

[15] Husserl, E., 2001. *Logical investigations, International Library of Philosophy*, vol. 1. Routledge. Available from: https://philpapers.org/archive/HUSLIV.pdf.

[16] Jaeger, W., 1986. *Paideia: The Ideals of Greek Culture, trans. Gilbert Highet. Vol. 2.* 2nd ed. Oxford University Press.

[17] Jung, C.G., 1916. *Analytical psychology*. New York: Moffat, Yard and company. Available from: https://openlibrary.org/books/OL24406782M/Analytical_psychology.

[18] Kagan, M.S., 1972. *Morfologiia Iskusstva Istoriko-Teoreticheskoe Issledovanie Vnutrennego Stroeniia Mira Iskusstv*. Iskusstvo. Available from: http://teatr-lib.ru/Library/Kagan/morph/.

[19] Klochko, O., Fedorets, V., Maliar, O. and Hnatuyk, V., 2020. The use of digital models of hemodynamics for the development of the 21st century skills as a components of healthcare competence of the physical education teacher. *E3S Web of Conferences*, 166, p.10033. Available from: https://doi.org/10.1051/e3sconf/202016610033.

[20] Klochko, O.V., Fedorets, V.M., Shyshkina, M.P., Branitska, T.R. and Kravets, N.P., 2022. Using the Augmented/Virtual Reality Technologies to Improve the Health-preserving Competence of a Physical Education Teacher. In: S. Semerikov, V. Osadchyi and O. Kuzminska, eds. *Proceedings of the 1st Symposium on Advances in Educational Technology - Volume 1: AET*. INSTICC, SciTePress, pp.726–746. Available from: https://doi.org/10.5220/0010927800003364.

[21] Klochko, O.V., Fedorets, V.M., Uchitel, A.D. and Hnatyuk, V.V., 2020. Methodological aspects of using augmented reality for improvement of the health preserving competence of a Physical Education teacher. In: O.Y. Burov and A.E. Kiv, eds. *Proceedings of the 3rd International Workshop on Augmented Reality in Education, Kryvyi Rih, Ukraine, May 13, 2020*. CEUR-WS.org, *CEUR Workshop Proceedings*, vol. 2731, pp.108–128. Available from: http://ceur-ws.org/Vol-2731/paper05.pdf.

[22] Knyazeva, E., 2014. *Enaktivizm: novaya forma konstruktivizma v epistemologii (Enactivism: A new form of constructivism in epistemology)*. Moscow, Saint-Petersburg: Tsentr gumanitarnykh initsiativ, Universitetskaya kniga.

[23] Knyazeva, E., 2014. Ponyatiye Umvelt Ya. fon Iskyullya i perspektivy ekologicheskoy mysli. *Vestnik mezhdunarodnoy akademii nauk*, (1), pp.75–82.

[24] Korablova, V., 2013. Antropolohizatsiia yak metadystsyplinarnyi trend: mezhi zastosuvannia (Anthropolonization as a metadisciplinary trend: the limits of stagnation). *Naukovyi visnyk Chernivetskoho universytetu*, (663/664), pp.218–223.

[25] Lakoff, G. and Johnson, M., 1980. *Metaphors we live by*. Chicago and London: The University of Chicago Press. Available from: https://ceulearning.ceu.edu/pluginfile.php/100337/mod_forum/attachment/9319/Metaphors%20We%20Live%20By.pdf.

[26] Learn through virtual experiences: customised virtual and augmented environments – .experience, 2016. Available from: http://web.archive.org/web/20200927043315/https://sgm-berlin.com/wp-content/uploads/2016/06/h-experience-brochure.pdf.

[27] Make AR & VR in the classroom, 2022. Available from: https://cospaces.io/edu/.

[28] Maturana Romesín, H. and Varela, F., 1984. *El árbol del conocimiento: las bases biológicas*

del entendimiento humano. Lumen, Buenos Aires.
[29] meleap, 2022. Available from: https://meleap.com/en.
[30] Millikan, R.G., 1984. *Language, Thought, and Other Biological Categories: New Foundations for Realism*. MIT Press.
[31] Nosov, N.A., 1999. Virtualnaya realnost [The virtual reality]. *Voprosy filosofii*, 10, pp.152–164.
[32] Savitskaya, T., 2014. Otkryvaya novuyu sotsialno-kulturnuyu paradigmu: plyusy i minusy tekhnologii dopolnennoy realnosti (Discovering a new socio-cultural paradigm: the pros and cons of augmented reality technology). *Observatoriya kultury*, 4, pp.34–41.
[33] Semerikov, S.O., Vakaliuk, T.A., Mintii, I.S., Hamaniuk, V.A., Soloviev, V.N., Bondarenko, O.V., Nechypurenko, P.P., Shokaliuk, S.V., Moiseienko, N.V. and Ruban, V.R., 2021. Development of the computer vision system based on machine learning for educational purposes. *Educational Dimension*, 57(5), p.8–60. Available from: https://doi.org/10.31812/educdim.4717.
[34] SGM Educational Solutions, 2021. Training Applications for Sports. Sports Strategy Training Through AR Experiences. Available from: http://web.archive.org/web/20211016001109/https://sgm-berlin.com/training-applications-sports-2/.
[35] Shapiro, L., 2007. The embodied cognition research programme. *Philosophy compass*, 2(2), pp.338–346. Available from: https://doi.org/10.1111/j.1747-9991.2007.00064.x.
[36] Smart Basketball, 2022. Available from: https://dribbleup.com/products/smart-basketball/default.
[37] Smart Soccer Ball, 2022. Available from: https://dribbleup.com/products/smart-soccer-ball.
[38] Smart Strength Ball, 2022. Available from: https://dribbleup.com/products/smart-medicine-ball/default.
[39] Stella, M. and Kleisner, K., 2010. Uexkllian umwelt as science and as ideology: the light and the dark side of a concept. *Theory in Biosciences*, 129(1), pp.39–51. Available from: https://doi.org/10.1007/s12064-010-0081-0.
[40] Student, 1908. The Probable Error of a Mean. *Biometrika*, 6(1), pp.1–25. Available from: http://www.jstor.org/stable/2331554.
[41] Sudakov, K.V., 2011. *Funktsionalnyye sistemy (Functional systems)*. Izdatelstvo RAMN.
[42] Uexküll, J. von, 1909. *Umwelt und innenwelt der tiere*. Springer. Available from: https://doi.org/10.1007/978-3-662-24819-5.
[43] Vygotski, L.S., 1929. II. The Problem of the Cultural Development of the Child. *The Pedagogical Seminary and Journal of Genetic Psychology*, 36(3), pp.415–434. Available from: https://doi.org/10.1080/08856559.1929.10532201.
[44] Yilmaz, R.M. and Goktas, Y., 2017. Using augmented reality technology in storytelling activities: examining elementary students' narrative skill and creativity. *Virtual Reality*, 21(2), pp.75–89. Available from: https://doi.org/10.1007/s10055-016-0300-1.