

Transformative, AI-Enhanced, Transdisciplinary Digital Educational Communication for Resilience

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ABSTRACT

The emergency (warfare-induced) and sustainable (pandemic-induced) digitization changes in the higher education sphere of Ukraine heralded the enhancement of pervasive dimensions of learning – digital, hybrid, and blended, synchronous and asynchronous, AI-enhanced.

This end-to end digital shift in the educational processes (communication, content, outcomes and outputs, skills) introduced the meta-disciplinary dimensions of learning, mitigated by human-in-the-loop and AI-in-the-loop formats of educational communication. These meta-disciplinary dimensions can be considered conduits of vertical (endocentric) and horizontal (exocentric) transdisciplinary of digital education as a sustainable dynamic system.

Applied trans-disciplinary lens contributes to the solution of holistic modeling of processes and results of updating models and mechanisms of the highly dynamic communication system of education in the digital environment as a whole and its individual formats in the emergency digitization measures of different types to foster resilience and sustainability.

Keywords: trans-disciplinarity, transformation, digital education, digital communication, sustainability and calamity, AI-enhanced communication, resilience.

1. INTRODUCTION

Dynamic transformation of the knowledge economy, development of Industry 4.0/5.0 and elaboration of the networked society in the Digital Age, emergency digitization of all social communicative spheres due to pandemic measures have imposed dramatic changes onto transdisciplinary overlap in different areas of human knowledge and experience, induced by the cross-sectorial job market demands of university level education, curriculum design and learning outcomes.

The emergency (warfare-induced) and sustainable (pandemic-induced) digitization changes in the higher education sphere of Ukraine heralded the enhancement of pervasive dimensions of learning – digital, hybrid, and blended, synchronous and asynchronous, AI-enhanced.

This end-to end digital shift in the educational processes (communication, content, outcomes and outputs, skills) heralded the introduction of meta-disciplinary dimensions of learning – digital, hybrid and, blended. These trans-disciplinary dimensions can be considered conduits of vertical (endocentric) and horizontal (exocentric) transdisciplinary of digital education as a communicative system.

Applied trans-disciplinary lens of the phenomenological approach contributes to the solution of holistic modeling of processes and results of updating models and mechanisms of the highly dynamic communication system of education in the digital environment as a whole and its individual formats at the beginning of the XXI century in particular.

As a product of modern civilization, the digital reality has become an independent format of being. Accordingly, electronic media act not only as a means of transmitting information, but also reveal their own world-creating, meaning-making and, as a consequence, language-forming and communicative potential [46; 48; 50]. The global digital realm stands as an integral environment, demanding new cognition and perception ways via complex philosophic, cultural, social, linguistic approaches, providing unlimited opportunities for human intellect, language development and research.

Given the conceptual system of identification of onto-mental and linguo-mental complex formations to identify constructs of reality, the global digital realm (cyberspace) and its innovative communicative shell can be located in the transdisciplinary coordinates of such paradigms: 1) philosophy - as a *particular type of substance* – material and ideal reality in the multitude of its forms; a meta-negentropy (the term after Nagib Callaos [6]); 2) anthropology – as an environment for actualization of post-humanistic forms of anthropogenesis; 3) psychology – as psychosomatic and emotional plane of a personality functioning; 4) sociology – as a system of multi-tiered and multi-directional social and communicative relations; 5) in culturology - as a sphere of spiritual experience, 6) in the theory of communication - as a system of multilevel, multidirectional social relations and communicative interaction.

Transdisciplinary communication in the global digital realm is, therefore, understood as an integrated at the macro and micro level set of cross-sectorial verbal referents, innovations and innovative communication practices and technologies, which by their specific characteristics are conditionally exhaustive

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phenomenological correlates of transdisciplinary elements of the digital environment.

The innovative nature of communication in the field of learning and education (formal and informal) in the global digital environment is determined by the phenomenological consolidation of substantive (ontological, pre-suppositional / cognitive [52]) characteristics of the macrostructure of communication in statics and end-to-end dynamic interaction of formal and semantic constituents and technological (digital) tools. The paradigm of innovation of educational communication in the digital realm (as a multidimensional, complex, dynamic system) is defined as the most comprehensive quantitative and qualitative terms of linguo-cognitive actualization of being, determined by a number of qualifying conditions of its emergence, existence and development. The inquiry results allow to provide a transdisciplinary synthesis of educational communication paradigm across communicative theory, information theory, philosophy, education and e-learning studies, semiotics, digital humanities.

Theoretical problems of holistic, transdimensional modeling of reality and its separate spheres are directed by the deterministic interaction of objects, signs of their reception and interpretation (in the field of individual and collective consciousness), embodiment, consolidation and retransmission of the results of interaction of these systems of features.

Conditions for the development of modern globalization civilization determine the expansion and refinement of the paradigm of views on the theoretical principles of determining the groundwork and characteristics of the consolidation of the world order, its perception in culture, collective social consciousness and natural language.

The transdisciplinarity of innovative educational communication in this respect is accessed through is the conceptual lens of the **logosphere**, synthetically perceived as 1) the plurality of language units, which are conditionally exhaustive phenomenological realizations of abstract and empirical elements of different spheres of life [4; 23]; 2) the zone of integration of thought, speech, and experience continuums of cultures [5; 16; 26]; 3) the plurality of culturally relevant universal meanings and signs - **semiosphere** [27]; 4) a plurality of transcendent spiritual meanings – **pneumatosphere** [14].

Foreign Languages Acquisition on university-level major programs is a rigorous process that involves different stages and a regimen of communicative educational activities, communication types and competences across interconnected domains [24; 25]. Transdisciplinarity and ubiquity (universality) of innovative communication for Foreign Languages Education (FLE) in the 21st century, therefore, is informed, in crucial ways, by intellectualization and amplified information capacity of human activities in general. Thus, the intellectualization of modern global culture determines a qualitatively new approach to understanding the processes of parallel development of human activities, cognitive (intellectual), and communicative experiences. That is the origin and methodological premise of the concept of "noosphere". Noosphere is the unity of "nature" and culture, especially from the moment when the intellectual culture reaches (by force of influence on the biosphere and geosphere) the power of a peculiar "geological force" [40].

The noosphere is defined as the current stage of development of the biosphere, associated with the emergence of humanity in it [16; 40], and is interpreted as part of the planet and planet ambient with traces of human activity.

The integral real component of the Noosphere is identified as the Technosphere - a set of artificial objects (technologies) created by the humankind, and natural objects changed as a result of

technological activity of humankind [28]. In turn, Computer Being (computer reality, cyberspace) is a complex, multidimensional sphere of synthesis of reality, human experience and activity mediated by the latest digital and information technologies; technogenic reality, a component of the technosphere of existence [17; 28].

Therefore, it is stipulated in **the study design**, that the cognitive and ontological (framework) premise of *transdisciplinary educational communication in the digital realm* (TECDR) is informed by the following **dimensions**: 1) the *metadisciplinary dimension* of ECDR, disclosed through the mutual transformative potential of information and modern technology, as "knowledge in a scientific sense can lag only slightly behind this world transformation because knowledge becomes transformed in the process" [17]; 2) the *universal dimension* of TECDR, disclosed through the pervasive, ubiquitous nature of humanitarian and linguistic (especially multi-cultural) knowledge applicability, as "science and technology revolutionize our lives, but memory, tradition and myth frame our response" [32]; 3) the *interoperable dimension* of TECDR, informed by the underlying anthropocentrism of linguistic knowledge and skills, providing the interface for development and application of skills and activities across different domains, as "a human is a nexus of existential horizons" [22].

The result of a fundamental Technosphere shift in the sphere of Education, induced by the COVID-19 pandemic, raging warfare, and the rise of Generative AI development and enhanced by continuous iterative digitalization measures, was the need to take quick comprehensive action [29; 36] in order to achieve such desirable results: in order to achieve such desirable results: a) To activate comprehensive transdisciplinary domains and corresponding interdisciplinary skillsets, otherwise latent or underutilized in the educational process; b) To enhance the scope of communication skills beyond the domains traditionally reserved for Arts and Humanities education; c) To boost information and communication technological competence and digital literacy, to meet the requirements of (post)COVID-19, AI-saturated job market and workplace; d) to introduce digital meta-solutions for facilitation of formal and informal educational workflow and communication in the unsustainable emergency conditions.

The **objective** of the study is to explore the modelling and profiling of transdisciplinary and transcendent dynamics of digital education, modified by the sustainable (pandemic) and emergency/calamity (wartime) digitization measures in learning process and social interaction.

The study of groundwork principles of universality and transdisciplinary of educational communication in professional linguistic training and linguistic education in general is a parcel of the framework project *TRANSITION: Transformation, Network, Society and Education* [28; 29; 30].

2. FINDINGS

Conceptual Groundwork of Meta-Disciplinarity in Digital Education for Resilience

The following grid of groundwork concepts is applied to profile the Innovative Communication for Foreign Languages Education (FLE) in such disciplinary dimensions:

- TRANSDISCIPLINARITY
- TRANSCENDENCE
- METADISCIPLINARITY
- SUSTAINABILITY
- INTEROPERABILITY
- SYNERGY

RESILINCE

The emergency and sustainable digitalization changes in the higher education sphere heralded the introduction of pervasive dimensions of learning - digital, hybrid and, blended. These dimensions can be considered the 3T coordinates ambient of

digital education: **transformation, transcendence, transdisciplinarity** (Fig. 1). These dimensions are conduits of vertical (endocentric) and horizontal (exocentric) transdisciplinarity of digital education as a cohesive system.



Figure 1: Conceptual Grid Dynamics of the 3T Model

The meaning of TRANSDISCIPLINARITY is synthesized for the purpose of this study as a transcendent agglomeration of two or more fields of knowledge into one scope/goal of study, inquiry or activity [6; 15; 18; 21].

UNIVERSALITY is generally understood as a property of object or state to **“exist everywhere (ubiquity), or involve everyone”** [7]. In the context of this study we suggest to attribute the property of universality/ubiquity to social activity, vocational activity and professional performance.

The concept of INTEROPERABILITY is disclosed across different approaches [20; 34] as a characteristic of an object, product or system, that allows its interface to be comprehensible, to work with other objects, products or systems.

CATASTROPHE THEORY [25] is a branch of bifurcation theory in the study of dynamical systems. Small changes in certain parameters of a nonlinear system can cause equilibria to appear or disappear, or to change from attracting to repelling and vice versa, leading to large and sudden changes of the behavior of the system.

SYNERGETICS is the empirical study of systems in transformation, with an emphasis on whole system behaviors unpredicted by the behavior of any components in isolation [31]. As applied to transdisciplinary communication in digital education, the concept of interoperability represents the property of functional, dynamic interconnectivity between the source and target domains of linguistic content, linguistic theory content, related areas of scientific and universal knowledge, and domains of professional and social application. Degrees of interoperability help define the measure of interdisciplinary transcendence and universality of activities, skills and competence applications of FLE stakeholders.

Transformative trans-disciplinary Framework of AI-enhanced Digital Education for Resilience

The dimensions of transformation of digital education fall into two categories: SUSTAINABLE AND EMERGENCY (Fig. 3).

SUSTAINABLE TRANSFORMATION:

- post-pandemic
- sustainable development
- Age of AI

EMERGENCY TRANSFORMATION:

- war
- natural disasters
- pandemic

The generic concept of multiple disciplinarity [1; 38] comprises, in its turn, of a framework of interconnected concepts: Multi-disciplinarity; Interdisciplinarity; Transdisciplinarity; Metadisciplinarity.

Multi-disciplinarity, thus, is understood as a multitude of fields of knowledge, that comprise the scope of understanding a certain object, problem or area of inquiry.

Interdisciplinarity in this respect is interpreted as the interconnectivity of multiple spheres of knowledge that comprised the content of a problem or area of inquiry.

Trans-disciplinarity, subsequently, is perceived as a transcendent product of merging multiple interconnected knowledge domains.

Transdisciplinarity of digital educational communication in general is, therefore, postulated in this study as a computational framework of interconnected types of disciplinarity.

Meta-disciplinarity of digital educational communication is determined through the digital ambient, content and tools of its implementation. The digital meta-dimension becomes the source of systemic structuring of innovative educational communication on macro- and micro-levels.

Multidisciplinary **input** into the education design and content in the form of data, information and facts across different source domains of human knowledge in order 1) to constitute the thematic content of language acquisition; 2) to constitute the semantic referents of linguistic units; 3) to constitute the vast framework of reference and contexts for communicative application.

Interdisciplinary connections of the educational **content** for FLE – internal interconnectivity of theoretical and applied disciplines, external interconnectivity of FLE content with non-related areas of human knowledge (computer science, physiology, anthropology, philosophy etc.).

Transdisciplinary **output** in the transcendent nature target knowledge domains and universal applicability of skills, training and outlook of the FLE professionals upon graduation.

Therefore, the framework correspondence of relevant complex skills constitutes a TRANSDISCIPLINARY META-FRAMEWORK of educational communication.

Interoperability for FLE skills ensured by the communicative nature of interdisciplinary skills. The core cross-sectorial domain that is referential for primary skills (social skills, emotional intellect, collaboration, communication, ICT-literacy), necessary for educational goals achievement, is COMMUNICATION.

The digital dimension of communicative interoperability of FLE

stems from the structure of Noosphere [40] and content of its components: ANTHROSPHERE - a set of people as living organisms, their activities and achievements; SOCIOSPHERE - a set of social factors characteristic of this stage of society development and its interaction with nature; TECHNOSPHERE - a set of artificial objects created by man, and natural objects, altered as a result of human activity.

Given the nature of increasingly digitalized context of foreign languages education and communicative application (“the Technospheric shift” [30]), it is suggested to consider the different types of information source and information destination (human and machine/computer/program, accordingly) in the structure of the groundwork Communication model (Cf. Claude Shannon [33]), when communication is approached as the core factor of interoperability of source and target knowledge and application domains in FLE.

Thus, the fundamental transdisciplinarity, that COVID-19 digital procedural transformations imposed on the educational process in the area of Foreign languages acquisition, is verified by a unified framework of correspondence between the components of a crucial communicative competence [19], comprising of a diverse skillset, and various aspects of ICT competence in Arts and Humanities [3; 12; 13; 39], utilized in the educational process, elaborated for the purposes of this study.



Figure 2: Dimensions of Transformation for Digital Education

The SYSTEMIC TRANSFORMATION CATALISTS for education, therefore, would fall into the following categories:

1) ATTRACTOR:

- Technological advances
- Rise of AI
- Accessibility
- Time/expedience
- Accommodation

2) REPELLER:

- Black swans
- Crisis
- War
- Calamity (Fig. 2).

Taking into account the nature of suggested modelling of educational communication across frameworks of complex

skills, it is stipulated that *META-disciplinarity* has become the universal vehicle or framework of education in the digital realm, whereas *TRANS-disciplinarity* can be perceived as a universal output of educational communication in the digital realm.

Consequently, the communicative dimension of education proper in the post-pandemic timeframe acquires a meta-digital and trans-digital (transcendent digital) properties (Fig. 3). The trans-digital characteristics of educational communication is ensured through the interoperability of such framework parameters as:

- Interaction,
- Disciplinarity
- Learning
- AI-enhanced communication



Figure 3: Pathway to Trans-digital Educational Communication

As a result, the structure and modelling of two transdisciplinary dimensions of digital educational communication are suggested: 1) *endocentric* (the transdisciplinary interoperability of CONTENT, TOOLS, INTERACTION OUTPUTS of educational communication); 2) *exocentric* (the transdisciplinary interoperability SKILLS, COMMUNICATION, MEDIA, OUTCOMES of education) – Fig. 4:

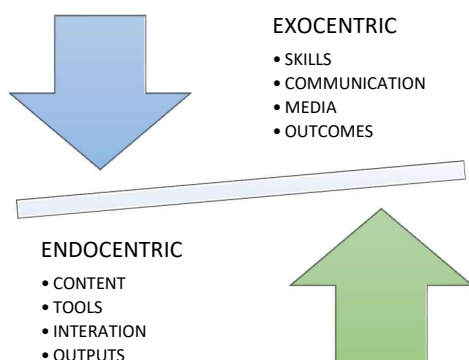


Figure 4: Metadisciplinary Dimensions of Educational Communication

Interdisciplinary Transformative Trends in AI-powered Digital Education

The viral transformation catalysts for digital education are identified as inverse to regular catalysts of systemic change:

1) REPELLER:

- - Black swans
- - Crisis
- - War

- - Calamity
- 2) ATTRACTOR:
- - Technological advances
 - - Accessibility
 - - Time/expense
 - - Accommodation
 - - AI-enhanced communication and workflow

The identified interdisciplinary communicative dimensions of the digital education allowed to single out integrated trends in digital education development in the pandemic and warfare timeframe.

Trend 1: TRANSFORMATION OF COMMUNICATION FORMATS IN DIGITAL EDUCATION.

Types of digital education formats, on the rise globally through the emergency digitization measures are determined as follows: E-LEARNING 1.0 - direct synchronous computer-assisted distant instruction; E-LEARNING 2.0 [43] - mostly asynchronous computer-supported collaborative learning; E-LEARNING 3.0 [35] - AI-assisted digital or hybrid learning; BLENDED LEARNING [46; 5; 11] - in-person teaching with asynchronous ICT assisted learning methods; HYBRID LEARNING [13] - synchronous instruction of in-presence and remote students via ICT tools.

Modelling of the comprehensive framework of educational activities and experiences in Liberal Arts transformation into digitally enhanced format [32] is, therefore, possible through an interoperable set of parameters: Time; Space; Communicative distance; Dependence on ICT tools and infrastructure. The level of communicative complexity of digital education format is proportionately dependent on the technological enhancement involved and counter-proportionally dependent on the communicative distance of the digital learning format.

The sub-trend 1.1 includes replication of *non-digital components* or creating *simulacra* in educational communication: learning space digital recreation; learning ritual/scenarios recreation; measurable learning outcomes recreation; learning interaction recreation.

The sub-trend 1.2 elaboration of authentic or self-aware components of digital communication, such as Flipped digital classroom; Inquiry-based digital learning; Digitally enhanced peer-assessment; Collaborative (networked) learning.

Transformative communicative model of digital education facilitates the identification evolution directions of e-learning formats, informed by the space-time constraints of the global quarantine measures and wartime measures (Fig. 5).



Figure 5: Emergency-Informed AI-enhanced Learning Formats Evolution for Resilience

This way, the mobile learning (m-learning) acquires features of ubiquitous learning in the lockdown perimeters. Ubiquitous learning adjusts from a space-centric model to a time-centric model due to time-zone discrepancies in digital educational

communication and becomes w-learning (whenever-learning), AI-ag.

Trend 2: AI-INFORMED TRANSFORMATION OF CONTENT IN DIGITAL EDUCATION. This trend heralds the observable shift from human-originated to digital content in education.

The sub-trend 2.1 is manifested through the development of an interdisciplinary paradigm of digital humanities – a diverse, open for augmentation, range of areas of knowledge, applied activities and education in Arts and Humanities, centered on *digital adaptation, production, processing, manipulation and dissemination of relevant thematic content*: Digital history; Digital philology; Digital art; Digital pedagogy; Digital sociology; Digital music etc.

The sub-trend 2.2 is manifested through the emergence and implementation of the “born digital” and “born AI” formats in education.

Born digital and born AI dimensions in digital education include: Born digital LEARNING OBJECTS; Born digital LEARNING SCENARIOS; Born digital LEARNING OUTCOMES; Born digital ASSESSMENT.

The primary result of these transformations in the nature of the educational content is interdisciplinarity as a fundamental endgame of digital education.

Interdisciplinary social domains most accommodating or lucrative for liberal arts education are estimated as follows: Private sector (business); Public sector (civil service, public education, state social sector, etc.); Foreign economic activity; Industry; IT sector; Law/ legislature; Agriculture; Volunteering; Finance. According to the data of the online survey, conducted as a parcel of the project ‘TRANSITION’, led by the authorial team, the highest average scoring transdisciplinary domains of education in the Liberal Arts application are the Private business sector (77%), Public service sector (68.65%) and Foreign economy sector (58.62%). IT sector is estimated among top 5 domains (48.5%).

Trend 3: TRANSFORMATION OF STAKEHOLDERS IN DIGITAL EDUCATION. This trend is manifested, primarily, through the ambidirectional shifts in human to machine interaction in education. The subsequent result is the introduction of Artificial Intelligence solutions in education (Fig. 6) as an alternative form of educational communication subjects – from limited in scope and complexity to sophisticated and communicatively independent: Chat-bots; Gamification of educational tasks; AI Teacher Assistant (LMS); AI Teacher Avatar (agent); AI learning companion; Educational robots.

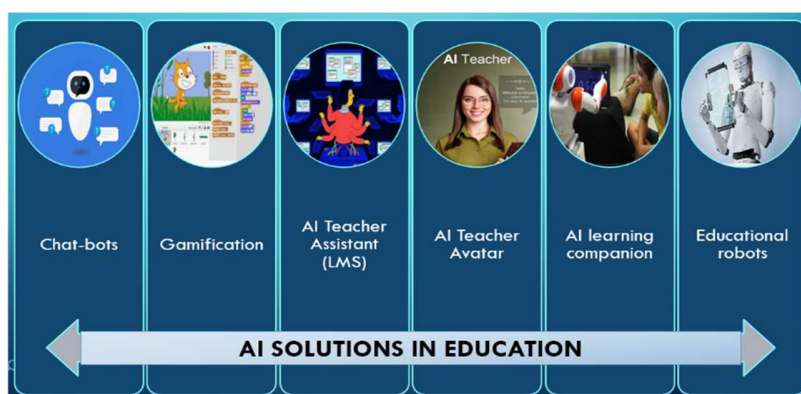


Figure 6: AI Solutions in Education in Emergency Conditions

AI enhancement of the learning stakeholders and communicative components informs transformations in other components of educational communication, namely the elaboration of machine learning powered mixed reality [28] learning environments and content, such as: AUGMENTED REALITY; VIRTUAL REALITY; ANNOTATED REALITY; 3D PRINTING.

For the multidisciplinary OUTPUT of Liberal Arts digital education dominant is the identified need to both interdisciplinary **upskill** in related humanities/Liberal Arts disciplines and cross-sectorially **reskill** in a technical/computer science field, which is consistent with the identified trend content and interaction transformation in the pandemic timespan and with the transdisciplinary understanding of Arts and Humanities education in general.

3. CONCLUSIONS

The study findings as to the systemic nature and paradigmatics of transdisciplinary educational communication in the digital environment allow to disclose the following key conclusions: the integrative theoretical and methodological bases of research of educational communication are defined; the methodological framework of modeling of transdisciplinary educational communication in the digital environment in the ontological,

linguistic and cognitive planes is introduced; the macrostructure of transdisciplinary educational communication is identified as a set of linguistic-communicative and digital instrumental innovations in the systemic semantic unity of their reference correlation with trans-disciplinary and cross-referential (ontological, epistemic, anthropological, technological) dimensions and elements of the global digital environment, the manifestation of which determines the phenomenological originality of the studied communicative sphere; experimental verification of the effectiveness of innovative educational communication in the global digital environment during the period of emergency quarantine restrictions are implemented; the principles of universality of interdisciplinary modeling of educational communication in the digital environment are identified; the anthropocentric bases of communication innovation in the field of acquiring new knowledge in the global digital environment are determined; the instrumental mechanisms of transdisciplinary educational communication in the digital environment are systematized.

The pandemic and wartime induced amplified digitalization measures in the higher education sphere, driven by the rise of generative AI and utilized to achieve sustainability and resilience. This end-to end digital shift in the educational processes (communication, content, outcomes and outputs,

skills) heralded the introduction of meta-disciplinary dimensions of learning – digital, hybrid and, blended. These meta-disciplinary dimensions can be considered conduits of vertical (endocentric) and horizontal (exocentric) transdisciplinary of digital education as a communicative system.

Applied trans-disciplinary lens contributes to the solution of holistic modeling of processes and results of updating models and mechanisms of the highly dynamic communication system of education in the digital environment as a whole and its individual formats in the emergency digitization measures of different types.

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