E-learning research within new European paradigm (MSCA4Ukraine multidisciplinary teamwork)

Tetyana Sergeyeva *1*, Sergiy Bronin *2*, Tadej Glazar *3*, Jim Njoo *4*

1 National Technical University "Kharkiv Polytechnic Institute" 2 Kyrpychova Str., Kharkiv, 61002, Ukraine
2 Taras Shevchenko National University of Kyiv, 60 Volodymyrska Str., Kyiv, 01033, Ukraine
3 University of Ljubljana, Faculty of architecture, Zoisova 12, 1000 Ljubljana, Slovenia
4 École Nationale Supérieure d'Architecture de Paris-La Villette, Gerphau EA 7486 144, avenue de Flandre 75019 Paris, France

Abstract

The article raises the problem of improving strategies, technologies, methods, techniques and tools of e-learning in connection with the change in the research paradigm, which will inevitably affect the education paradigm. Modern education, in fact, develops agents of changes who are called upon to maintain and develop the viability of society in the face of systemic economic, social and environmental crises. Therefore, goal-oriented science and education are gradually being transformed into impact-oriented, with the introduction of social, moral, economic, environmental and security criteria. The New European Bauhaus initiative is the quintessence of modern trends in the development of an advanced society, as a human-centered and aimed at human wellbeing through the formation of a sustainable-enriching-inclusive environment. The scale and speed at which changes are taking place require a new approach to students' development. They must respond quickly to changes and use a challenge as an opportunity for development. Within the framework proposed by the authors, the eco-humanistic approach to human-environment interaction respond to new demands and can be integrated into e-learning multidisciplinary developmental environment, which simulates the real conditions of self-development in an ambiguous situation. The metacognitive approach as well as tailor-made and fit for purpose innovations make it possible to consciously manage the process of one's own development depending on individual conditions and needs. Modeling real work and life developmental environment demands multidisciplinary and multi-actor approaches for co-creation of efficient e-courses of a new generation. The authors propose an innovative strategies, techniques and tools for providing efficiency of e-courses.

Keywords [1]

new European research paradigm, e-learning; multidisciplinary developmental environment; metacognitive approach; eco-humanistic approach; multi-actor approach.

1. Introduction

Modern education, in fact, develops agents of changes who are called upon to maintain and develop the viability of society in the face of systemic economic, social and environmental crises. Therefore, goal-oriented science and education are gradually being transformed into impact-oriented, with the introduction of social, moral, economic, environmental security criteria. New European Bauhaus (NEB) initiative is the quintessence of modern trends in the development of an advanced society, as a human-centered and aimed at human wellbeing through the formation of a sustainable-enriching-inclusive environment. The scale and speed at which changes are taking place require a new approach to students' development. They must respond to changes and use a challenge as an opportunity for development. Considering the fact of the unprecedented growth of the proportion of e-learning in the modern education system, the question arises: "Is e-education capable, in principle, of responding to the challenges caused by the science and education paradigm change, as a result of fundamental changes

of modern society needs? Is it possible to develop truly efficient agents of changes possessing new skills of the future within the framework of e-learning?". Our answer is positive, although such a prospect requires innovative e-learning strategies, technologies, methods, techniques and tools relevant to the change in the research paradigm, which inevitably affects the education paradigm.

The objectives of this paper are:

1. to analyze the developmental efficiency of existing e-learning strategies, methods, techniques and tools in the context of students' senses, competencies and skills development for meeting needs of society that is in an ambivalent state of safe-keeping and development;

2. to consider innovative eco-humanistic approach to human-environment interaction for integration into the e-learning multidisciplinary developmental environment as a simulator of the real conditions of self-development in an ambiguous situation;

3. to consider metacognitive approach as well as tailor-made and fit for purpose innovations for conscious management of self-development depending on individual conditions and needs;

4. to consider a multidisciplinary approach to the co-creation of e-courses based on the "multi-actor approach" as well as an innovative tool for the selection of a multidisciplinary team to co-create e-courses of a new generation.

2. Analysis of recent e-learning research and publications

An analysis of publications in the target area [1,2] showed that they lag behind the requirements for modern research, which arose in connection with a shift in the scientific paradigm, as a result of reorientation of goal-oriented science into impact-oriented, with the introduction of social, moral, economic, environmental security criteria. Such a change in the scientific paradigm [3] inevitably leads to a change in the educational paradigm, since it changes the entry point into the development of students as an integral personality [4], and not just as the owner of the set of professional and general competencies [5,6]. This, in turn, changes the requirements for the learning environment with which the student interacts, and, consequently, for the strategy, methodology and technology of e-learning [7].

The time itself and the trials that have befallen Ukrainian education have made a total transition to distance learning inevitable, revealing the real state of the art. Unfortunately, universities were not ready to provide quality educational services through e-learning, which would have the same (or even higher in particular cases) developmental potential as full-time education [8]. The resistance of university professors, who are committed to the conservatism traditional for any education and skeptical attitude towards the new, which has not yet proven its expediency, has led to a poor transfer of the efficient methodology to university platforms. Like Mark Twain's hero cracking nuts with the state seal [9], most educators misuse smart platforms without even realizing the huge opportunities they can present. As the analysis shows, most teachers adhere to the traditional formats of lectures and seminars, using the platform exclusively as a means of communication. At best, students are provided with lecture presentations, links to materials, and multiple-choice tests. The platform is rather perceived as a necessary evil to control conduct and attendance of classes, but not as an efficient learning and developmental environment [10].

The solution of both scientific-educational and practical problems lies in the plane of eco-humanistic [11], metacognitive [12] and multidisciplinary [13] approaches used in the context of a new research paradigm. To create truly efficient developmental e-learning courses [14-18] that meet modern requirements for the development of society, it is necessary: 1) to build a holistic profile of a modern graduate as an agent of positive changes in society, including professional, social and personal spheres of life [19]; 2) to build a virtual developmental environment that simulates the target developmental conditions [20]; 3) to form a multidisciplinary team [21] capable of creating an efficient interactive e-courses aimed at forming a student's holistic personality, including the development of a cognitive-semantic structure (scheme), professional, social and existential competencies, abilities and qualities.

3. E-learning research methods and methodology

Study is aimed at the search for ways of developing high-quality and efficient e-learning that meets the needs of modern society. It is assumed that such e-learning should not only give way to face-to-face training, but surpass it due to technological capabilities. Our study [22] found that effective e-learning can be provided by taking into account the patterns of students' personality & transferable skills development based on multidisciplinary, metacognitive and eco-humanistic approaches in the format

of interactive e-courses. Investigation included: 1) researching internal mechanisms of human-environment synergetic interaction resulting in mutual development; 2) developing patterns for creating virtual developmental environment simulating real life/work conditions; 3) identifying and evaluating student's cognitive scheme and competence profile for creating individual program of development; 4) developing principles of creating digitized technique for curriculum development, customization & efficiency evaluation based on competence and labor market needs profiles overlay that identifies gaps as zones of personal and curriculum/labor market development; 5) elaborating principles of designing e-learning courses of high developmental efficiency based on internal mechanisms of human self-development in interaction with virtual reality; 6) creating predictive model of professional development based on technological and social innovations; 7) developing technique of multidisciplinary team selection based on personality and competence profiles.

Our study received new research impulse due to the situation in which Ukrainian science and education occurred due to the war. MSCA4Ukraine program [23] for supporting research at risk proposed to continue investigation in cooperation with European colleagues on their research and educational base. Architectural Institute of Ljubljana University (ULFA) became unique experimental base for multidisciplinary research. It was decided to continue study in the context of the new European research paradigm, investigating principles of e-course construction aimed at developing architecture-students, as creators of an existential environment within NEB coordinates (AC-NEB). E-course is aimed at architecture-student's eco-humanistic consciousness-competence-behavior development as creators of a sustainable-enriching-inclusive NEB environment based on human-environment synergistic interaction as a key factor of mutual development. This choice greatly expanded the prospects for research because architectural field of knowledge is multidisciplinary by its nature. Architecture is created by a human being for a human being, therefore, architect in addition to the compulsory professional architectural and engineering competences needs SSH competences that are related to society, human nature and self. When creating environment architect interacts with ecosystems relevant to environment development, therefore, for efficient interaction, architect should select and work within multidisciplinary team. Architect creates existential environment with given properties that needs knowledge not only about the properties, but also about the principles of human-environment interaction. This interaction causes mutual development, therefore, architect understanding the relevant laws can influence the development both of human being and society as well as influence the formation of identity through the environment creation. More than that, architect needs understanding developmental trends of modern society striving for human wellbeing through the formation of a sustainable-enriching-inclusive environment being Eco-friendly; Digitally-supportive; Socio-responsive; Communication-welcoming; Gender-sensitive; Identity-developing; Diversity-respecting; Entrepreneurship-inspiring; Perception-harmonious; Movement-comfortable. All these multidisciplinary issues can be solved within proposed research, that is a real challenge for e-learning.

At the same time collaborative research has the prospect for mutual benefits via two-way knowledge transfer within multidisciplinary researchers' teamwork. Ukrainian innovative technique helped to identify zones of mutual interest by comparing expertise profiles of EU and UA research groups revealing the gaps that were transformed into synergetic research collaboration program. The very concept of human-environment interaction as a system forming factor clearly denoted an exchange fund: ULFA shares information, knowledge and competences related to the development of architectural environment, and UA researchers invest competences related to students' personality (SSH) [24] and digital transferable skills [25] development based on Eco-Humanistic-Technology. In particular UA researchers shares expertise for developing AC-NEB interactive e-course [26] content and methodology including: 1) principles and strategies of synergistic personality-environment interaction as condition for mutual development; 2) environment influence on the personality self-identity development; 3) architect's personality development as an agent of change; 4) principles of multidisciplinary team creation for solving sustainable development issues; 5) techniques for involving educational-industrial-social ecosystems into solving developmental issues. ULFA in its turn provides: 1) testing ground for exploring architects' development as creators of sustainable-enriching-inclusive NEB environment within traditional and e-learning; 2) data for constructing competence profile developed within existing and AC-NEB curricula; 3) 'Studio' as learning environment modelling real conditions of professional development to test the efficiency of eco-humanistic principles with prospective of developing virtual 'Studio' for providing a real multidisciplinary developmental site providing impact-approach for guide, support and advise directly in the course of research.

As an added bonus of complementary collaboration is researchers' training based on European principles of achieving "Excellence in research". It is carried out in 3 directions: 1) developing

competence in European Research & Innovations for supporting UA integration into EU science space; 2) mastering strategies and instruments for synergistic interaction of researchers' multidisciplinary multicultural team; 3) mastering transferable skills for fostering innovations. An essential part of the collaborative research team work is the study of transferable skills development within e-learning framework. It is investigated transferable skills specific for AC-NEB with the prospect of results transferring to other specialties because AC-NEB set is relevant to future labor market set of skills: (a) Green set dealing with developing eco-consciousness – eco-competence – eco-behavior, ethical issues of human – environment interaction; (b) Digital set dealing with getting accustomed to the digital landscape; exploiting tools relevant to the AC-NEB; pan-European digital ecosystem and digital hub networking; Open Educational Resources (OER); Metaverse training capacity and gamification techniques; (c) Entrepreneur set dealing with stimulating sense of initiative, attitudes, and behavior relevant to entrepreneurial mindsets; acquisition of social entrepreneurship model for economic growth via inclusive, creative and sustainable societies and economies; (d) Good citizen set dealing with the capacity to adapt, manage change and care for each other as a community: developing social and emotional intellect; developing AC-NEB attitudes, self-identity and behavior; understanding existential space as reflection of human values, sense of community, individual and group/collective identity; creating enriching environment determining healthy, comfortable and aesthetic human wellbeing; creating inclusive environment based on a dialogue across cultures, disciplines, genders and ages; (e) Efficient personality set dealing with: developing cognitive, communicative and existential efficiency; meta-cognitive understanding of the world, once own place in it and key role of human-environment interaction; using existential experience as means of learning; developing motivation as a key factor of professional, social, existential efficiency; efficient problem solving; identifying key result arias, prioritizing, delegating; (f) Teamwork set dealing with: selecting and leading the balanced multidisciplinary team; understanding value of diversities for synergetic teamwork; practicing sharing leadership; team learning from life including collaborative analytical and critical thinking; generating new ideas and making decisions; developing ethical framework, respecting points of view derived from different cultural, age, gender or disciplines background; adopting proactively to changing situations.

A characteristic feature of research work in European universities is its organization in the format of a project. To guide Ukrainian researchers, we present a specific case based on our experience. Research work plan was developed on the bases of constructing and transforming "Problem tree" into "Task tree" at research, education and social levels. Results obtained were presented in Logical Framework Matrix (LFM) format as narrative summary of intervention logic including general and specific objectives, activities and deliverables divided into 7 Work Packages (WP) in correlation with: 1) objectively verifiable indicators corresponding to QQT descriptors; 2) means of verification; 3) prerequisites which may prevail the goal. WP matrix includes tasks, milestones and deliverables description in correlation with impact, dissemination and sustainability strategies. Risks description and risk-mitigation measures are presented in "Risk management matrix".

E-learning research work plan, objectives and activities are organized in the logic of Work Packages (WP), including: 1) identifying target multidisciplinary e-course competence profile; 2) identifying target multidisciplinary e-course developers team profile; 3) training target multidisciplinary e-course developers; 4) developing target e-learning curriculum; 5) piloting target e-learning curriculum; 6) quantitative and qualitative evaluation of target e-learning curriculum; 7) identifying impact zones, results dissemination and sustainability program. AC-NEB e-learning research work plan (Figure 1) includes the following activities: WP1: researching zones of architects' personality and competence development as creators of existential NEB environment; WP2: researching and developing profile of synergetic multidisciplinary team of experts belonging to academic-industry-social ecosystems relevant to NEB; WP3: developing research competences and skills within e-training program; WP4: developing principles of creating innovative flexible AC-NEB e-curriculum; WP5: piloting AC-NEB development within research-training experiment; WP6: providing qualitative and quantitative analyses of experiment results; WP7: generalizing results regarding research impact, results' application, sustainability and dissemination both in EU and UA.

AC-NEB e-learning research objectives includes: (WP1) Identifying multidisciplinary SSH competence profile for creators of sustainable-enriching-inclusive NEB environment on the bases of studying EU documents and structured interview with experts of relevant ecosystems; (WP2) Creating database of EU and UA experts of ecosystems relevant to NEB environment development for selecting multidisciplinary teams and developing networks for co-creating AC-NEB curriculum and prospective programs of post-war UA recovery and development within NEB coordinates; (WP3) Mastering competences and skills: (a) corresponding to European research and innovations program, (b) needed

for multidisciplinary interaction with research team; (c) fostering AC-NEB innovations via transferable green, digital, entrepreneurship, active citizenship, efficient personality, multidisciplinary teamwork skills within training program; (WP4) Creating eco-humanistic model of flexible multidisciplinary e-curriculum specified for developing architecture-student's personality, competences and self-identity as creators of NEB sustainable-enriching-inclusive environment; (WP5) Piloting AC-NEB e-training based on eco-humanistic approach within developmental experiment under condition of real university training; (WP6) Qualitative-quantitative analyses of developmental experiment results; (WP7) Generalizing making conclusions regarding research impact, results' application and dissemination.
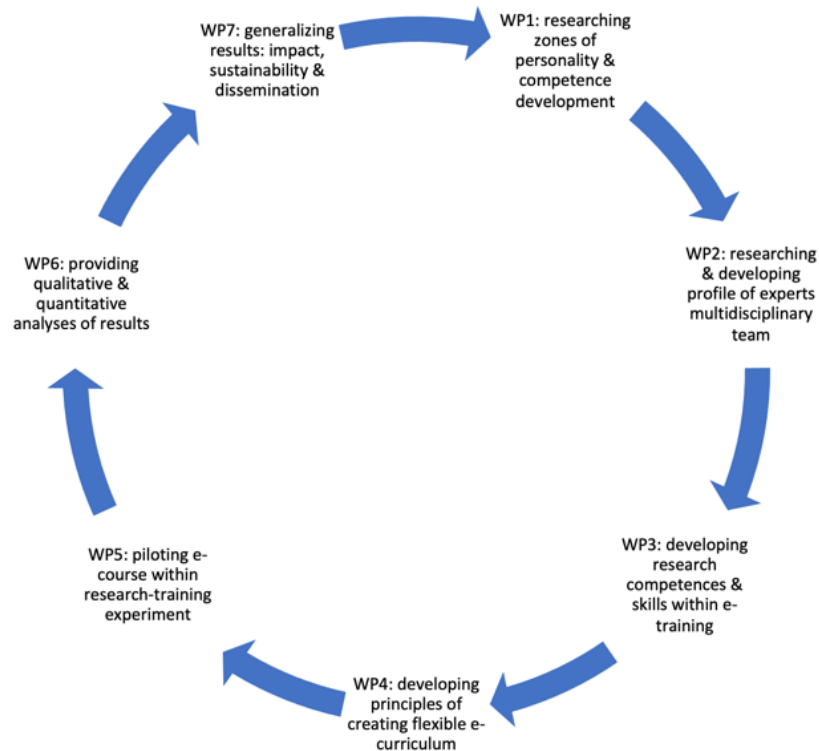

Figure 1: AC-NEB e-learning research work plan

Envisaged AC-NEB e-learning research activities include: WP1: investigating zones of architect's personality and competence development as creator of existential environment within NEB coordinates by identifying: (a) "IP" profile (architect's ideal profile as NEB environment creators); (b) "RP" profile (architect's real profile provided by existing curricula in EU & UA); (c) gaps as zones of development by overlaying IP & RP profiles (with comparative analyses of EU & UA curricula); WP2: researching and developing profile of synergetic multidisciplinary team of experts belonging to academic-industry-social ecosystems relevant to NEB based on discovered zones of architecture-students development for co-creating AC-NEB curriculum; WP3: developing research competences and skills within training program including: 1) competence in ER&I program for Ukrainian science integration into European research space; 2) mastering practices and tools for researchers' multidisciplinary teamwork; 3) transferable skills for fostering AC-NEB innovation; WP4: developing principles of creating innovative flexible Eco-Humanistic AC-NEB e-curriculum with multidisciplinary team considering discovered gaps for AC-NEB development; WP5: piloting AC-NEB development within research-training experiment under condition of real university training; WP6: providing qualitative and quantitative analyses of the developmental experiment results; WP7: generalizing results and making conclusions regarding research impact, results' practical application and dissemination both in EU & UA.

Thus, modern research within the framework of the new European research paradigm, no matter what field it belongs to, is inherently multidisciplinary. This approach, oriented to the project work format, makes it possible to form e-courses initially taking into account all stages of their development, including not only the training content and process (1), but also the selection (2) and training (3) of the relevant team, piloting (4), evaluation (5), dissemination (6) and providing sustainability of results (7). Moreover, for evaluating impact-oriented research quality, social, moral, economic, environmental and security criteria are introduced. All this complicates, but at the same time improves the quality of work.

Along with the innovative approach, no one cancels the correct use of a systematic experimental study to verify the reliability of the results. To achieve research purpose, a set of theoretical and empirical methods is used, selected and combined in accordance with study objectives. The complex includes: 1. Theoretical and methodological analysis, systematization and generalization of data: (a) tendencies of ER&I including impact-driven shift of paradigm and gender dimension, SSH integration, ethics measurement, open science practices, social innovations; (b) patterns of human-environment interaction and consciousness-competence-behavior development; characteristics of NEB sustainable-enriching-inclusive environment and relevant architect's personality and competence profile; 2. Experimental study under real condition of HEI including: (a) confirmatory study – identifying AC-NEB developmental zones by original techniques of profiles and cognitive schema overlay; b) formative research - creating and piloting innovative flexible Eco-Humanistic AC-NEB curriculum; (c) control research - qualitative and quantitative analyses of experiment results, determining the efficiency of AC-NEB development; 3. Results generalization regarding prospective and practical application. Techniques, strategies and tools: 1. Statistical data processing (correlation and dispersion analysis followed by qualitative interpretation and generalization) is used for identifying investigated phenomena and characteristics links the cause of which is established by experiment; 2. Student's individualized program identification on the basis of original techniques of overlaying individual sense-cognitive schemes (ISCS) and personality profiles; 3. Diagnostics of AC-NEB course cognitive and personality development efficiency carried out on the basis of measurement: (a) complexity of ISCS (overlay technique); (b) problem solving efficiency calculated by formula of completeness, fluency and accuracy data (digitized technique "Progress Bar"); (c) level of individual resources development: capacity of individual sense orientation: professional, social, existential; meta-abilities: decision-making, synergistic interaction, self-development; meta-qualities: proactivity, autonomy, objectivity, responsibility, creativity, flexibility, empathy (EHTSD questionnaires, tests, content analysis).

4. E-learning environment and research innovations based on EHTSD

In our previous article we described in details concrete results of e-training experiment based on Eco-Humanistic Technology of Self-Development (EHTSD). Here we summarize the principles of organizing efficient e-learning environment based on EHTSD student-centered methodology reflecting the human integrity as a living self-developing system supporting cognitive, communicative and regulative functions. Soft skills formation is realized in synergy of cognitive, communicative, practical and developmental sets. Eco-Humanistic model presented as "existential circle of self-development" (Figure 2) includes the stages of (1) awareness of the event personal sense; (2) assessment of the resources' availability for personal sense realization; (3) choice of strategy for the missing resources development; (4) implementation of developmental activities; (5) successful actions repetition, automation and integration into internal resources; (6) transition to a new developmental round. The process of soft skills development is based on the internal mechanisms of (a) consciousness and behavior synergistic interaction as basic engine; (b) balancing personal senses - individual resources - external conditions as driving force; (c) sense-cognitive orientation as determiner of developmental capacity; (d) initial strategic orientation as a means of developmental optimization. Developmental propertied of e-learning environment determining the efficiency of soft skills formation are amplified by digital technologies.

The internal mechanism of strategic orientation provides the developmental process optimization and determines its capacity. That is why it is important to identify competence profile that is expected to be developed within e-course from the very beginning. The competencies are divided into cognitive, communicative, practical, developmental and integral. The proposed system is centered on meta-senses determining professional, social and existential efficiency. The meta-competencies developed in the context of meta-senses provides efficiency of decision-making (regulatory), synergistic interaction (communicative) and self-development (cognitive) activities. Student's personality development in its integrity significantly increases the developmental efficiency due to the synergistic effect.

"Techniques of competency profiles imposing" allows comparison of a real and ideal profiles and identifying gaps as zones and programs of individual development. This provides initial strategic orientation. It is proposed a modern university graduate ideal balanced profile that reflects "professionally-socially-emotionally competent, efficient-moral-harmonious, thinking globally and acting locally agent of society sustainable development and the subject of self-development". This profile in essence is relevant to the NEB agent profile. The difference is based on system-forming factor.

"Ideal graduate profile" is uniting soft skills on the basis of scientifically sound principles of their integration at the cognitive, communicative, practical, developmental and integral metalevels, which fully correspond to the cognitive, communicative and regulatory functions of consciousness. "NEB agent profile" is organized around future labor market demands in digital-green-entrepreneurship-good citizenship-efficient personality-multidisciplinary works transferable skills. This centering vividly reflects a change in the research paradigm from goal-oriented to impact-oriented.
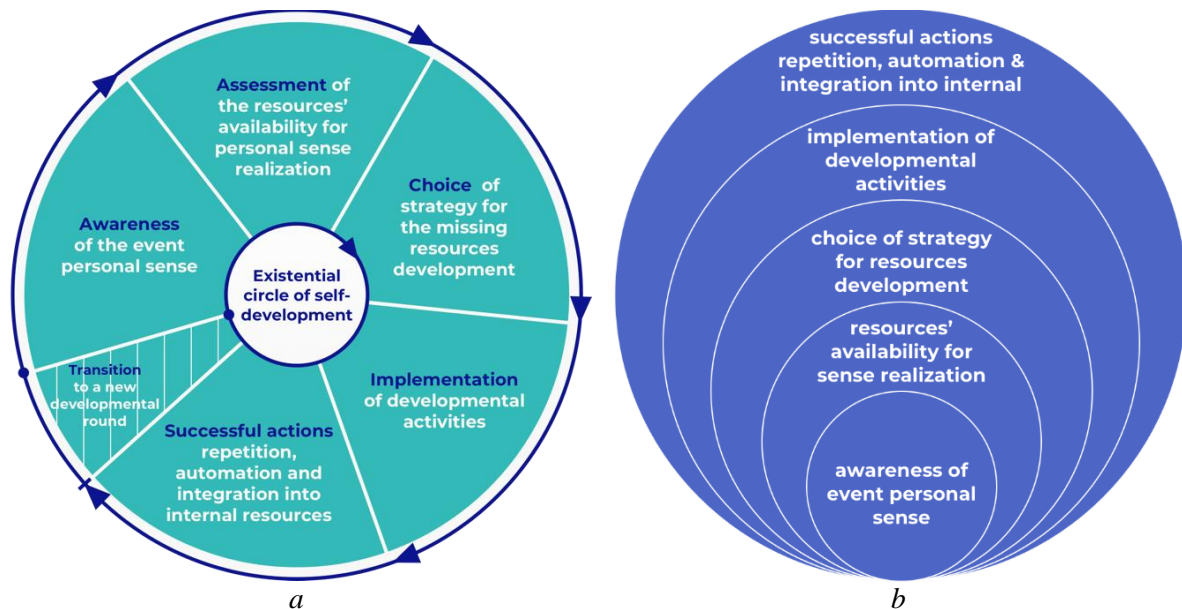

Figure 2: Existential circle of self-development

The proposed e-learning course based on EHTSD enhances the developmental effect through digital technologies. It has a full-fledged digital learning environment. In traditional, blended and online learning the differences of the learning environment lies in the degree of student independence whose role is gradually transferred from the object to the subject of the study. The role of the teacher is also transformed into the role of tutor with partial (blended learning) or full (online learning) functions delegation to a computer program. Efficient developmental environment is achieved by modelling existential circle of self-development (see above). Soft skills are developed as real internal actions, when the result of the previous action becomes a means of the next one. Optimization is achieved through the initial focus on the final goal – the Graduate Profile. Awareness of actions is provided by the metacognitive orientation (knowledge about oneself, about the process of cognition and about the subject) allowing self-management of the e-learning. The e-course structure consists of: (1) Start Test for identifying gap between Individual and Course Profiles; (2) Individual e-learning program based on the identified gap including: (a) introductory video lecture, answering questions WHAT? WHY? HOW? students learn structure, content, methods, tools and specifics of the work; (b) work plan presented as questions/problems with indicating mode of their processing accompanied by slide numbers as sources of information; (c) transferring acquired knowledge into practice by generalization in the form of questions for self-control and formulating algorithm of work within the e-course. Further activities are aimed at practice of problem solving as conscious and optimal process based on cognitive scheme gradual formation without unnecessary objects and links due to initial strategic orientation.

E-learning practice includes digital tasks in pace with stages of existential circle of self-development (see above). Program sets tasks and processes performance results. Individual training program "Progress Bar" (PB) is presented as multifunctional tool serving navigator and allowing to evaluate results in the form of a graph of success and personal profile. PB is displayed in the format of task codes within module with reference to tests and color markers of the processing level and task types. PB provides e-learning self-management by self-monitoring and self-assessment of success via: (a) individual success graph, built automatically on the bases of each task results calculated on the parameters of speed, completeness and accuracy; (b) individual profile of progress built automatically in accordance with e-course goals achievement; (c) self-assessment based on original matrix of "color palette" of assessment; (d) operational self-monitoring of success based on keys/samples of answers (Figure 3). The speed of advancement is determined by success: each task is performed until the

efficiency reaches the level of 0.7. To determine the mode, duration and frequency of work, a special table allows calculating the individual weekly load. d.
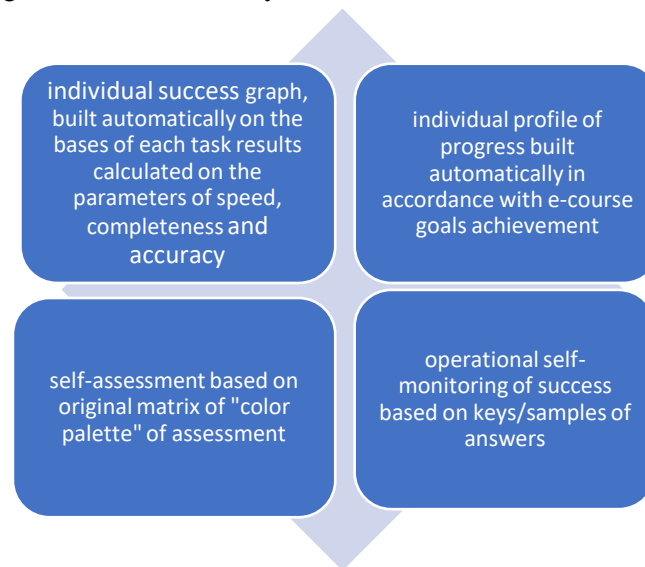

Figure 3: Progress Bar

Tutor System includes: e-tutor (online program on the platform); self-tutor (independent activity according to a given algorithm); personal-tutor (consulting teacher); expert-tutor (expert on request); social-tutor (social networks to share experiences); partner-tutor (interaction within forums and course events). Feedback system works in five modes: automatic (instruction letters, reminders, results of solving tasks and tests); correspondence, MS Teams, Zoom, Google meet or Telegram (communication with the tutor); forums on the platform (views exchange and assistance in quality control "report a bug"); FAQ (answers to the typical questions). Friendly interface provides comfortable training environment: each task is formulated for students understanding their actions meaning, opportunities, resources and being capable to seek help in a timely manner for monitoring their progress constantly. Help can be obtained in the form of instructions and solution format or sample, up to a detailed description of actions in text and video formats.

The results the psycho-pedagogical experiment have revealed characteristic features of the efficient e-course organized as training activities based on psychological laws of soft skills development. They include: (1) e-learning environment that simulates real conditions for self-development and provides a friendly interface; (2) educational activity optimally organized by initial focus on the ultimate goal presented as graduate profile; (3) individual "tuning" to student's experience, resources, conditions. It was measured the efficiency of soft skills development and growth of indicators ($\triangle$) in the control (k) and experimental groups, working in traditional (e1) and e-learning (e2) mode. Analysis of the results based on a comparison of starting (ES) and final (ER) level showed the development of:

a. *practical skills in $ER^k = 0,38$ ($ES^k = 0,36$, $\triangle = 0,01$; in $ERe^1 = 0,53$ ($ESe^1 = 0,38$, $\triangle = 0,14$; in $ERe^2 = 0,64$ ($ESe^2 = 0,39$, $\triangle = 0,26$);*

b. *cognitive skills in $ER^k = 0,37$ ($ES^k = 0,49$, $\triangle = 0,12$; in $ERe^1 = 0,62$ ($ESe^1 = 0,37$, $\triangle = 0,25$; in $ERe^2 = 0,79$ ($ESe^2 = 0,37$, $\triangle = 0,42$);*

c. *communicative skills in $ER^k = 0,37$ ($ES^k = 0,38$, $\triangle = 0,01$; in $ERe^1 = 0,51$ ($ESe^1 = 0,38$, $\triangle = 0,13$; in $ERe^2 = 0,65$ ($ESe^2 = 0,39$, $\triangle = 0,26$);*

d. *self-development skills in $ER^k = 0,40$ ($ES^k = 0,36$, $\triangle = 0,04$; in $ERe^1 = 0,62$ ($ESe^1 = 0,37$, $\triangle = 0,25$; in $ERe^2 = 0,69$ ($ESe^2 = 0,38$, $\triangle = 0,31$);*

e. *integral soft skills in $ER^k = 0,41$ ($ES^k = 0,38$, $\triangle = 0,03$; in $ERe^1 = 0,53$ ($ESe^1 = 0,42$, $\triangle = 0,11$; in $ERe^2 = 0,65$ ($ESe^2 = 0,42$, $\triangle = 0,23$).*

AC-NEB e-learning research has the following original qualities and innovative objectives that go beyond state of the art and are potential to create contribution to the e-learning research field:

1. Multi-impact e-learning research achieved by introducing human-environment interaction as a system-forming factor of e-learning. Human-social scale of scientific research producing synergistic effect of students' development derived from diversities interaction causing research-eco-social-human mutual development. As added value this impact can be measured;

144

2.   System multidisciplinarity of e-learning research. Focused on human-environment interaction study is multidisciplinary by definition since it requires understanding both human being and environment in their interaction causing mutual development. This complex multidisciplinary system can be investigated and measured by innovative technologies of cognitive schema and profile overlay. Their application solves multidisciplinary issues of building competence profiles, developing curricula and selecting team of experts belonging to different ecosystems;

3.   Multi-scale dimension of e-learning research. In addition to the traditional measurements of scientific quality, research includes gender - green - digital - entrepreneurship - citizenship - personality - moral – openness measurement reflecting research impact dealing with sustainable-enriching-inclusive development. Indirect measurement of research deliverables by innovative techniques and tools presented below is used;

4.   Set of original technology-techniques-tools for e-learning research includes: 1) Eco-Humanistic Technology of Self-Development modelling existential process reflecting human-environment interaction based on internal mechanisms of (a) consciousness-behavior synergy; (b) self-development driving force energized by ambivalent desire for conservation and development via balancing senses-resources-conditions; (c) developmental efficiency determined by the capacity of sense-cognitive orientation; (d) optimization of self-development by bringing forward the ultimate goal for organizing actions in system where the result of the previous action becomes a means to realize the next one; 2) the techniques of cognitive schemes and competence profiles overlay allowing to identify and measure zones and corresponding programs of personal, curriculum, labor market development as well as multidisciplinary team selection and development; 3) the tools of measuring personal, e-training course, curricula, professor's virtual lecture or workshop efficiency on the bases of measuring complexity of cognitive schemes, problem solving efficiency (integrating accuracy, fluency and completeness measurement), personality meta-senses, meta-capacities and meta qualities measurement;

5.   Transferable skills development within e-courses based on Eco-Humanistic approach. Labor market significant set of green, digital, entrepreneurship, good citizenship, efficient personality and multidisciplinary teamwork skills are acquired within innovative strategy of student-developmental environment synergetic interaction resulted in student's consciousness-competence-behavior development. Process is based on metacognitive approach providing understanding: a) self-developmental process in terms of internal mechanisms of its organization, driving force, efficiency and optimization; b) developmental environment in terms of existential cycle of self-development; c) self in terms of personal efficiency dependance on the way of interaction with environment. This existential eco-humanistic model allows developing transferable skills directly in the course of mastering professional subjects;

6.   Developmental capacity of e-simulated environment. NEB environment developmental capacity is manifested through human-environment interaction (Eco-Humanistic approach). It is considered a determining factor of human development. On the bases of this concept development of architecture-student's personality is realized via tasks of NEB environment creation aimed at providing sustainable-enriching-inclusive qualities being Eco-friendly; Digitally-supportive; Socio-responsive; Communication-welcoming; Gender-sensitive; Identity-developing; Diversity-respecting; Entrepreneurship-inspiring; Perception-harmonious; Movement-comfortable. To create environment of this complexity, students are self-developing their skills relevant to NEB environment in the course of its creation;

7.   Digitalization-sensitive deliverables of research. Since the process of architecture-students development is focused on an existential model with clearly understood internal mechanisms of self-development in terms of specific subject actions and their corresponding tasks, the digitalization process is facilitated by modeling the developmental environment and algorithmizing the relevant actions. Training organized in this way is easily transformed into e-course not only without losing developmental capacity, but adding e-advantages (visibility, individualization, self-management, self-evaluation, tracking dynamics of development, use of mnemonics and techniques for automating actions, virtual, augmented reality etc.) (Figure 4).

5. Concluding remarks

Change in the research paradigm, which will inevitably affect the education paradigm, causes changes in strategies, technologies, methods, techniques and tools of e-learning. Change from goal-oriented to impact-oriented science led to the strategic task of developing an

advanced human-centered society aimed at human wellbeing through the formation of a sustainable-enriching-inclusive environment (NEB). All these in its tern demanded new approach to students' development and, as a consequence, to the developmental capacity of e-learning environment.
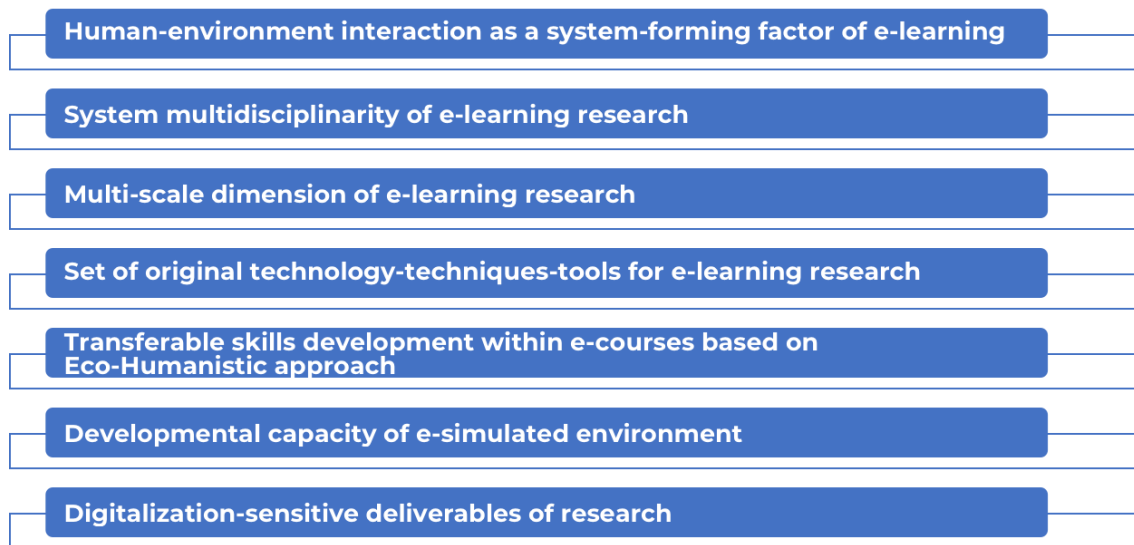
- **Human-environment interaction as a system-forming factor of e-learning**
- **System multidisciplinarity of e-learning research**
- **Multi-scale dimension of e-learning research**
- **Set of original technology-techniques-tools for e-learning research**
- **Transferable skills development within e-courses based on Eco-Humanistic approach**
- **Developmental capacity of e-simulated environment**
- **Digitalization-sensitive deliverables of research**

Figure 4: Qualities and objectives of AC-NEB e-learning research

To solve this problem the Eco-Humanistic approach to human-environment interaction is proposed. It responds to new paradigm and can be integrated into e-learning multidisciplinary developmental environment, which simulates real condition of self-development in an ambiguous situation. Modeling developmental environment demands multidisciplinary team for co-creation of efficient e-courses of a new generation. Metacognitive approach makes it possible to consciously manage the process depending on individual conditions and needs. E-courses of new generation corresponding to new paradigm can be created within multidisciplinary project teamwork that add to traditional activities: (1) selection of balanced multidisciplinary team relevant to e-course eco-system, (2) training of the team, (3) piloting, (4) evaluation, (5) dissemination, (6) providing sustainability of the results. Experimental study proved the efficiency and prospective of eco-humanistic approach including: (1) Eco-Humanistic model presented as "existential circle of self-development" integrating 4 internal mechanisms; (2) e-course structure corresponding to the stages of "existential circle" with tasks based on internal mechanisms; (3) meta-senses strategic orientation determining professional, social and existential efficiency; (4) "Ideal graduate" or NEB profiles. A range of innovative strategies, techniques and tools is proposed: (1) multi-impact e-learning; (2) system multidisciplinarity; (3) multi-scale dimension; (4) EHTSD; (5) cognitive schemes/competence profiles overlay technique; (6) tools for measuring personal, e-course curricula, materials and events efficiency; (7) existential eco-humanistic model for developing transferable skills in the course of mastering professional subjects; (8) digitalization-sensitive deliverables.

6. References

[1] Schoop, E., Köhler, T., Börner, C., Schulz, J. Consolidating elearning in a higher education institution: An organisational issue integrating didactics, technology, and people by the means of an eLearning strategy. Knowledge Communities in Online Education and, Visual Knowledge Management - Proceedings of 19th Conference GeNeMe 2016, as part of IFKAD 2016, p. 39-50

[2] Roblyer, M.D., Doering, F.H.: Integrating educational technology into Teaching. Pearson new international edition, 6th edition (2014)

[3] Research and innovation strategy 2020-2024 https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024_en

[4] Montalvo-Garcia, A., Martí-Ripoll, M., Gallifa, J. Emotional Competence Development in Graduate Education: The Differentiated Impact of a Self-Leadership Program Depending on Personality Traits. 2021 Frontiers in Psychology 12,666455

[5] Sergeyeva, T., Barber, J. Developing generic competences in learning to learn. Operativnaya poligrafiya, Kharkiv (2016)

[6] Byrne, Z.S., Weston, J.W., Cave, K. Development of a Scale for Measuring Students' Attitudes Towards Learning Professional (i.e., Soft) Skills. 2020 Research in Science Education 50(4), p. 1417-1433

[7] Kanth, R., Skön, J.-P., Toppinen, A., (...), Laakso, M.-J., Heikkonen, J. Innovative and efficient teaching methodology for digital communication systems using an e-learning platform. 2019 Journal of Communications 14(8), p. 689-695

[8] Bronin S., Pester A. (2021) Towards a National Digital Competence Framework for Ukraine. SIST 2021 - 2021 IEEE International Conference on Smart Information Systems and Technologies. DOI: 10.1109/SIST50301.2021.9465946

[9] Twain, M. The Prince and the Pauper. 1881 Canada, James R. Osgood & Co

[10] dComFra: Digital competence framework for Ukrainian teachers and other citizens. Erasmus plus 598236-EPP-1-2018-1-LT-EPPKA2-CBHE-SP. 2018-2022 https://dcomfra.vdu.lt

[11] Sergeyeva, T.: Eco-humanistic technology of self-development. Blok, Kharkov (2010)

[12] Akben, N. Effects of the Problem-Posing Approach on Students' Problem Solving Skills and Metacognitive Awareness in Science Education. 2020 Research in Science Education 50(3), p. 1143-1165

[13] Hambrusch, S., Hoffmann, C., Korb, J.T., Haugan, M., Hosking, A.L.: A multidisciplinary approach towards computational thinking for science majors. 2009 SIGCSE Bulletin Inroads, 41(1), pp. 183–187

[14] Korhonen, T., Ravelin, T., Halonen, R.: Developing an E-learning course on serious games: A multidisciplinary approach. 31st Bled eConference: Digital Transformation: Meeting the Challenges, BLED 2018, pp. 171–186

[15] Paechter, M., Maier, B., Macher, D.: Students' expectations of, and experiences in e-learning: Their relation to learning achievements and course satisfaction. 2010 Computers and Education, 54(1), pp. 222–229

[16] Giesbers, B., Rienties, B., Tempelaar, D., Gijselaers, W.: Investigating the relations between motivation, tool use, participation, and performance in an e-learning course using web-videoconferencing. 2013 Computers in Human Behavior, 29(1), pp. 285–292

[17] De Medio, C., Limongelli, C., Sciarrone, F., Temperini, M.: MoodleREC: A recommendation system for creating courses using the moodle e-learning platform. 2020 Computers in Human Behavior, 104, 106168

[18] Panjaburee, P., Komalawardhana, N., Ingkavara, T.: Acceptance of personalized e-learning systems: a case study of concept-effect relationship approach on science, technology, and mathematics courses. 2022 Journal of Computers in Education, 9(4), pp. 681–705

[19] Worthington, S.L.S., Downey, L.X. Profiles in Tech Entrepreneurship: Maria Rios. 2019 IEEE Engineering Management Review 47(2),8708195, p. 15-17

[20] Ivanov, I., Cobo, J.C., Kosonogova, M. Implementation of developmental education in the digital learning environment. 2020 Procedia Computer Science 172, p. 517-522

[21] Housley, W.: Interaction in multidisciplinary teams. Routledge (2017)

[22] Sergeyeva, T., Festeu, D., Bronin, S., Turlakova, N Student training environment interaction: Soft skills development within e-learning. CEUR Workshop Proceedings, 2022, 3132, pp. 290–298

[23] MSCA4Ukraine https://sareurope.eu/msca4ukraine/information-for-applicants/

[24] Caspi, A., Roberts, B.W., Shiner, R.L. Personality development: Stability and change. 2005 Annual Review of Psychology 56, p. 453-484

[25] Bronin S., Kuchansky A., Biloshchytskyi A., Zinyuk O., Kyselov V. (2021) Concept of Digital Competences in Service Training Systems. In: Auer M.E., Tsiatsos T. (eds) Internet of Things, Infrastructures and Mobile Applications. IMCL 2019. Advances in Intelligent Systems and Computing, vol 1192. Springer, Cham. https://doi.org/10.1007/978-3-030-49932-7_37

[26] Lu, W., Tingey, S., Preusser, D., Zoghi, B.: Design of An Interactive Scenario-Based Technical Management Communication Course - A Unique Addition to Future Engineering Leaders' Toolbox. 2022 ASEE Annual Conference and Exposition, Conference Proceedings,