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Digitization of learning environment of higher education institutions: conceptual foundations and practical cases

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Abstract. Digital transformation involves the use of digital technologies for rebuilding processes and increasing their efficiency. It is confirmed by the results of the research on transformational processes in various spheres. This research paper deals with the development (modernization) of digital learning environments of higher education institutions, which creates conditions for creating models of real production and social processes by means of modern digital technologies. It will strengthen the competence potential of all the stakeholders of higher education institutions, which train specialists in digital technologies. The need to upgrade the existing educational environments of higher education institutions in the context of crisis situations related to global challenges (for example, COVID-19) or the specifics of a specific country (the war in Ukraine) or an educational institution is substantiated. The research paper specifies a conceptual model of the next generation digital learning environment of a higher education institution, which involves the distribution of resource distribution and provision of integration of resources, data and users according to three levels (micro, meso and macro levels), and provides the cases of its implementation in National University of Life and Environmental Sciences of Ukraine and Borys Grinchenko Kyiv University. The monitoring data are presented both at the level of external (development of the component composition of the environment) and internal (change of organizational processes according to the students' demand) design of the environment. The need for designing a change management system at the level of a higher education institution or its structural subdivisions is identified.

1. Introduction
The idea of digitalization is aimed at the use of the technologies not only for the automatization of the existing business processes of production and the sphere of service sector, but also for the creation of the fundamentally new ones. Accordingly, the economic development and competitiveness of modern states largely depend on the availability of educated and competent specialists as well as technologies that increase the productivity of their activities. Thus, in the report on global competitiveness for 2020, the upgrade of infrastructure and education curricula, investment in research and innovation in order to create "markets of tomorrow" [1] are identified as priorities for expanding the capabilities of human capital which, as a result, will stimulate the long-term digital transformation of the economy.

In the other document "World Economic Forum Annual Report 2021-2022" [2], experts focus on learning, development and growth. In particular, this document states the necessity to cultivate a learning organization, as well as to design courses on change management and targeted programs for managing people and teams in higher education institutions.

Every year Horizon experts identify trends, technologies and practices that shape the future of technologies affecting the development of higher education [3, 4], the digital transformation (DT) of higher education is at hand [5,6] is not being currently implemented, but it is extremely relevant, as these approaches allow us to describe complex relations between subjects in the technologically supported educational sphere [7].

If for business the need and adoption of digital transformation is rather a question of survival, for educational organizations the introduction of digital technologies can help institutions become more competitive [8]. However, as it is evidenced by the results of the research by Rodríguez-Abitia and Bribiesca-Correa [9] regarding the assessment of the state of digital transformation of higher education institutions, universities in this process are significantly inferior to institutions of other industries. At the same time, Rof et al. [10] emphasize that the future of higher education depends on the ability of its managers to foresee the process of digital transformation and manage it in a new competitive environment.

According to the systematic literature review of digital transformation in higher education institutions, carried out by Benavides et al. [11], the following DT dimensions were highlighted: Research (RE), Teaching (TE), Business Process (BP), Human Resource (HC), Curricula (CU), Infrastructure (IN), Administration (AD), Marketing (MK), Information (INF).

Comparing digital innovations and digital transformation, Drechsler et al. [12] propose to consider digital transformation (and we share this assumption) from the point of view of the relationship between changes in the structure, strategy and technologies as a response to the requirements for the modern digital educational environment, emphasizing the need for a balance between its existing and new elements. Since the authors of the study research digital transformation of higher education institutions from the technological, organizational and social points of view, the need for the development (modernization) of the institutional digital learning environments becomes an actual one.

This research paper aims to provide a rational behind a conceptual model of the structure of the next generation university digital learning environment (NGDLE) and illustrate the practical cases of its implementation in Ukrainian universities.

2. Conceptual model of the structure of the next generation university digital learning environment

Although higher education institutions still use centralized models of supporting learning process, for example, ones based on learning management systems, massive digitalization and modern students' needs actualize the necessity to create next generation digital learning environments (NGDLE) [13].

Lane and Goode [14] define NGDLE as a distributed, loosely coupled component model consisting of free and open source software designed to provide:

- constant integration and interaction of various teaching aids and research tools;
- encouragement and support of the personalization and collaboration of all users or separate groups;
- availability of educational tools for the analysis of students' data and course information used by the teachers and learning design support staff.

The expectations of modern students regarding the increased integration of digital technologies in their learning environments laid the foundation for the design of the NGDLE models. A description of cases of design and implementation of the NGDLEs in the

learning process, namely Motivational Active Learning (MAL) and Task-Test-Monitor (TTM) is presented in [15].

In the Netherlands and Denmark the effectiveness of using the NGDLEs for further integration into the social context, such as social interactions outside of formal institutional settings and social media, aimed at the improvement of new digital learning practices is confirmed in [16]. In particular, Ossiannilsson et al. [16] the impact of the NGDLEs on the development of personal learning environments (PLE) of the stakeholders of higher education institutions. Under the conditions of the NGDLEs the students study with other people, control their own educational resources, integrate their learning in different institutions, get knowledge from various sources and manage their own activities as well. Basically, faculties and students will use the NGDLE to design their personal learning environments (CLEs) so that each participant will be able to maximize their own potential.

The idea is confirmed by the results of studies, carried out by non-profit educational organizations. These studies deal with the design and development of learning environments as well as with monitoring and evaluation of their effectiveness:

- according to Edutainme the aim of the digital learning environment is to declare the principles of creating digital learning environments where a student will be the subject of learning process and will be responsible for his or her own development [17];

- within the framework of the concept of the "Next Generation Digital Learning Environment" (NGDLE), EDUCAUSE looks for a balance between the openness of education and the need for connection of education with environment; emphasizes personalization, collaboration, accessibility and universal learning design [18].

At the same time, the issue of upgrading the existing learning environments of higher education institutions [19] for the creation of NGDLEs with subsequent expansion to digital learning ecosystems remains uncovered. The specified need is actualized due to the fact that modern environments of higher education institutions function in crisis situations related, for example, to COVID-19 (global challenges) or the war on the territory of Ukraine (the local context).

In our opinion, in order to ensure flexibility within the existing digital learning environments at the level of individual components, academic program or individual learning trajectory of a separate student, it is necessary to ensure sufficient control and support provided at the level of higher education institution. One of the ways to solve this task is to manage the content of programs and services at the institutional level by means of ensuring a high level of reliability, security and freedom of users' choice. In the Netherlands, as part of the SURFnet project, the metaphors of "fortress" and "open city" were introduced [20]. It is necessary to decide on the definition of components (functional elements, programs, services) for centralized and decentralized management, as well as tools that are not subjects of the institutional management. In order to make an appropriate decision, the manifestation of each functional component of the environment is evaluated according to a three-point scale (low, medium, high) against the following criteria: confidentiality, integrity and availability of data inside the component. Components with a high level of manifestation against one or more criteria are placed in the "fortress". These are components which the institution has the greatest control over (centralized management). As a rule, these components include business processes and, accordingly, the tools for learning content design, management of educational analytics data, evaluation of learning outcomes of educational activities, etc. Components that are located in the "city" have a medium or low level of manifestation against the specified criteria. Formal and informal learning, conducting research, educational and scientific communication take place in the "city" but with the use of resources and data from the "fortress". There is more freedom in the "city"; management, in most cases, is decentralized (occurs at the level of separate departments,

structural divisions, academic programs and project teams), however, at the institutional level, performance criteria of evaluation are determined, monitoring and control are carried out. In the "country", surrounding the "fortress" and "city", processes of external communication, cooperation, implementation of academic and scientific mobility take place. Maximum freedom of the users is guaranteed.

If we take the approaches of the SURFnet project regarding the creation of the NGDLEs of higher education institutions, when designing the IT infrastructure, as a basis (figure 1), let's distribute the resource provision according to the following levels:

- micro-level (corresponds to the "fortress" metaphor) involves centralized institutional management, increased confidentiality and security, integration of both resources and users; it takes place at the level of one institution;

- meso-level (corresponds to the "city" metaphor) includes institutional re-sources and services external users have access to;

- macro-level (corresponds to the "country" metaphor) at the institutional level involves the integration of external resources (services, platforms) into the institutional NGDLE in order to solve educational tasks with the subsequent integration of stakeholders of learning process into a single educational and scientific environment (personal learning environments tend to expand due to the implementation of active personal learning and scientific activities); it presupposes a subsequent expansion of the functionality and resource provision of the institutional digital environment (if necessary) according to the users' demand.

At the same time, it should be noted that the proposed distribution is a quite conditional one. For example, Google Workspace or MS Office 365 cloud services can be used at all levels, as it depends on the category of participants, educational tasks and pedagogical technologies used for their fulfillment. As a kind of example we can mention a joint work on the creation of electronic documents or implementation of joint projects within the framework of the course "Information Technologies" [21]. It is a case that illustrates the development of students' approximate set of actions necessary for the effective group work. Therefore, the use of the corporate cloud occurs at the micro-level.

In case when the third-party users join the work (mesolevel), the access to joint work with certain shared documents or services can be given by the students themselves or the registration in the corporate segment at the administrator level may be allowed. The case illustrating the tasks which require such actions is the use of the corporate community for professional development or the creation of shared knowledge using Wiki platforms (e.g., `http://wiki.kubg.edu.ua`). An example of the integration of resources (technical, human) at the macro-level is an institutional subscription to Google Workspace or MS Office 365, as well as joining external cloud services.

It is obvious that not all the resources can be used at different levels. In fact, the component composition of such environments varies depending on the tasks and capabilities of a separate higher education institution. On one hand, University of Wisconsin-Madison uses Canvas as the main LMS, and the DLE component composition is more focused on supporting the learning process (`https://kb.wisc.edu/page.php?id=65466`). On the other hand, digital learning environment of Borys Grinchenko Kyiv University is larger (`https://digital.kubg.edu.ua/`) and LMS Moodle is used to support e-learning.

3. Case study of the NGDLE model implementation

While exploring learning environments from the point of view of pedagogy, scientists reveal the specific effects of their influence on the subjects of the educational process. These stakeholders are carriers of certain experiences and tools (in particular, it goes about personal learning environment). Therefore, it is advisable to monitor and adjust the components of DLE at
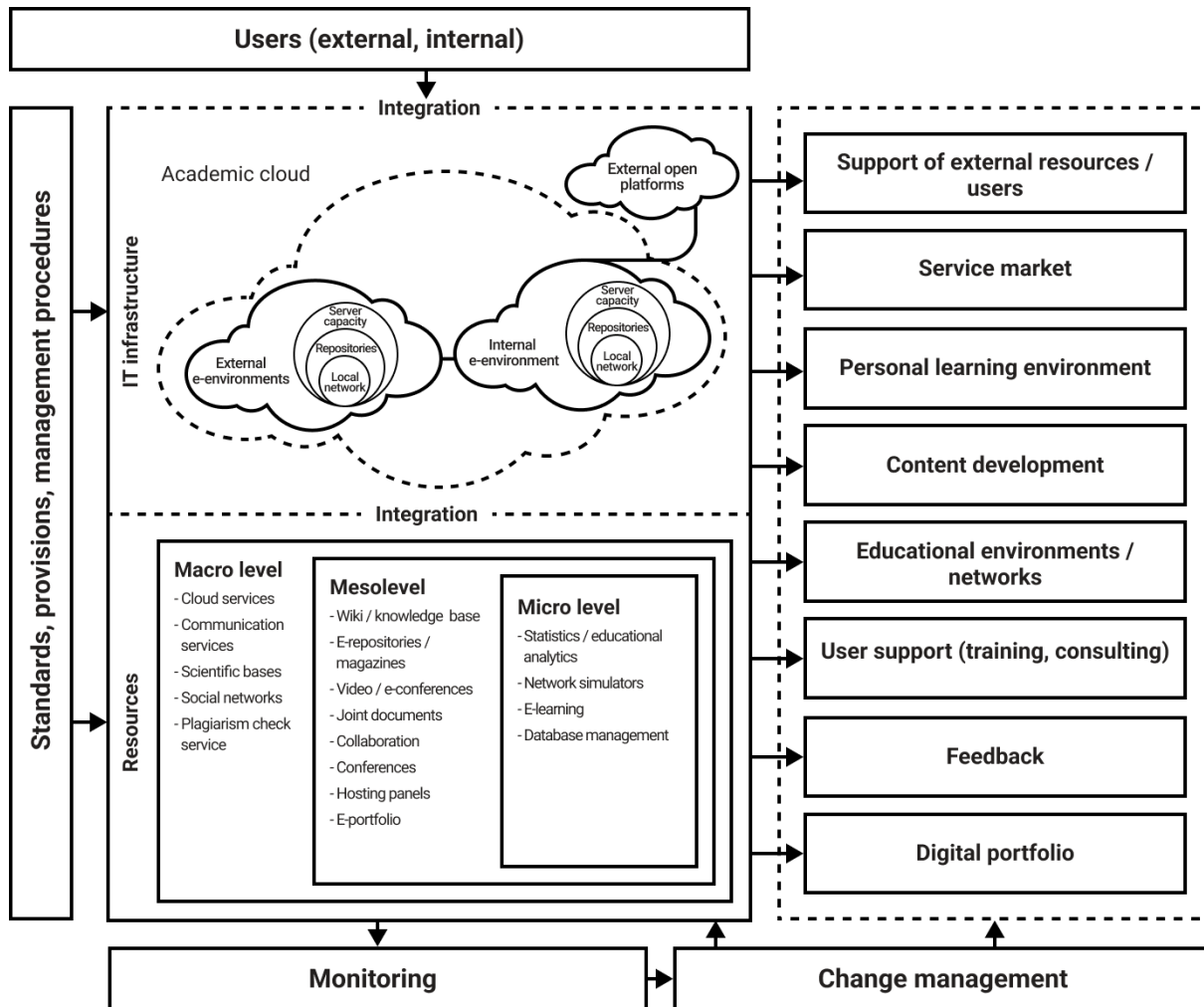
Figure 1. Conceptual model of the next generation university digital learning environment.

the level of external design with the involvement of project team representatives from among institutional and external experts. This process should be based on the analysis of technological and educational trends, requirements for the organization and digitalization of educational and scientific activities of higher education institutions, in particular, standards of higher education (figure 1). There is one more factor in the improvement (transformation) of the institutional digital learning environment. There should be relevant results of evaluating the effectiveness of the environment application for further formation (internal design). In this case, subjects of educational and scientific activity of a higher education institution act as experts [22].

For example, based on the results of an expert evaluation of the effectiveness of the designed DLE application [22], the project teams of Borys Grinchenko Kyiv University and the National University of Life and Environmental Sciences of Ukraine initiated the expansion of the component composition of the institutional digital learning environments (table 1) in accordance with the requirements of strengthening the scientific share, in particular, according to the results of the rating of higher education institutions [23].

Accordingly, certain steps were taken regarding the integration of resources, data and subjects of educational and scientific activity, namely:

- institutional means of supporting scientific communication (improvement of resource

Table 1. Means of scientific communication in the structure of the institutional learning and scientific environment.

Category	National University of Life and Environmental Sciences of Ukraine	Borys Grinchenko Kyiv University
Institutional repository	Institutional repository of National University of Life and Environmental Sciences of Ukraine `http://elibrary.nubip.edu.ua`	Institutional repository of Borys Grinchenko Kyiv University `http://elibrary.kubg.edu.ua`
Repository of Master's theses	Repository of Master's theses `http://studtheses.nubip.edu.ua`	Database of Master's theses `http://studbase.kubg.edu.ua`
E-journals	E-journals of National University of Life and Environmental Sciences of Ukraine `http://journals.nubip.edu.ua`	Open educational e-environment of modern University `http://openedu.kubg.edu.ua`
E-conferences	Online scientific conferences `http://econference.nubip.edu.ua`	Scientific conferences and seminars of the Borys Grinchenko Kyiv University `http://conf.kubg.edu.ua/`

support according to the students' demand) were created; it was done with a purpose of modeling business processes of scientific communication [24] and acquisition of relevant experience by young researchers (Master's students, postgraduate students); in particular, Master's students submitted their scientific publications to the institutional e-journal (e.g., `http://masters.kubg.edu.ua`) and passed the stage of scientific paper review; this is the way how the DLE components were improved in technological and organizational aspects before being integrated at the micro-level (in the higher education institution);

- scientific e-conferences were held (e.g, `http://econference.nubip.edu.ua`), including conferences for young scientists [25] and publications in the open access journals (e.g, `https://openedu.kubg.edu.ua`) with the involvement of other scholars, external experts (reviewers, key speakers); educational and scientific communication was expanded due to the involvement of leading experts; it ensured the integration of scientific communication tools at the meso-level;

- source base of research was expanded by providing access to scientometric databases such as Scopus and Web of Science (institutional subscription), students were involved in project activities and academic mobility through the organization of internships and dual degree studies. Implementation of the proposed functionality creates conditions for ensuring integration at the macro-level, however, the implementation of these conditions depends on the activity of Master's students, the scientific potential of higher education institutions and level of competence of scientific and scientific-pedagogical staff.

Improvement of the NGDLE concept and implementation of the proposed model (figure 1) in 2 universities prove the relevance of similar projects which meet the requirements of the transformational challenges of modern society [26] namely:

- strengthening the competence potential of the digital environment, which not only enhances the improvement of digital literacy but also promotes digital equity;

- increased requirements to resource support, which can be considered the basis for the implementation of individual learning trajectories, a transformation of educational activities taking into account individual learning styles and authentic learning experiences;

- leading role of educational and scientific communication as a learning technology can be explained by the readiness to use digital environment for collaborative learning, in particular, for the establishment of cross-institution and cross-sector collaboration);

- initiation and support of external communication, which contributes to the dissemination of experience, promotes new professional ties and stimulates an active search for partners, experts, etc. It confirms the need for cross-institution and cross-sector collaboration and adaptation of the learning process to real (production) business processes of the digital economy.

At the same time, change management is an important aspect of the development of learning environments in the digital age (figure 1). It is a systematic approach aimed at the creation of strategies and methods that will be used to implement changes and develop the ability of subjects of the learning process of a higher education institution to effectively respond to these changes and adapt to them [27]. We agree with Sartori et al. [27] that "training, development, and innovation are three different but interconnected functions by which organizations manage change". We consider this direction as a perspective for further research. In particular, there are some other areas of research that require more detailed attention – monitoring changes in the implementation of e-learning with a focus on the use of digital technologies and tools for modeling the dynamics of industrial and social contexts (including individual behavior and group dynamics), as well as strengthening the competence potential of the subjects of the educational process of higher education institutions.

4. Conclusions

While working in the dynamic and interconnected internal and external environments of the modern digital age, organizations in general and higher education institutions, in particular, are faced with increasingly complex challenges trying to achieve sustained success.

Solution to these problems requires constant monitoring of the organizational context and control over it. It involves analysis and identification of risks and opportunities, as well as effective change management. In the case of higher education institutions, these processes are taking place in the digital learning environment, which is a complex project containing three main components: administrative, technological and educational. Moreover, the implementation of this project is ensured by different groups of specialists.

The need to create a next-generation digital learning environment (NGDLE) or to upgrade the existing educational environments of higher education institutions to the ecosystem consisting of learning tools and other components that adhere to common standards meets the requirements of digital transformation in a broad context and is amplified by the consequences of the pandemic for higher education in general, and there is an urgent need to preserve the quality of education in Ukraine under the conditions of military operations.

The functional model that implements a modular approach in the process of creating a digital educational environment is taken as the basis of the conceptual model of a new generation digital educational environment. The use of this model, namely the distribution of resource distribution and the provision of integration of resources, data and users according to three levels (micro, meso and macro levels), allows to respond flexibly to external challenges and monitor the effectiveness of both external and internal design.

Examples of the application of the proposed NGDLE conceptual model at two universities of Ukraine can be useful both to representatives of the administration of higher education institutions and to scientific and pedagogical workers and educational analysts for the development of modern digital educational environments of a specific educational institution.

Since the future of higher education depends on the ability of its managers to foresee the process of digital transformation and manage it in the modern competitive environment, it

is the analysis and development of change management processes in the digital educational environment that can be referred to the prospects for further research.

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