Exploring modern trends in developing a digital educational environment for university: A case study of Ternopil Volodymyr Hnatiuk National Pedagogical University

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Abstract. This article delves into the contemporary tendencies shaping the development of digital educational environments in universities and proposes a model for their implementation in pedagogical institutions. The study analyzes the concept of educational environments, explores their components, and highlights the distinctive structural features. Additionally, it introduces the notion of a digital educational environment and elucidates its essential components for teachers' professional training at Ternopil Volodymyr Hnatiuk National Pedagogical University (TNPU): technological, didactic, and social aspects. Notably, the article discusses the characteristics of this environment, such as its information-rich and open nature, digital transformation, and emphasis on social practices and collaboration. To evaluate the efficacy of the digital educational environment for teachers' professional training, a comprehensive study was conducted with the participation of 432 master's students across various disciplines at TNPU. Expert assessments were employed for statistical analysis, aiming to determine the significance level of each component's indicators within the digital educational environment. The results highlight substantial changes observed in the technological and social dimensions of the university's digital educational environment, which significantly influence the quality of teachers' professional training.

Keywords: digital educational environment, teachers' professional training, pedagogical university, technological integration, social practices

1. Introduction

The key problems of the higher pedagogical school of today are the lack of manifestation of the cultural and historical context for the higher school, which sets the framework for higher education. The rapid development of educational management leads to process-oriented

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management of an educational institution and the emergence of terms such as "educational space", "educational landscape", "educational field", "educational environment".

The new educational perspective on the development of the contemporary educational environment requires the reorganization of many aspects of future teacher training.

The transition from traditional educational models to modern ones envisages a change in the organizational, cultural, institutional dimensions, management models and digital educational environment for the teachers' professional training.

Given this, there is a problem of resetting all pedagogical education, rethinking the role of pedagogical universities and other educational institutions in society, analysis of the educational environment of teachers' professional training in order to improve their quality of knowledge.

The analysis of the literary sources shows that the issues of formation of the educational environment are an important component of the training of modern specialists both in Ukraine and abroad.

The educational environment is traditionally defined as learning, which depends on various environmental factors, a set of objective external conditions, factors, social objects [18, 19, 21]. It is a system of influences and conditions of personality formation, as well as opportunities for its development, which are contained in the social and spatial-subject surroundings [12]. The educational environment is a contemporary temporal, spatial and social situation of learning, which consists of many different educational spaces of different levels, which have educational potential and interact in one way or another. In this environment, the interaction of different levels of the education system and personality happens and the corresponding cultural context is also included [27]. As a result of a detailed historical study, Spivakovsky et al. [34, 35] have determined that the most promising model for building an educational environment is a hybrid model. Glazunova and Shyshkina [10] have been confirmed these findings for the case of university cloud-based learning and research environment.

Panchenko [28] determined that modern specialists should be able not only to use, but also to model and create an educational environment.

Today, the following structural components of the educational environment are distinguished:

1. Physical environment – the room, its design, size and the spatial structure of the training classrooms.
2. Human factor – the university contingent structure, its influence on the social behaviour of students, the quality of lecturer training, etc.
3. Training program – the nature of training programs content, technologies of training, style and methods of training, forms of educational activities, the nature of control [1]. The components of the educational space are united by certain ideas and values.

The main features of the educational environments that characterize the new millennium have been determined by many researchers [6, 14, 29]. They point out that the university educational environment should include such components as the information and communication environment, the research environment, the organizational and management environment in accordance with the principles of intensity, psychological comfort and democratic possibilities of individualization of learning, openness and accessibility of information resources.

In most studies, the educational environment is described in terms of "educational institution efficiency" as a social system – emotional climate, personal well-being, features of the micro-culture, quality of the educational process. The educational environment has a significant impact on students' learning and behaviour. There is a strong link between the learning environment and value components such as students' satisfaction and success. The educational environment defines physical and mental self-feeling and motivation and promotes emotional and behavioural responses. Anderson and Day [2], Licite and Janmere [25] analysed the physical environment using three aspects: the planning and size of study rooms, ergonomics and technology, the informal environment and comfort. Describing the ideal auditorium, students noted the importance of technology and comfort role. A broader understanding of the educational environment supposes the inclusion of various communications (press, radio, television, internet resources) created by young people in their own cultural micro-environment.

The work [30] focuses on the importance of the professional environment of teachers and not only on their professional training. This point should be emphasized, because over the past few years, academic research has forced many experts to assess not only the need to increase teacher effectiveness (for example, through qualification increasing), but also to change the educational environment by improving educational institutions policies, amending laws, and supporting by communities, improving decision-making process, digitizing education that can contribute to quality change in the education sphere.

Modern digitalization means the need to create a new educational environment [11, 15]. As digital technology becomes a central part of everyday work, teachers are forced to rethink and transform previous educational traditions through technology. These problems create insurmountable requirements for universities to develop teachers' professional training strategies in the context of mastering digital pedagogy and the digital educational environment [8, 13, 16, 36].

2. Results

### 2.1. The structure of educational environment

During the research the following methods were used: analysis of scientific and methodological and technical literature in the field of educational environments, state standards of higher education. In the course of the experimental research, the methods of observation, questioning and expert assessments were applied. The questioning of the respondents was conducted according to the methodology of expert assessments, with further processing of its results using the methods of mathematical statistics.

Analysing the views of various scientists about the particularities of the educational environment [7, 26, 31], we introduce the concept of digital educational environment as a way of integrating and adopting many of its dimensions. In our study, as the concept of "digital university educational environment" we will consider systemic formation, which is a sociocultural and digital surroundings of the subject of learning, which includes technological, didactic, social components that are able to provide quality professional training for teachers.

Such subjects (involved in the process of creating educational values) as lecturers, students, undergraduates, graduate students, educational institutions, organizations, scientific centres are important in digital university educational environment for teachers' professional training.

Transformation of education is a modern stage of its informatization [9], which involves saturation of educational space with appropriate digital devices, tools, systems and electronic communication between them, which allows the interaction of virtual and physical, i.e. creates a digital educational environment [4, 5, 17].

Let us consider the components of the educational environment which were forming at the Ternopil Volodymyr Hnatiuk National Pedagogical University (TNPU) in recent years in the context of teachers' professional training (figure 1).
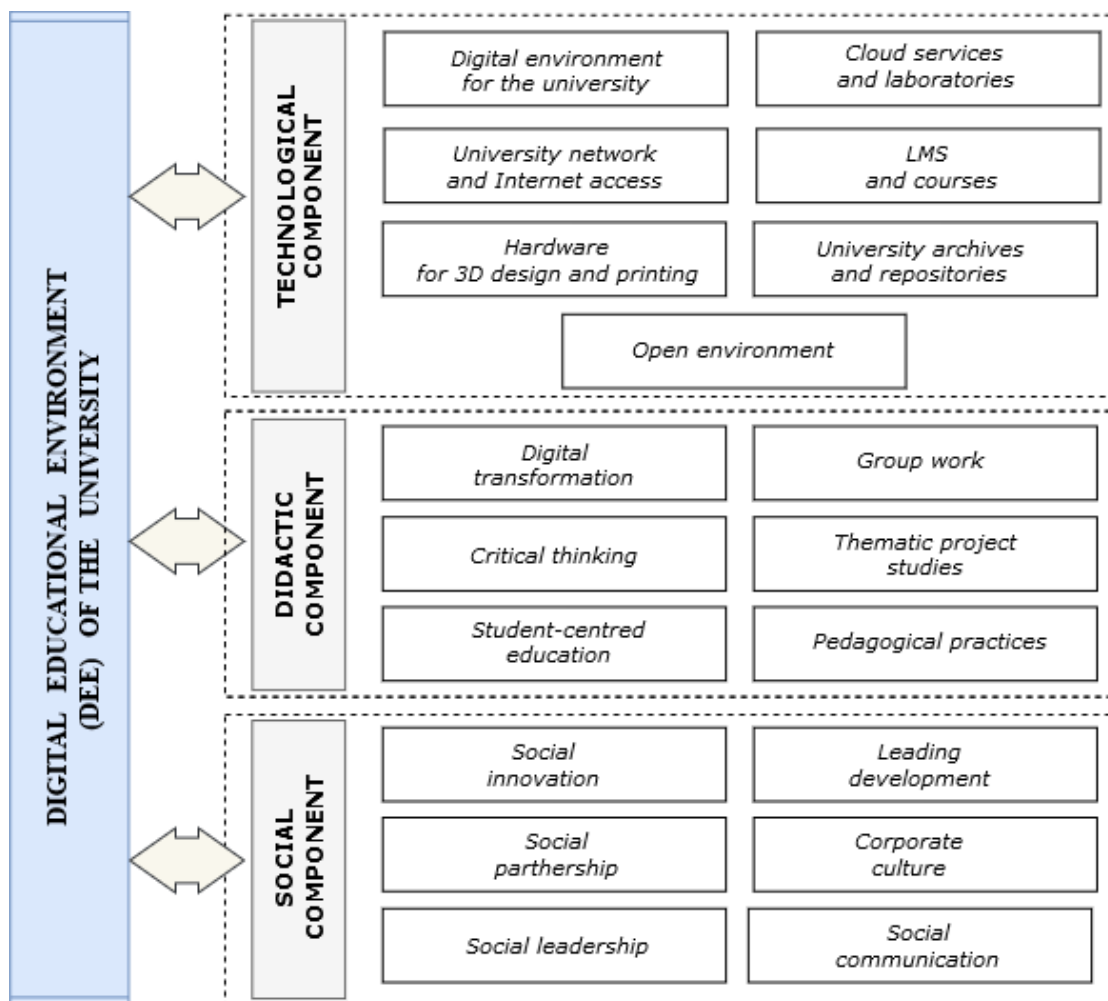
Figure 1: Transformation model of the digital educational environment (DEE) of the TNPU.

The **technological component** of the digital educational environment for teachers' professional training was provided through the creation of a digital environment for the university. The University digital environment infrastructure is a system of software, computing and telecommunications tools that implements the providing of information, computing, telecommunication resources and services to all participants in the educational process. Various tools have been

integrated into the university digital environment, which enrich the educational process. In terms of infrastructure this environment is based on the use of university LMS, cloud-based learning environment (CBLE), university digital repository, Web 2.0 services. Kuzminska et al. [20] found 4 main components that group all the factors of the digital educational environment into such areas of focus as IT infrastructure and resources' provision, students' and teachers' digital competencies, scientific and educational communication between the students, teachers, and stakeholders, and educational process organization [20].

The effectiveness of CBLE in teaching and research has been investigated and tested by Spirin, Nosenko and Iatsyshyn [32], Spirin et al. [33], Vakaliuk [37].

We consider that indicators of **technological component** development are:

1. **University network and Internet access**. TNPU provides access for students and lecturers from anywhere on campus to the resources of educational environment and the Internet. Local wired and wireless technologies have been used for this purpose. All resources are accessed using a single authentication data.

2. **Learning Management System and courses**. An advanced learning management system is functioning at the university. All subjects that are studying by students have relevant e-courses in this system. In total, more than 600 courses have been developed by lecturers. Practically all kind of students' activities are recorded in this system.

3. **Cloud services and laboratories**. Since 2012, the lecturers of Computer Sciences Department and Methodology of Its Teaching have been working on the deployment of a cloud-oriented learning environment.
   Today, it operates according to a hybrid model and integrates many services of public and private platforms. Significant computing power was required to deploy cloud infrastructure. Due to the high cost of server equipment, it was decided to use ordinary components for personal computers. As a result, a corporate cloud was designed, installed, and configured. The free Apache CloudStack platform was used to solve this problem. It provides the deployment of the corporate cloud according to the most functional model "Infrastructure as a service".
   In general, the physical infrastructure of the corporate cloud has the form shown in figure 2.
   It now operates according to a hybrid model and integrates many services of public and private platforms. CBLE provides unified, ubiquitous and secure access to file and computing resources (repositories, virtual computers, and networks). Cloud infrastructure provides management of educational resources, aggregation of computing resources, knowledge sharing services, increasing the flexibility of their use by participants in the educational environment.

4. **Hardware for 3D design and printing**. Within the frame of work of STEM-centre [3] promising technologies of 3D-modeling and 3D-printing, technologies of virtual and augmented reality, technologies of the Internet of things, robotics are being implemented at the University. These technologies ensure the execution of innovative projects through the formation of tool environments, the use of project management services. Work on educational projects (for example, a project on 3D-reconstruction and 3D-printing of the destroyed historical castles of Ternopil region) takes place inside a technologically equipped modern educational environment.
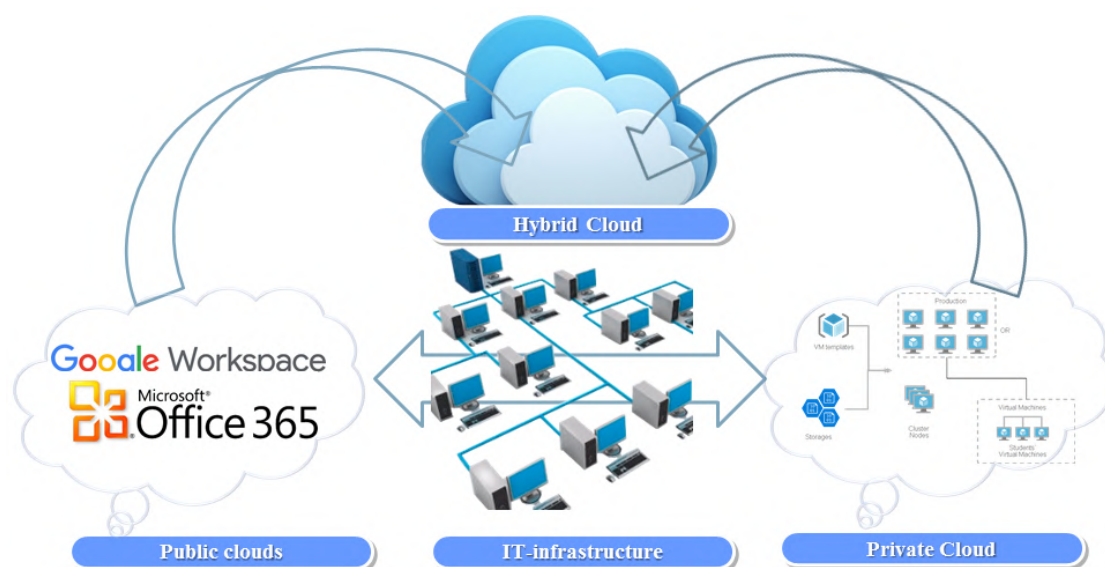
Figure 2: Scheme of the university corporate cloud.

5. **Open environment**. An open, non-formal learning environment with lecturers and students has created at the University. The traditional academic hierarchy is gradually being replaced by an approach where students are respected as junior colleagues, and their opinions are appreciated and encouraged by more experienced colleagues. Such teaching is based on modern didactic approaches such as personality-oriented and synergistic. The technological basis of open education at TNPU is modern digital technologies, in particular cloud. This approach encourages dialogue and collaboration between students and lecturers, and creates new opportunities for the development of up-to-date professional training for future teachers.

6. **University archives and repositories**. The University has implemented a system of digital archives. The TNPU Institutional Repository contains materials published by lecturers, such as: monographs, books, manuals, articles, abstracts. Some faculties have digital archives for educational purposes. In addition to the materials of lecturers, they contain the results of students' learning – materials of practices, articles of students, master's works, etc.

Among the important components of the digital educational environment of the university should be distinguished didactic, which includes the structure of students' activities, teaching style, nature of control, forms of study, the content of study programs. For example, the professorial and teaching staff of TNPU pays special attention to the modernization of educational programs in the context of the tasks of the New Ukrainian School through:

- implementation of a competency, personality-oriented approach in pedagogical education;
- formation of managerial skills for effective activity in the conditions of real autonomy of educational institutions;

- providing practical training through continuous pedagogical practice of students at different educational institutions.

In TNPU, the didactic component of the digital educational environment for future teachers' professional training is characterized by digital transformation, student-centred education; using:

- thematic project studies;
- critical thinking;
- group work;
- social practices.

Let's take a closer look at these efficiency indicators of the **didactical component** for digital educational environment:

1. **Digital transformation**. The digital transformation of the university educational environment is a series of coordinated steps and changes in the information infrastructure, in the digital culture of lecturers and students. This makes it possible to embody new educational models, including digital pedagogy, and transform the activities of the university, aiming at value propositions and strategic directions for the development of modern society.
2. **Group work**. Group work is characteristic of many university disciplines. Its purpose is for students to practice teamwork in small groups, as well as to develop problem-solving and leadership skills. Group work is an important aspect of future teacher training with aim of real professional situations modelling.
3. **Critical thinking**. Critical thinking is encouraged in all activities at the university. At seminars, workshops, laboratory work the students analyse and present solutions to problems and tasks. Theoretical concepts are tested in practical situations, and practical experience is used to develop and enrich the theory.
4. **Student-centred education**. Studying at TNPU is student-centred. There is great support from educators, lecturers play the role of facilitators, helping students understand the content of the course. The focus is on giving students the opportunity to develop their critical and analytical thinking skills, self-study, group work, problem-solving and leadership skills to prepare them for careers.
5. **Thematic project studies**. The teaching methods used in university study focus on critical analysis of course content using real cases where possible. Invited teachers and speakers from schools, local authorities, and public organizations participate in the educational program to further link research with the professional environment.
6. **Pedagogical practices**. Much of the learning process takes place outside the classroom when students apply acquired professional competencies in real-life situations while undergoing pedagogical practices. Learning technologies are partly beyond the bound of university classrooms.

Let us characterize the indicators of the effectiveness of the **social component** of digital educational environment of teacher training of the TNPU in the context of exploring ways of improving their professional development.

It is traditionally considered that university education is constructed based on the context of the surrounding reality, the cultural space and the environment in which the education takes place. Therefore, at TNPU the main indicators of the effectiveness of digital educational environment of teacher training in the social aspect are: social innovation, leading development, corporate culture, leadership, social partnership, and social communication:

1. **Social innovation**. In our opinion, the departure from the traditional functions of TNPU and the implementation of innovative ones became important for the professional development of teachers:

   - creation of conditions for the system of qualitative training and professional development of teachers through overcoming the fragmented responsibility of different educational institutions for different stages of becoming and professional development of the educator;
   - transition from "translational" education to "active" based on the implementation of digital technologies, project and competency learning technologies.

2. **Leading development**. The essence of leading-edge development lies:

   - in building curricula and learning programs in the university around cross-cutting topics relevant to a particular public community, a united territorial community;
   - in preparing graduates to organize the life of their local community in accordance with the principles of sustainable and successful development.

3. **Corporate culture**. We consider that not only structural components are the social component achievement of the digital university educational environment, but first of all – corporate culture. The key factor to the success of university education transformation projects has been the formation of a collective subject for change. The corporate culture of the university is based on a system of values that determine the philosophy of its activity, the attractiveness of the university brand in the scientific, educational and contemporary socio-cultural environment.

4. **Social leadership**. Social leadership means:

   - engraftment of innovation as a way of thinking and a key leadership tool;
   - distributed leadership in the development of new educational decisions and educational reforms,
   - formation of teachers, as educators of leaders of the new generation, integral personalities.

   The University promotes the growth of students as individuals through quality professional training of highly qualified professionals and personal growth.

5. **Social partnership**. Digital educational environment at the TNPU serves as a catalyst for a new social reality in the region. The University is an active social partner and an element of the social system. The collaboration and partnership of the university educational environment with various actors of the educational field and the public is developing. Lecturers share knowledge and experience in the educational environment, give the products of their professional and innovative activities in the public usage, participate in volunteer activities, assessments and expertise, and more.

6. **Social communication**. Communication has become a key prerequisite for the creation of new meanings, ideas and projects of the University, organization of applied research at the request of regional companies, authorities and the local community. It is important that the university is open to industry, government and other stakeholders. We believe that the greater the degree of openness of a university, the better it develops. The University successfully builds all necessary for its own existence and development of communications with other entities – authorities, manufacturing companies, civil society institutions.

The process of involving the components (technological, didactic, social) of the educational environment of TNPU in the educational process is shown in figure 3.
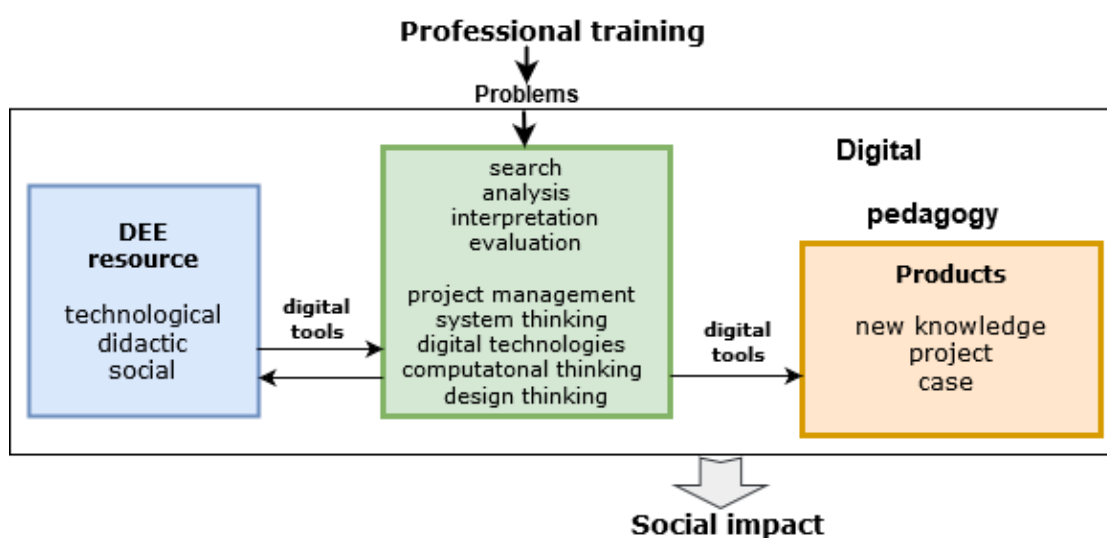
Figure 3: Teacher's training at the Pedagogical University in the context of digital pedagogy.

The basis of modern innovative teaching at the university is teaching students to solve problems. The problems that the authors propose to solve arise from the life context of a person or a local community. This can apply to any aspect of life: work, study, leisure, and so on. The authors began by encouraging students to use digital technology to solve specific problems.

To solve the problem, students must first determine its essence, use the opportunities of the digital educational environment of the university (technological, didactic, social) and the relevant digital competencies. This concerns, first of all, the ability to interpret, understand and express one's creativity through digital tools with the involvement of critical thinking. Students are guided by critical thinking and other technologies (project management, system thinking, design thinking, etc.) as a basis for meaningful and effective participation in solving problems of their community. The conscious use of digital competencies in the process of solving life's problems has an important social impact through the development of a product or solution aimed at solving a practical problem.

Digital pedagogical technologies provide new conditions for students' activities and the formation of their competencies in demand by the digital society and the digital economy.

2.2. The study on the effectiveness of educational environment design

In order to determine the effectiveness of the created digital educational environment for the teachers' professional development in 2017/2019, a study was conducted in the form of a survey among future teachers. 432 masters of all pedagogical specialties of the University participated in the survey. We viewed undergraduates as internal stakeholders.

The questionnaire suggested to assess the importance of development each component of the digital university educational environment. In each component we have identified indicators of its development (table 1).

Table 1
List of indicators for assessment of the components of the digital university educational environment.

Component of the educational environment	Cipher of indicator	The name (description) of the indicator
Technological	T1	University network and Internet access
	T2	Learning Management System and courses
	T3	Cloud services and laboratories
	T4	Open environment
	T5	Hardware for 3D design and printing
	T6	University archives and repositories
Didactic	D1	Digital transformation
	D2	Group work
	D3	Critical thinking
	D4	Student-centred education
	D5	Thematic project studies
	D6	Pedagogical practices
Social	S1	Social innovation
	S2	Leading development
	S3	Corporate culture
	S4	Social leadership
	S5	Social partnership
	S6	Social communication

In each questionnaire, we explained to the experts the value of each indicator. To determine the most significant indicators of educational environment development, we used the ranking method. It was to determine the relative importance of the objects under study based on their ordering. A scoring system for assessment was proposed for each component. In each component of the educational environment development, the experts gave points. One point was awarded to the least significant indicator and six points to the highest significant one. The results of the survey are summarized in a table, the columns of which correspond to the codes of indicators, and in rows – sequence numbers of experts (see table 2, where first column is sequence numbers of experts). The table data can be viewed in its entirety by the hyperlink: https://drive.google.com/file/d/1YHaqVE0NSVktz9GlwzqGVGy2HAK7CDWy/view?usp=sharing.

In order to prevent psychological clues that could influence the expert's choice of a certain ranking order, indicators of a certain criterion in the card were placed in alphabetical order.

Table 2
The final results of the study data processing.

	Technological						Didactic						Social					
	T1	T2	T3	T4	T5	T6	D1	D2	D3	D4	D5	D6	S1	S2	S3	S4	S5	S6
1	5	6	3	4	1	2	6	5	1	4	2	3	6	5	1	4	2	3
2	6	5	4	3	1	2	6	4	5	1	3	2	6	3	4	1	5	2
...																		
432	6	5	4	3	1	2	4	5	6	1	2	3	6	4	1	5	3	2
S_j	2394	1946	1573	1405	770	984	2368	2153	1300	1119	969	1164	2369	1682	750	1736	1593	934
d_j	882	434	61	-107	-742	-528	856	641	-212	-393	-543	-348	857	170	-762	224	81	-578
$S(d^2)$	1810798						1758963						1734814					
W	0.55445265						0.539						0.53118692					

An expert assessment method was chosen to work out the results of the survey, which was applied to each component of the university educational environment individually due to the independent ranking of indicators within each component.

The most obvious value of assessment an indicator is its total rank, which is determined by all experts ($S_j = \sum\limits_{i=1}^{m} R_{ij}$, where R_{ij} is the j-th indicator exhibited by the i-th expert, m is the number of experts).

However, such aggregate rankings will be objective if there is a certain level of agreement between the experts. The degree of such agreement is described by Kendall's coefficient of concordance W [24], which is defined as follows:

1. For each indicator, we find the difference between the totals and their average:

$$d_j = \sum_{i=1}^{m} R_{ij} - 0.5 \cdot m \cdot (n+1) \tag{1}$$

2. Find the sum of squares of values obtained from relation (1) $S(d^2)$

$$S(d^2) = \sum_{j=1}^{n} d_j^2 = \sum_{j=1}^{n} \left[\sum_{i=1}^{m} R_{ij} - 0.5 \cdot m \cdot (n+1) \right]^2 \tag{2}$$

3. The maximum value of $S(d^2)$

$$S_{max}(d^2) = \frac{1}{12} \cdot m^2 \cdot (n^3 - n)$$

is achieved if all experts rank the criteria (indicators) equally.

4. The coefficient of concordance is equal:

$$W = \frac{S(d^2)}{S_{max}(d^2)} = \frac{12 \cdot S(d^2)}{m^2 \cdot (n^3 - n)} \tag{3}$$

According to formulas (1) – (3) we find the values of the total ranks S_j, the values d_j, $S(d^2)$ and calculate the coefficient of concordance W for each component of the educational environment. The results of the calculations are presented in table 2.

This value is always between zero and one. If $W = 0$, then there is no correlation between expert rankings, if $W = 1$, then the rankings are completely the same. We get the coefficient $W = 0.55; 0.54; 0.53$ is substantially different from zero, so it can be argued that there is objective agreement between experts.

However, such a value of W is not a criterion for objectivity, since it could be obtained by accidentally setting of ranks one or the other indicators.

The value $m \cdot (n-1) \cdot W$ is distributed by the law χ^2 with $n-1$ degree of freedom. Using the ratio

$$\chi_W^2 = \frac{12 \cdot S(d^2)}{mn \cdot (n+1)}$$

we find the value of $\chi_W^2 = 1197.62; 1187.77; 1147.36$ for the relevant components of the educational environment. Comparing them with the table value for $\vartheta = n - 1 = 5$ degrees of freedom and for the significance level of $\alpha = 0.01$, we obtain $\chi_W^2 > \chi_t^2 = 15.1$. Hence, we conclude that there is consistency between experts' findings.

Consider the results of the survey regarding the importance of technological, didactic and social components of the university digital educational environment for teachers' professional development of teachers of the pedagogical university (figures 4, 5 and 6).

From the conducted study it follows that:

- of the technological component, the most important for the teachers' professional development are University network and Internet access, Learning Management System and courses, Cloud services and laboratories;
- of the didactic component most important for the teachers' professional development are Digital transformation, Group work, Critical thinking;
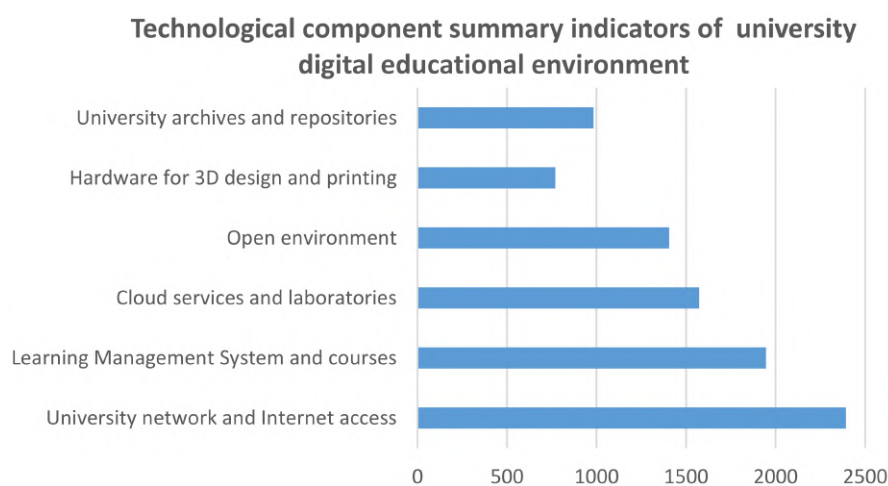
Figure 4: Study results of technological component importance of university digital educational environment in the context of teachers' professional development.
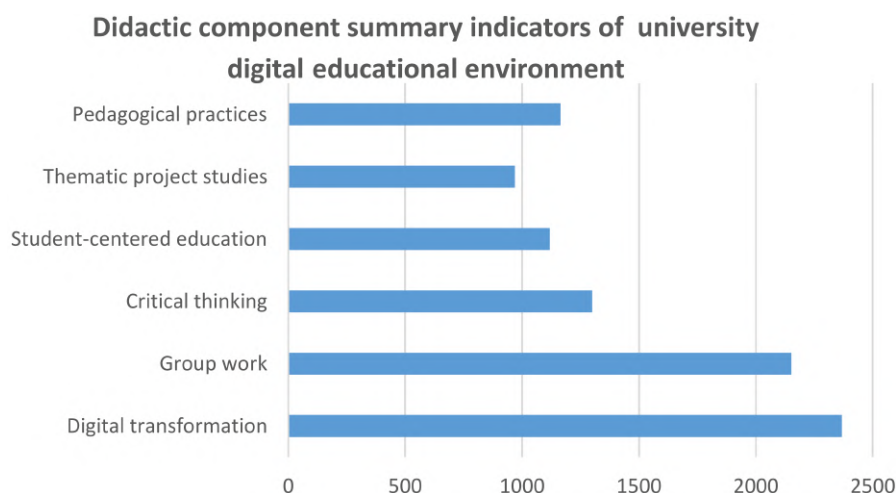
Figure 5: Study results of didactic component importance of university digital educational environment in the context of teachers' professional development.
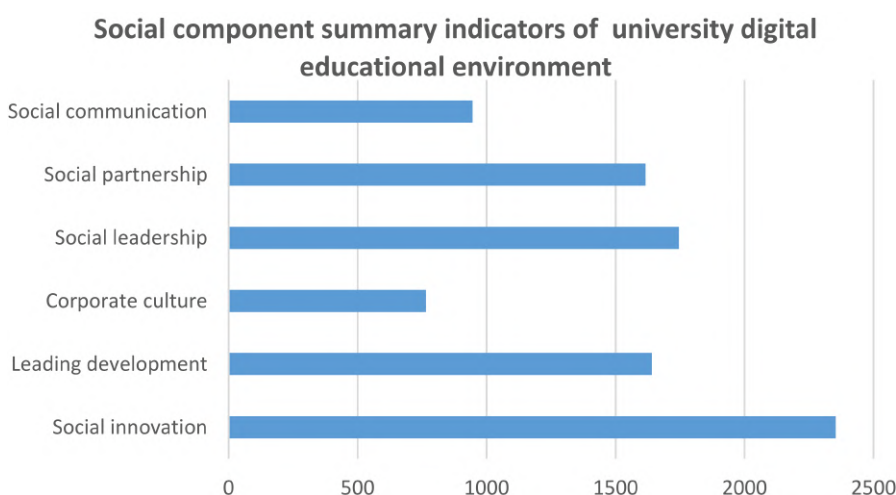
Figure 6: Study results of social component importance of university digital educational environment in the context of teachers' professional development.

- of the social component the most important for the teachers' professional development teachers are Social innovation, Social leadership, Leading development.

To determine the significance degree of each component of the educational environment, we calculated the arithmetic mean of the scores for each indicator (table 3). The indicator was considered positive if the arithmetic mean of expert estimates was at least 3.0.

The significance degree of each component was determined as follows:

- not significant enough: more than 50% of the criteria are negative;
- critically significant: 50% – 55% of the criteria are positive;
- significant enough: 56% – 75% of the criteria are positive;

Table 3
Significance degrees of the university educational environment.

	Technological component						Didactic component						Social component					
	Indicators																	
	T1	T2	T3	T4	T5	T6	D1	D2	D3	D4	D5	D6	S1	S2	S3	S4	S5	S6
Average value	5.54	4.50	3.64	3.25	1.78	2.28	5.48	4.98	3.01	2.59	2.24	2.69	5.48	3.89	1.74	4.02	3.69	2.16
%	66.7%						50.0%						66.7%					
	Degree of significance																	
	significant enough						critically significant						significant enough					

- highly significant: 76% − 100% of the criteria are positive.

From the conducted study it follows that at the TNPU over the past three years, according to the view of undergraduates, technological and social components of the digital educational environment have become crucial for teachers' professional development.

We tried to investigate the specifics of the distribution of grades depending on the specialty (educational, scientific achievements) of masters.

To do this, we used the Kendall package from the language R. In our table, we added a column group, which tracks the affiliation of students to one of the groups such as:

1 – undergraduates majoring in computer science

2 – masters of natural or technical specialties (physics, mathematics, labor training)

3 – masters of humanities or arts

Function *kendall.global* from R computes and tests the coefficient of concordance among several group of judges through a permutation test. We used it to identify significant group associations.

Here is a fragment of the function *kendall.global* call as follows:

kendall.global(transpose(cr1), group = transpose(groups))

Vector *cr1* contains columns T1-T6 from the data frame. They correspond to the Technological component of the model. The *group* vector contains the numbers 1, 2, 3. They are responsible for grouping. To comply with the syntax of the function, we transposed these vectors using the *transpose()* function.

The results of calculating the concordance coefficients for all three components are shown at table 4.

The result of the function contains the following data:

- W – Kendall's coefficient of concordance;
- χ^2 – Friedman's χ^2 statistic used in the permutation test of W.

To analyze the obtained concordance coefficients, we use the following interpretation of the distribution W [22, 23]:

- 0.01−0.20 – poor agreement;

Table 4
Concordance analysis for 3 groups.

Statistical indicator	Group.1	Group.2	Group.3
	Technological component		
W	0.6609843	0.4683366	0.5467262
χ^2	475.9087	337.2024	393.6429
	Didactic component		
W	0.5636905	0.5701720	0.5272652
χ^2	405.8571	410.5238	379.6310
	Social component		
W	0.5811287	0.5189649	0.5101356
χ^2	418.4127	373.6548	367.2976

- 0.21−0.40 − fair agreement;
- 0.41−0.60 − moderate agreement;
- 0.61−0.80 − good agreement;
- 0.81−1.00 − very good agreement.

Based on the data from table 4, we can draw the following conclusions.

In all three groups for Didactic and Social components, the concordance coefficient W is in the range of 0.41 to 0.60, which corresponds to the mediocre consistency of estimates within each group of experts for Didactic and Social components. Our groups of experts differ little in terms of their readiness to use digital technologies in their learning and future professional activities, but their specialties and orientation of vocational education programs are somewhat different in terms of their ability to assess Didactic and Social components according to relevant criteria. This explains the fact that the concordance coefficients W for all three groups are mediocre.

If we consider the concordance coefficient W for the Technological component, it corresponds good agreement for group 1. This is not surprising, because experts of group 1 (undergraduates majoring in computer science) are able not only to use digital technologies, but also to develop them. Therefore, they are able to assess the Technological component of the digital educational environment of the university according to the relevant criteria more unanimously and more professionally. For groups 2 and 3, the concordance coefficient W for the Technological component is within the same limits as the coefficient W for all groups in Didactic and Social components.

In the RStudio environment using the function *qchisq (p = 0.95, df = 5)* we found the critical value $\chi^2_{cr} = 11.0705$ for degrees of freedom and for the significance level of $\alpha = 0.05$, which corresponds to the value obtained from other sources. As can be seen from table 4, the values of χ^2 calculated by the *kendall.global()* function for all three groups and for each component of the digital educational environment of the university are in the range from 337 to 476, which are significantly higher than χ^2_{cr}. This indicates the consistency of expert assessments within each group at the appropriate significance level.

3. Conclusions

An analysis of the literature indicates that the term "educational environment" has no unambiguous interpretation. The study proposes to define the design of the digital educational environment as a systemic formation, which includes technological, didactic, social components that are able to provide quality professional training for teachers.

It should be noted that the design features of the modern digital educational environment of the TNPU are: openness and information saturation, student-centred education, thematic project studies, social practices, a harmonious blend of pedagogy and digital technology and, as a result, the digital transformation of the entire educational environment.

To identify the effectiveness of the created design of the university educational environment for the teachers' professional development the components of their formation and their corresponding indicators were determined. In the process of research, the undergraduates noted that the greatest influence on their professional development has social (Social innovation, Social leadership and Leading development) and technological component of the digital educational environment (University network and Internet access, Learning Management System and courses, Cloud services and laboratories).

Thus, the activities in the digital educational environment of the university are aimed at the professional development of the individual and the creation of conditions for the socialization of students on the basis of social and cultural values accepted in society.

We consider that in the development of educational environment design of pedagogical university promising directions are such as:

- developing educational strategies and monitoring their implementation and effectiveness;
- realization by the university of its socially transformative role – social and humanitarian innovations, humanitarian paradigm of education;
- organizing effective interaction between the university and external players in order to attract investments to create quality conditions for learning and nurturing successful and competitive human capital.

The perspectives of further research are in experimental testing the created digital educational environment by other internal and external stakeholders like as lecturers, teachers, developers, IT-managers etc.

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