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Educational and technological conditions as a factor of university environment development

Most universities in our country are multifunctional complexes solving the task of improving the quality of higher education. This task is one of the highest priorities at the present time. One of the conditions for solving this problem is creation of a special educational environment. Such environment provides training for specialists not only today, but also in the near future. A modern university is a unique form of organization and development of the educational environment, which increases the effectiveness of educational spaces, promotes the unification of education, science, research, innovative technologies and business, integrated with the city and industry, increasing regional attractiveness. The higher education practical importance and the value of interuniversity cooperation and partnership with leading specialized companies is increasing. This explains the significant attention and assistance to the Russian higher education system rapid transformation by the state and regional authorities in recent years. However, changes are also taking place within the university. New educational technologies are emerging at universities, the educational environment is changing, the material and technical base is being updated, education itself is becoming more flexible and adaptive, and the importance of cross-disciplinary links is increasing. At the same time, the same external environment requires universities to be more resilient and have a more developed infrastructure. The university has to become a multifunctional environment combining education, scientific activity, innovation and culture. For this reason, the material space should meet clear functional and technological requirements for the processes that will unfold and develop within the university and on its territory, in accordance with the adopted functional model of the entire educational complex, as well as be able to adapt to changes. How and with the help of what tools can these tasks be solved at the current level of development of higher education, architecture, construction?
Keywords: *educational environment, educational technologies, material and spatial environment, register of requirements, regulatory and technical documents, regulatory and legal documents, functional and technological requirements*

INTRODUCTION

In the conditions of post-industrial society, the approach to the organization of the educational process is changing. The new concept of education (Education 3.0) implies the integration of traditional and digital technologies in creating the educational environment and organizing the educational process. Modern education increasingly acquires the characteristics of Education 3.0, namely, personality-oriented education based on web technologies. Proficient use of modern computing devices allows students to largely independently shape their educational environment, thereby introducing elements of the concept into their professional training [1].

The concept of "educational environment" itself is becoming more complex — it is being technologized, i.e. the introduction of modern learning and development technologies; all subjects of educational activity and external partners interact in the conditions of informatization, other effective organizational and technological mechanisms and tools for this interaction are being built. Educational activities are always at the center of attention of the state [2]. It requires organized efforts to create conditions of comfort and safety for educational processes based on the effective use of budgetary funds. And the value of the educational space as a social system acquires greater significance in the conditions of generating new development goals [3]. The need for such changes logically follows from the processes taking place in society and the economy. The Fourth Industrial Revolution requires specialists to acquire competencies corresponding to the demands of the digital economy [4].

The concept of technological development of the Russian Federation until 2030 defines structural changes in education and science as a challenge of technological development[1]. At the same time, involvement in innovative scientific and technical projects of a wider audience raises questions about the proper distribution of resources and the availability of prospective groups of future innovators[2]. Since technological sovereignty in the field of critical and cross-cutting technologies is seen as the benchmark of technological development, preference is given, first of all, to natural science and engineering disciplines in training the personnel reserve. Unfortunately, at the moment, only 9 % of students engage in science, participate in startup accelerators and acquire digital competencies[3]. In addition, the ability to engage in scientific and

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1 Concept of technological development of the Russian Federation. URL: http://static.government.ru/media/files/KlJ6A00A1K5 t8Aw93NfRG6P8OlbBp18F.pdf

2 Report "University campuses and the city: cooperation for the sake of competitiveness". Center for Strategic Research (CSR). University 2035. VEB.RF. URL: https://www.csr.ru/upload/iblock/3f0/kbpm276p3tau6knlzdla3d6ozz0fve0e.pdf

The collection of statistics according to the data of the Short statistical collection Education in numbers 2022, Ministry of Education, Ministry of Lighting, FSSS, HSE, monitoring of the Russian Technological University. URL: https://monitoring.miccedu.ru/?m=vpo, statistics. "Employment of graduates in the field of study", HSE, Moscow Power Engineering Institute, Statistics ANO NTI Platform. URL: https://platform.nti.work /?ysclid=lshdkaf0pj477649224. Materials of the University 2035 website. URL: https://www.2035.university/

scientific-technical creativity is not common: the so-called scientific and technological elite is a small stratum of specialists capable of implementing innovative and scientific projects. In order for it to appear in the country, it requires revision of educational and scientific trajectories in universities, popularization of science, as well as appropriate educational, material and spatial environment[4].

THE UNIVERSITY CAMPUS AND ITS MATERIAL-SPATIAL ENVIRONMENT

The university campus and its material-spatial environment serve as a vivid example of the complex environment of higher education. It is an organized set of multifunctional objects performing educational, research, innovative, social, and service functions, unified by infrastructural development issues and a common model of interaction with the territory of presence[2].

The concept of "campus" correlates with the concept of an educational or educational-technological environment, which is defined as "a set of organizational and pedagogical conditions related to the processes of designing and deploying clearly defined algorithms and mechanisms of continuous development and self-development of all participants in the educational process, as well as the educational organization as a whole as an object of study and practice, assuming a complex substantive, technological, organizational-practical, and managerial structure" [3]. At the same time, the educational environment is not a stable system even for a period, as its transformations are associated with the constant search for and implementation of new technologies and methods of organizing the educational process in practice. If initially it was supposed to be favourable or well appointed, providing external and internal conditions for achieving the goals of the educational process, then now it is defined as a set of opportunities for personal development arising from interaction with its social and spatial-object environment [5]. In previous publications, the authors also proposed a definition of the educational environment as a systematically formed space in which interaction of the subjects of the educational process with the external and internal environment (architectural space) takes place, as a result of which the individual characteristics of the student's personality are revealed and enable him to receive a good education in conditions of fairly free choice of an individual educational trajectory. Thus, we see the educational environment of the university as a complexly organized system, depending on many factors, a significant part of which is of a material-spatial nature. It would be reasonable to assume that the corresponding material-spatial environment (hereinafter MSE) of the university transitions from additional conditions to basic requirements for ensuring the educational process.

The elements of the material component of the educational environment, which includes the educational process, are the building itself, its spaces, structures and design of premises, engineering systems and equipment providing internal microclimate, low-current networks, functional and technological equipment.

Most accurately, according to the authors, the definition of "elementary" MSE with one function is revealed by the following definition: a material environment limited by the boundaries of the space with content (including equipment, facilities, structures and decoration), providing the necessary and sufficient conditions for the implementation of the activity (function) envisaged by the educational technology in this space.

To be fair, there is a lack of research on the impact of MSE on learners. Until now, the importance of material factors for enhancing the effectiveness of the educational process has been described from an economic perspective, taking into account ergonomic principles[5]. Changes in forms and technologies of learning, roles of participants in the educational process, are likely to change perceptions of space, functional zoning, and equipment of universities. Modern educational technologies are very diverse and significantly differ from each other in terms of MSE requirements. Among them, we can highlight: distance learning, the use of AR and VR technologies, STEM education (Science, Technology, Engineering, Mathematics), blended learning, mobile and flexible learning, work in virtual educational laboratories, hybrid interaction formats, project-based learning (involving students in practical and research tasks both within and outside the university), and others. Also gaining momentum is advance training – accelerated professional education, one of the approaches to which assumes that "the number of highly qualified workers prepared should exceed the existing demand for them in order to form the educational-professional potential of society"[6]. More startup incubators are emerging (an association that provides young entrepreneurs with infrastructure, educational programmes, expert support to develop and successfully launch their startups)[7]. At the same time, we cannot forget about research activity. Considering the current demand for the implementation of scientific and innovative activities at the university, factors capable of influencing personal development and increasing the effectiveness of intellectual activity gain additional weight. Thus, the MSE should meet all the needs and possibilities of the participants in the educational process, be technological, transformable, interactive, and multifunctional.

EDUCATIONAL AND TECHNOLOGICAL CONDITIONS OF THE UNIVERSITY

As already reflected, the modernization of higher education, the implementation of adaptive, practice-oriented educational programmes requires flexibility and multifunctionality from the educational environment, and the introduction of new educational methods necessitates the reorganization of existing spaces and the creation of new ones. One of the obstacles on this path is the lack of mechanisms and rules for determining, forecasting, and describing the properties and parameters of the created MSE of the university or even the entire campus. This is especially relevant considering that this environment will provide conditions for positive changes in the field of science and higher education, the profile development of regions, and the country as a whole[8].

On the one hand, the properties and parameters of the environment largely depend on the functional and technological content, which is most relevant for inter-university campuses, while on the other hand, they determine architectural, construction, engineering, technological, and other requirements. Some of these requirements may have a functional and technological character, while others may be normative-technical or even regulatory-legal.

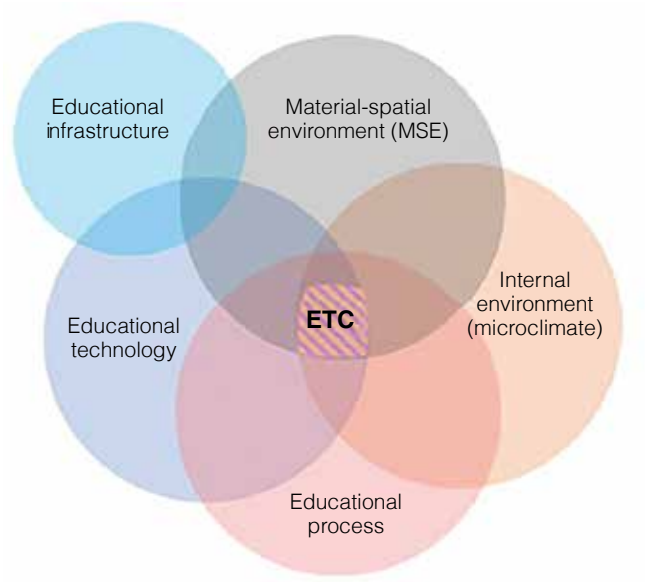
4 Sergeev A.M. Science should be! Moscow International Salon of Education 06.10.2021. URL: https://scientificrussia.ru/articles/mmso-prezident-ran-a-sergeev-nauke-byt

5 Solovyova E.A. The study of the role of the subject-spatial component in the formation of the educational environment of the university. Psychological Sciences. 2005; 83-95. URL: https://cyberleninka.ru/article/n/issledovanie-roli-predmetno-prostranstvennogo-komponenta-v-formirovanii-obrazovatelnoy-sredy-vuza/viewer

6 Blinov V.I., Satdykov A.I., Osadcheva S.A., Krasovsky N.A. Advanced vocational training: formation of system-forming components. DOI: 10.22394/2078-838X-2020-4-84-93. URL: https://edpolicy.ranepa.ru/core-components

7 Materials of the MIPT Startup Studio website. URL: https://ssmipt.ru/

8 The concept of technological development for the period up to 2030. URL: http://government.ru/docs/48570/



ETC formation scheme

These requirements regulate the parameters of the MSE provided at the stage of designing a new, reconstructed, or renovated university building. Regulation of compliance with these requirements is carried out during construction and installation or repair-restoration works. Regulation of maintaining these requirements is carried out during the operation of buildings. The solution to this problem proposed by the authors may be the formation of a new type of multicollinear conditions and requirements based on the relationship between the parameters of the implemented educational (scientific-educational, educational-research) activities and the parameters of the MSE. Multicollinearity is determined by mutual influence: educational activities determine the conditions and requirements for the MSE, while the latter, in turn, determines the requirements and restrictions for the implemented educational activities.

In accordance with the conditions described above, the authors propose to call them Educational-Technological Conditions (hereinafter ETC). They may include a set of properties and features of the building, its structures, engineering systems, and technological equipment that determine the ability to satisfy the need for physical space corresponding to the conditions of educational activities. It is absolutely true that ETC can only be defined and modeled by the university as the functional customer. ETC can be most vividly represented in the following two examples.

1. In full compliance with the prepared ETC by the university, designers develop project documentation for the construction of a new building or for reconstruction with adaptation of an existing building. This case is analogous to the development of a technological project in industrial construction.

2. As part of the development of a project for the overhaul of a university building, the selection of educational processes and technologies that can be built into certain spaces of the building is made on the basis of ETC.

From a qualitative point of view, ETC represents a system of engineering parameters — measures of an effective, safe, and comfortable educational environment. However, ETC does not aim to replace normative-technical, regulatory-legal, or sanitary-hygienic requirements. It can be reasonably assumed that ETC may in the future complement the task of developing project cost estimates for construction, reconstruction, or major repairs of buildings.

Figure shows the scheme of forming ETC, which, as noted above, reflects the mutual correspondence of the MSE, educational infrastructure, represented, for example, by laboratory or educational equipment, applied educational technologies, and regulated indoor environment, i.e., microclimate of various functional zones. It should be noted that in the presented scheme, educational infrastructure participates in determining ETC indirectly, as they are part of the MSE. From the scheme, it is evident that the degree of mutual correspondence of elements of the educational environment, expressed through ETC, corresponds to the area of the intersection zone of the elements.

The proposed methodology for applying ETC fully corresponds to the ongoing transformation in the construction industry, associated with the transition to a registry-based principle and a system of parametric regulation, and in the future will allow for the initiation of the formation of a digital model of university facilities, including those within campuses, already at the pre-design stage.

PRINCIPLES OF APPLYING EDUCATIONAL AND TECHNOLOGICAL CONDITIONS

Since the mechanism of ETC is only being proposed to the professional community, it is difficult to outline its clear goals, objectives, and areas of application. However, general principles of application can already be formulated, including:

- ETC can be applied in describing any zone with one or more interconnected functions;
- ETC can define functions that are either rigidly fixed or transformable over time;
- ETC can have different levels of detail and depth of content;
- ETC should adequately reflect operational, functional, and technological requirements for zones;
- ETC should include requirements for the location of zones in the complex, determined by their functional-technological purpose;
- ETC should contain information on the number of people from all groups present in the zones;
- ETC should include requirements for providing access for people with reduced mobility;
- ETC should include requirements for equipping zones with workstations (including automated, high-tech ones);
- ETC should incorporate data on hazardous technological processes;
- ETC should have the ability to integrate into the existing functional model of the university, and so on.

A promising direction for the development of ETC is seen in defining and considering parameters that contribute to improving the psychological state of learners, regulating and enhancing the efficiency of processes and communications between functional zones, and fully integrating scientific-production functions.

CONCLUSION

Today, there is a rapid transformation of the Russian higher education system. Adaptability and resilience have become the main directions of university infrastructure development. Completely new educational methods and techniques are emerging, universities are increasingly integrating into urban environments, and the value of inter-university cooperation and partnership with leading profile companies is increasing[9]. However, there is no single methodology for forming functional and technological requirements for the space of higher education institutions, especially university campuses.

9 The main activities of the Government of the Russian Federation for the period up to 2024. URL: ne0vGNJUk9SQjlGNNsXIX2d2CpCho9qS.pdf (government.ru)

The nearest requirements contained in regulatory-technical documents regulate individual issues of building microclimate and the placement of basic technological equipment. Therefore, the tasks of building a general functional model of the university and forming a set of requirements for each functional zone at the stages of design, construction, and operation fall on the educational institution itself. The proposed mechanism for using ETC can be a helpful tool for universities in their development, especially in collaboration with designers, contractors, and operating organization.

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Образовательно-технологические условия как фактор развития университетской среды

Большинство университетов нашей страны являются сложными многофункциональными комплексами, решающими задачу повышения качества высшего образования, которая является одной из самых приоритетных на данный момент. Одно из условий решения этой задачи — создание специальной образовательной среды, обеспечивающей подготовку специалистов не только сегодня, но и в обозримом будущем. Современный университет — это уникальная форма организации и развития образовательной среды, которая повышает эффективность образовательных пространств, способствует объединению образования, науки, исследований, инновационных технологий и бизнеса, интегрированная с городом и отраслью, повышающая региональную привлекательность. Значительное внимание и содействие процессу стремительной трансформации системы российского высшего образования со стороны государства и региональных властей в последние годы обусловлено повышением практической значимости высшего образования, ценности межвузовской кооперации и партнерства с ведущими профильными компаниями. Но изменения происходят и внутри университета: появляются новые образовательные технологии, меняется образовательная среда, обновляется материально-техническая база, само образование становится более гибким и адаптивным, повышается значимость кросс-дисциплинарных связей. При этом та же внешняя среда требует от университетов большей устойчивости, более развитой инфраструктуры и многофункциональности, чтобы объединить образование, научную деятельность, инновации и культуру. По этой причине материальное пространство должно отвечать четким функционально-технологическим требованиям к процессам, которые будут разворачиваться и развиваться внутри университета и на его территории в соответствии с принятой функциональной моделью всего учебного комплекса, а также иметь возможность адаптироваться к изменениям. Как и с помощью каких инструментов могут быть решены эти задачи на современном уровне развития высшего образования, архитектуры, строительства?

Ключевые слова: *образовательная среда, образовательные технологии, материально-пространственная среда, реестр требований, нормативно-технические документы, нормативно-правовые документы, функционально-технологические требования*

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