Transdisciplinary Ecoenvironment of the System of Information and Analytical Support for the training of Scientific and Pedagogical Staff

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Abstract. Challenges that create opportunities arise with the growth of technological influence and globalization. This points to the need for innovation to achieve the strategic goals of higher education . It is becoming important to create and develop a transdisciplinary ecoenvironment for training scientific and pedagogical staff that meets the technological, social and environmental challenges of the 21st century. This makes it possible to acquire cross-cutting competencies by future specialists, whose training should be carried out by competently trained scientific and pedagogical staff in higher education institutions. The purpose of the study is to rethink the methodological approaches of the transdisciplinary ecosystem, as well as to present the structure and practical significance of information and analytical support for the digital transformation of scientific and pedagogical staff training. The transdisciplinary approach as a new paradigm of thinking and an adequate concept of formation and development, in particular of educational ecosystems, is the main methodology of the modern postmodern scientific and educational space. The transdisciplinary nature of information and analytical support for the training of scientific and pedagogical staff in the context of digital transformation will include: educational analytics on adaptive management; information analytics on adaptive policy, social and organizational analytics on human infrastructure. In this way, Industry 4.0 closely interacts with Education 4.0. This is possible through the convergence of scientific approaches – transdisciplinary, competence, adaptive, acmeological, ontological. The transdisciplinary ecosystem of information and analytical support for the digital transformation of teaching staff training is dynamic and open to convergence.

Keywords: Transdisciplinarity · Ecoenvironment · Training of Scientific and Pedagogical Staff · Higher Education

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1 Problem Statement

With the growth of technological influence and globalisation, challenges arise that create opportunities, indicating the need for innovation to achieve the strategic goals of higher education. The functioning and development of a transdisciplinary ecoenvironment of information and analytical support (hereinafter – IAS) for the training of scientific and pedagogical staff is becoming an urgent problem that provides a response to the technological, social and environmental challenges of the 21st century.

Changes in the technological, economic and socio-cultural environment create the need for new approaches to teaching and research.

The development of the information and analytical component of transdisciplinary competence among participants in the ecoenvironment is a critical task. This requires the use of digital and electronic platforms for lifelong learning, the appropriate implementation of educational activities, and the acquisition of competencies in working with artificial intelligence, virtual and augmented reality, and design technologies. Therefore, the ecoenvironment of an educational/scientific institution that meets the information and analytical needs in the context of digital transformation at a transdisciplinary level must be smart.

In this sense, it should be noted that crosscutting competences can be acquired by future specialists, whose training in higher education institutions should be carried out by competently trained research and teaching staff who have acquired information and analytical competences at the transdisciplinary level. The main tools for the acquisition of transdisciplinary competences and the formation of its information and analytical component are information technologies, including digital ones. Today, researchers and teachers need knowledge of the cognitive, emotional and social aspects of human life as a subject of transdisciplinary ecoenvironment.

The purpose of the study is to rethink methodological approaches to the functioning of the transdisciplinary ecoenvironment, to present the structure and practical significance of IAS for the digital transformation of training of scientific and pedagogical staff, aimed at the development of Education 5.0, to clarify the main components of the transdisciplinary competence of scientific and pedagogical staff, to conduct a survey for analytical and synthetic processing of the results to clarify the theoretical and methodological foundations in the context of the applied research 'Information and analytical support of digital transformation of education and pedagogy: domestic and foreign experience'.

Thus, the problem of increasing the efficiency of IAS for the training of scientific and pedagogical staff in the system of work of higher education institutions and research institutes (scientific institutions) is relevant in the context of the development of a transdisciplinary paradigm of education and knowledge society. This area of information and analytical activity in the vector of scientific research deserves attention and detailed elaboration, since almost every stage of training of scientific and pedagogical staff begins with the use of information analytics tools – both purely educational content of training for the training of scientific and pedagogical staff/scientists, and in the organisation and conduct of research and teaching activities.

2 Analysis of Recent Research and Publications. Approach

It should be noted that during 2020–2024, the Department of Scientific Information and Analytical Support of Education of the V. Sukhomlynskyi State Scientific and Educational Library of Ukraine (hereinafter – SSLU) analyzed the scientific achievements in introducing a transdisciplinary approach to educational practice. The SPSS researchers systematized and summarized in the format of analytical reviews the literature sources to fulfil the tasks of applied scientific research, paying attention to the transdisciplinary approach in education. The prognostic analysis showed that it is advisable to train scientific and scientific-pedagogical staff with an eye to the future, taking into account certain conceptual provisions of the advanced development of education. Such development is possible on the basis of a transdisciplinary approach, which, in the times of transition to Society 5.0, erases interdisciplinary boundaries and brings to the surface of the world scientific consciousness a transdisciplinary paradigm of humanity in general and the educational sector in particular [1–3]. The results of the analytical searches are presented on the SSLU web portal and the functionality of the Electronic Library of the National Academy Educational of Sciences of Ukraine [4].

In this sense, the relevance of innovative training of scientific and pedagogical staff is determined by many researchers, such as: N. Vavilina, O. Reshetniak (training of scientific staff) [5, 6], S. Lytvynova, O. Liashenko, Y. Malovanyi, O. Spirin (digital competence of scientific and scientific-pedagogical workers) [7], O. Kapinus, T. Makhynia, N. Prykhodkina T. Rozhnova, O. Sholokh (quality problems of training of scientific and pedagogical staff in higher education institutions) [8], etc. The authors assume that in the context of the global digital transformation of the educational process, this training requires new approaches and the introduction of appropriate innovations. However, in our opinion, there is a lack of studies that would reveal the essence of the information and analytical component in the process of formation and development of transdisciplinary competence of subjects of training of scientific and pedagogical staff in the context of digital transformation of society.

For example, researcher N. Vavilina argues that ‘the human resource potential of science, education, and high technology industries is becoming one of the main resources for economic growth in the era of information, bio and nanotechnology, the era of globalisation and internationalisation, as well as the rapid growth and development of the “knowledge industry”, when the amount of knowledge doubles every five years’ [5]. However, how the training of scientific and pedagogical staff will be provided in this context is not disclosed in sufficient depth. Researcher O. Reshetniak points out the interdependence of the training of scientific and scientific-pedagogical staff on the model of the education system that operates in the country [6]. However, insufficient attention has been paid to the question of how the functioning of the education model will interdepend in the context of global digitalization and what approach should balance this interdependence with this training.

The content analysis of the source base allows us to assert that the issues of information analytics, including monitoring studies, are currently receiving a lot of attention from researchers and are the subject of many scientific papers. We were interested in the works of such scholars as: O. Serbin and T. Yaroshenko (functioning of information and analytical centres of universities and libraries in the challenges of time) [9], O. Nesterenko,

V. Polischuk, S. Zharinov (application of integrative information technology in the evaluation processes of research institutions) [10], and others. These researchers also make certain statements about the need to implement transdisciplinary strategies in the design and construction of information and analytical systems that are adequate to the present time.

In addition, it has been found that the development of transdisciplinary methodology is devoted to the powerful scientific heritage of such researchers as: J. Piaget [11], J. Osborne [12], B. Nicolescu [13], D. Jeder [14], B. Lavrynovych [15], O. Lucianinova [16], etc. For example, in the book "Modernising Learning: Building the Future Learning Ecosystem" [17], edited by J. Walcutt and S. Schatz explores the implementation of a transdisciplinary approach in educational systems, discusses the creation of adaptive ecosystems to ensure individualisation and integrity of education and training, etc. Thus, the researchers reveal different methodological vectors in the context of transdisciplinarity: pedagogical, psychological, economic, technological, etc. However, in our opinion, the main aspects of IAS for the training of scientific and pedagogical staff in the context of the development of the transdisciplinary paradigm in the context of the digital transformation of education have not been sufficiently covered in the scientific literature. This led to the priority of choosing the topic of our study.

Also, the study of the source and historiographical base of the study revealed that in the propaedeutic aspect, a "green" transition from "Education 4.0" to "Education 5.0" is currently underway (Table 1). This has a significant impact on the realities of the digital transformation of higher education and provides adaptive tools for the transdisciplinary eco-environment of training of scientific and pedagogical staff.

Table 1. Features and Purpose of Education 4.0 and Education 5.0 in the Context of Digital Transformation of Higher Education

Education 4.0	Education 5.0
Harmonisation of Ukrainian and European educational spaces	Noosociety, Nooscience, Nootechnology
Creation of modern digital educational infrastructure and tools	Training for new professions, for example, emotion designer, city farmer, space tourism manager
Individual poly-model lifelong learning. In subsystems – communication, cooperation	Culture of production, cooperation, management, analysis methodology, business models, interaction with consumers (through virtual space); cooperation of people, machines, services, processes; establishing personalisation of services and products
Use of innovative pedagogy: the main principle is technocratisation and informatisation of education, the main form of competence is the ability to analyse various information flows	Focus on the use of alternative modes of interaction model management (other than technology); human-centred approach to the use of technology; corporate responsibility

(*continued*)

Table 1. (*continued*)

Education 4.0	Education 5.0
Digital educational infrastructure and digital tools	Digital pedagogy: critical thinking, innovative way of thinking, multitasking, analytical skills, design, compassion – turns into noopedagogy; balance of technical, fundamental and humanitarian disciplines
Industrial competitiveness and development of high-tech production	Deepening digital skills and the ability to turn them into life wisdom
The result: an educational and research hub for industry 4.0	The result: training of specialists with knowledge and skills of Industry 5.0, 6.0; ability to live in the digital world without losing humanity

In our opinion, for the functioning of an effective system of training of scientific and pedagogical staff, innovative transformations should take place primarily in the transdisciplinary ecoenvironment of the IAS system, in particular, when it comes to the digital transformation of the education system.

Thus, based on the analytical research, a number of author's ideas emerged in the context of our study.

3 Basic Research Terminology

The presented study is based on a certain semantics of basic concepts, the terminological field of which is confirmed by intermediate and final results.

It should be noted that the essence of the definition of the category "training of scientific and pedagogical staff" is based on the current legislation and educational policy of a particular country. For example, in Ukraine, according to the current legislation, the main forms of training of highly qualified scientific staff are postgraduate studies, adjunctancy and doctoral studies.

However, the authors' judgement on the choice of conceptual apparatus was clarified and verified in the process of conducting a survey of educators and scientists using the Google questionnaire "Digital Trajectory of an Educator in Society 5.0" developed by the authors [18]. The structural and semantic construct of the terminological field "transdisciplinary ecoenvironment of information and analytical support for the training of scientific and pedagogical staff" is defined. The study proposes to consider the following basic concepts as the main definitions: "transdisciplinary ecoenvironment" and "information and analytical support of education".

The structural and semantic construct of the term field "transdisciplinary ecoenvironment of information and analytical support for the training of scientific and pedagogical staff" is allocated. The main definitions in the study are the following basic concepts: "transdisciplinary ecoenvironment" and "information and analytical support of education".

That is, in our study we will assume that:

1. The transdisciplinary ecoenvironment is a dynamic triangle consisting of the environment of information and analytical support subsystems (e.g., educational and scientific institutions), methodology of the information and analytical support system (which includes principles, methods, tools, information technologies and forms of process organisation), as well as the subjects of the environment and transdisciplinary relations in the information and analytical support subsystems (including the process of training of scientific and pedagogical staff, external and internal influences) (Rostoka M. L.).
2. Information and analytical support of education is a system of support for the effective conduct of research and organisation of the scientific and educational process, which includes a set of technical and technological solutions for the collection, processing, evaluation, analysis and synthesis of information data, including for monitoring and making various options for rational decisions (Rostoka M. L.).
3. Information and analytical support of training of scientific and scientific-pedagogical staff is a system of organisation of scientific and educational process, which includes a set of technical and technological solutions for analytical collection, processing, evaluation, analysis and synthesis, as well as structuring of information data for their prompt and timely receipt by users (subjects of the training process) (Rostoka M. L.).

4 Statement of Basic Material and the Substantiation of the Obtained Results

The development of a transdisciplinary ecoenvironment for IAS of academic staff training is an adaptive process. This includes generating innovative ideas, organising new project solutions, holding professional competitions and workshops, creating comfortable workspaces, providing adequate consultations with leading world experts, ensuring the adaptive functioning of personal networks, and developing own start-ups. Various formats of the educational process are now being updated: distance (online), blended (online + offline), and natural (offline). In addition, learning is a natural need of our brain.

The transdisciplinary ecoenvironment of IAS is a space for determining an individual learning trajectory for each of its subjects, individual funding, support for retraining and advanced training of academic staff, introduction of micro-qualifications, short-term courses; it includes open educational resources, monitoring of labour market needs for digital and green skills, non-formal education centres; more opportunities for applicants to develop a unique set of competencies. In such an ecoenvironment, intellectually, socially, and emotionally strong individuals can be trained, and IAS will supplement the transdisciplinary systematisation of knowledge and in the educational ecosystem of the city, country:

– Scientific and educational centres.
– Electronic repositories of full-text documents of leading libraries.
– Content of the regulatory framework for education.
– Network information and analytical evaluation system.
– Event analysis of scientific events.

- Innovative and professional activities of libraries (presentation of exhibition activities as an effective methodological tool for IAS in the context of digital transformation of education through the presented scientific, practical, educational, methodological, technological applied innovations (exhibits);
- Bootcamps for mastering digital skills, etc.
- Educational associations and public organizations.
- International, national, interregional scientific, practical and methodological events – scientific fairs-presentations of domestic HEIs, forums, round tables, webinars, etc.
- In the educational ecosystem of the university – an online educational platform, a scientific library (open education, e-textbooks, electronic repository), opportunities of a public university, various forms of education (full-time, mixed, distance, dual), IT service of digital support for teachers, scientific community, university centres (for the development of professional education, social and humanitarian support of the educational process, interdisciplinary workshops, webinars, seminars, interdisciplinary research (between departments, institutes).
- Cooperation with stakeholders, production – a base of production practices for students, a database of interactive links; and professional development platforms.

The transdisciplinary ecoenvironment of IAS for the digital transformation of scientific and pedagogical staff training will be effective if:

- Purposefully develop the information, analytical and digital components of the transdisciplinary competence of the ecoenvironment.
- To carry out information and analytical replenishment of the ecoenvironment resource.
- To promote and ensure digital transformation of training of scientific and pedagogical staff on the basis of acmeological, transdisciplinary, systemic, synergistic, competence, adaptive approaches.
- To use effective digital technologies for the development of a transdisciplinary ecoenvironment of IAS for the digital transformation of scientific and pedagogical staff training.

Let us specify the above organisational and pedagogical conditions. The transdisciplinary ecoenvironment of IAS for the training of scientific and pedagogical staff is a space where there is a close relationship between a person, education, its information and analytical activities through the university, local culture, production, business, cooperation with the community, and alternative sources of education. It is necessary to purposefully develop the information and analytical component of the transdisciplinary competence of the trainees so that they can actively and dynamically develop.

It is worth noting that the implementation of information and analytical content of the transdisciplinary IAS ecoenvironment through digitisation and automation of information and analytical activities will contribute to the transformation of social and educational institutions. In accordance with the transformation processes in education, the university should act as a centre and provider of the educational ecoenvironment, determining the key, including "environmental" positions of education.

It is important to provide IAS for the digital transformation of the training of scientific and pedagogical staff on the basis of the main methodologies – transdisciplinary,

systemic and synergistic. This process can be represented in the form of a triangle: scientific approaches to the functioning of the IAS system, the ecoenvironment itself and its subjects.

The transdisciplinary ecoenvironment is inherently an experimental platform or research platform for the development and confirmation of our research hypothesis. Its central element is the system of IAS, supplemented by electronic scientific, educational and information resources, academic disciplines, management and control through digital means. The ecoenvironment of IAS is gaining signs of a communication channel that provides a combination of subject-subject interaction of its participants through digital technologies and management tools.

Accordingly, the transdisciplinary approach as a new paradigm of thinking and an adequate concept of formation and development, in particular of educational ecosystems, is the main methodology of the modern postmodern scientific and educational space.

The central element of the transdisciplinary ecoenvironment for training scientific and pedagogical staff is the component of IAS (replenishment with electronic scientific, educational, information and analytical resources, etc.) The content of this component is aimed at taking into account the needs of each subject of information and analytical activity, competence-based organisation or a high level of universality, specificity of knowledge, free orientation in fast-moving information and digital flows, acquisition of information and analytical competence in a particular field of knowledge, etc.

The transdisciplinary nature of IAS for the training of scientific and pedagogical staff in the context of the digital transformation of education will include:

- Educational analytics for adaptive management (development and updating of interfaces for joint programming and balancing competing interests in educational, commercial and governmental organisations).
- Information analytics for adaptive policy (development of recommendations and regulations that define the rules of behaviour in the system).
- Social and organisational analytics of human infrastructure (development of critical human infrastructure of the educational ecosystem of the future; training of training engineers and software developers of educational courses).

Thus, Industry 4.0 closely interacts with Education 4.0. This is made possible by the convergence of scientific approaches – acmeological, transdisciplinary, competence-based, adaptive and ontological.

Research methods used: content analysis of Ukrainian and foreign scientific sources to clarify the definitions of ‘transdisciplinary ecoenvironment’, ‘transdisciplinary competence’, ‘information and analytical support’; thematic analysis of the experience of covering the problem of development of the transdisciplinary ecoenvironment of IAS the digital transformation of training of scientific and pedagogical staff; application of author′s and modified survey methods (modified questionnaire for the Degree) on the state of digital transformation of training of scientific and pedagogical staff.

The criteria for the development of the transdisciplinary IAS ecoenvironment are established and the methodological tools are defined.

In order to substantiate the foundations of the transdisciplinary ecoenvironment of IAS for the digital transformation of the training of scientific and pedagogical staff in the context of force majeure, namely the war in Ukraine, the number of respondents was

88, representing different levels and branches of education by specialisation. But they are united by their educational activities. The survey participants had the opportunity to answer a number of questions in the author′s questionnaire ‘Digital Trajectory to Society 5.0’ [18].

It was interesting to see how many respondents (educators) took part in the survey from different levels of education and by specialisation (Figs. 1, 2).

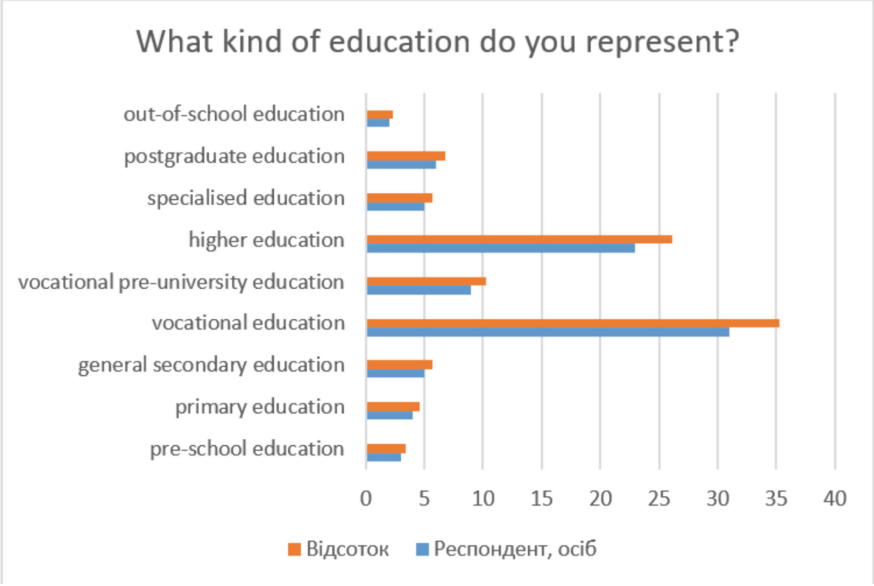

Fig. 1. Indicators of the distribution of the surveyed scientific and pedagogical staff by the links of the educational environment

Having analysed the responses of the survey participants (scientific and pedagogical staff) from different levels of education and in different specialisations, we can state that it is the representatives of the purely educational sector, namely scientific and pedagogical staff of higher and vocational education with specialisation in the field of pedagogical sciences and the art industry, who are mostly striving for innovation with a view to advanced development. The definition of the concept of transdisciplinary ecoenvironment of IAS for the digital transformation of scientific and pedagogical staff training has been preliminarily generalised based on the analysis of the answers to the questionnaire.

Thus, the transdisciplinary ecoenvironment of IAS for the digital transformation of academic staff training is a space for the development of transdisciplinary skills, knowledge, and abilities from problem solving beyond the existing disciplines and sciences to the ability to develop new transdisciplinary strategies with the help of products of IAS for educational activities.

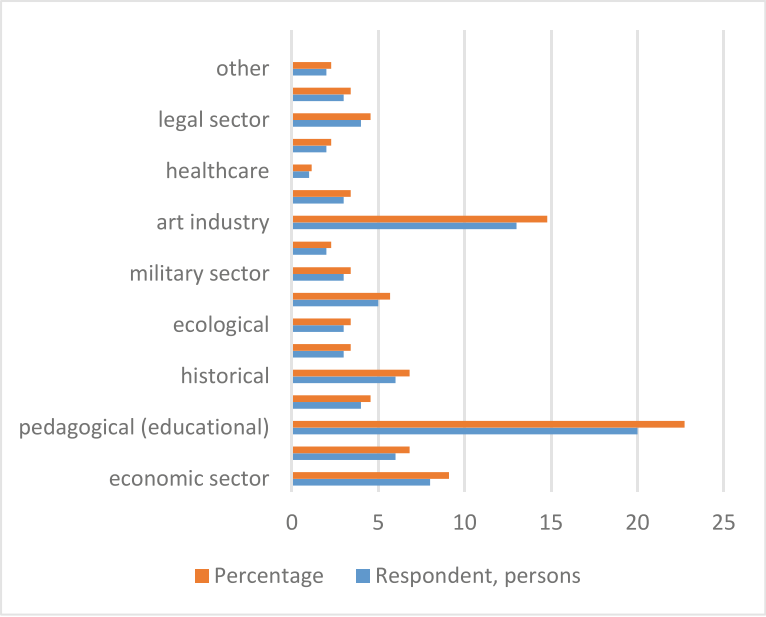

Fig. 2. Indicators of the distribution of scientific and pedagogical staff who have expressed interest in the specialisation of education. (Question: in which field of specialisation of sciences do you carry out professional activity?)

5 Conclusions

The training of scientific and pedagogical staff involves the use of the latest information technologies and monitoring methods, as well as digital processing of analytical information and enhances the analytical component in information and analytical results through the transfer of knowledge from various fields of science and education. To facilitate environmentally conscious decision-making, it is recommended to reform the training of scientific and educational staff to include transdisciplinary knowledge and skills in information analytics. This is because everything on the planet is part of the global ecosystem. The transdisciplinary ecoenvironment of IAS for the training of scientific and pedagogical staff is a component of the transdisciplinary ecosystem of information and analytical support for the digital transformation of education in general. The ecoenvironment has transdisciplinary connections and is aimed at solving complex analytical pedagogical and research tasks that go beyond disciplinary knowledge.

This ensures the synergy of qualitative results to solve complex problems and enable conclusions:

1. The transdisciplinary ecoenvironment of information and analytical support for the training of scientific and pedagogical staff is intellectual, dynamic, evolutionary, flexible, open, adaptive to convergence, reliable, capable of determining the individual trajectory of a particular higher education institution or research institution in general and for each of their subjects in particular.

2. Thus, the transdisciplinarity of both the research itself and the implementation of an effective methodology of a transdisciplinary approach to the creation and development of the ecoenvironment in the system of information educational analytics is ensured, which allowed to gain new knowledge and competencies in the system of this training.
3. The terminology base for implementing transdisciplinary strategies in information analytics is also being improved.
4. The level of quality of training of scientific and pedagogical staff is being improved by the convergence of scientific and practical approaches, which is ensured by transdisciplinarity.
5. The criteria for indicators of the information and analytical component of the development of transdisciplinary competence in the training of scientific and pedagogical staff in the context of digital transformation are being further developed, etc.

The prospects of our research are outlined in the focus of studying the methodology of building an information and analytical system, which should facilitate the prompt implementation of information and analytical support for any scientific and pedagogical activity.

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