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DIGITAL REFORM OF HIGHER EDUCATION: IMPLEMENTATION EXPERIENCE

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Abstract. The study examines the existing experience in implementing digital reform in higher educational system, and outlines the prospects for its further development. The philosophical and pedagogical issues of different approaches to implementing educational trajectories and customized lifelong educational routes are tackled and substantiated. The main aim of underpinning the existing steps of implementing the reform is proved to be the advancement of student self-development. The practical significance of the research lies in the attempts of designing a matrix of competencies underpinning the possibility of building up individual educational routes. The main results comprise the introduction of 16 main industries of higher education for the future. Further development of this topic is seen in the study of the interdisciplinary and cultural aspects of interaction in the educational process, implemented in digital management of the stated industries, such as Industry of Cognition, Industry of Thinking and Design, Industry of Health Preservation, Industry of Knowledge, Neuro Industry, Industry of Management, Industry of Law, Industry of Culture, Industry of Hospitality, Industry of Territories, Industry of High Technologies, Industry of Logistics, Industry of Production Systems, Industry of Resource Conservation and Efficiency, Industry of Research, Industry of Transfer, Industry of Social Initiatives.

Keywords: digital reform; higher education; development prospects; digitalization; quality of education; digital quality management; industry of knowledge; customized lifelong educational route; educational trajectory; customized educational programmes; educational process; design of educational standards.

ЦИФРОВАЯ РЕФОРМА ВЫСШЕГО ОБРАЗОВАНИЯ: ОПЫТ РЕАЛИЗАЦИИ

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Аннотация. В статье исследуется имеющийся опыт внедрения цифровой реформы в систему высшего образования и намечаются перспективы ее дальнейшего развития. Обоснованы философские и педагогические вопросы использования различных подходов к реализации кастомизированных жизненно-образовательных маршрутов и индивидуальных образовательных траекторий обучающихся. Доказано, что основной целью подкрепления существующих шагов по реализации цифровой реформы высшего образования является содействие саморазвитию студентов. Практическая значимость исследования заключается в попытках построения матрицы компетенций, лежащих в основе стратегий построения индивидуальных образовательных маршрутов обучающихся. Основные результаты связаны перспективным реинжинирингом образовательных и научно-образовательных структур организаций высшего образования и формированием полипредметных полей и каскадов 16 основных научно-образовательных индустрий высшего образования будущего. Дальнейшее развитие данного исследования видится в изучении междисциплинарных и межкультурных аспектов взаимодействия всех субъектов образовательной среды, реализуемых в цифровом управлении указанных научно-образовательных индустрий: индустрии знаний, индустрии мышления и дизайна, индустрии здоровьесбережения, нейроиндустрии, индустрии управления, индустрии права, индустрии культуры, индустрии гостеприимства, индустрии территорий, индустрии высоких технологий, индустрии логистик, индустрии производственных систем, индустрии ресурсосбережения, индустрии исследований, индустрии трансфера, индустрии социальных инициатив.

Ключевые слова: цифровая реформа; высшее образование; перспективы развития высшего образования; цифровизация; качество образования; цифровое управление качеством образования; индустрия знаний; кастомизированный жизненно-образовательный маршрут; индивидуальные образовательные программы; индивидуальные маршруты; учебный процесс; разработка образовательных стандартов.

Introduction

The process of digitalization of our life today sets out new guidelines for the education system, which must instantly respond to the challenges of the time posed by the digital economy. The wider the range of interaction is, the more information is received and processed with the help of various gadgets, the more valuable individual personality becomes, the higher are the stakes on the advanced development. Researchers from all over the world are discussing issues for solving various types of tasks that reveal the specifics of interaction, impact, and human reaction to the digital space [1–7]. It has been widely accepted that with all the shortcomings of the digital space in the context of the lack of communicative cultural awareness, axiological values and conceptual orientations, there are significant advantages of it. First of all, they are associated with a considerable fastening of routine processes, allowing us to free up time and save it for the individual development and advancement in vital activities during the life course. The digital space has a consolidating power that ensures joint actions of people, their activity in making common decisions, taking com-

mon responsibility and, most importantly, achieving a collective result, taking into account a large number of opinions and judgments. Another advantage of the digital space is the creation [8–15] of conditions for self-improvement, comprising the processes of self-organization, self-management and self-development. The identified issues and problems will be relevant for quite a long time, since they affect one of the main priorities of modern education, being the preadaptation and adaptability enhancement for students and their upward individual development.

The situation that exists today at the universities of the Russian Federation with the construction of individual educational routes that contribute to more effective adaptation of the student has been broadly and structurally described by V.V. Gamukin [16]. The author rightly observes that «most of the steps» in designing an individual educational route «require not a humanitarian approach, when you may choose what you like, but an engineering one, which implies that you should choose what you need to achieve the result». Also, the author identifies significant problems not only with the implementation of individual educational routes, but also with their theoretical understanding.

Materials and methods of research

Finding a solution to rather complex challenges of real construction of an individual educational route in a digital space was carried out using the methods of dialectics (theoretical understanding of the interaction of a student and digital environment), synergetics (perception of the essence of a large number of emerging interaction scenarios and their self-organization), modeling (construction of a process, its stages and functionality of each stage), predicting the expected results (the formation of conceptual categories and qualities of designing an individual route).

Research results

The experimental research began in 2009. It was carried out in four stages and was based on the principles of openness, flexibility, focus on advanced development, and «corporate» individualization. The functional model of building an individual educational route was designed by the authors on the basis of a theoretical understanding of the concept and its essence, presented in the research paper.

The first stage was associated with restructuring of the design of educational programmes of higher education in terms of providing sufficiently large freedom for students in the choice of courses, modules and other elements of the educational programme. We have created a matrix of competencies for the graduate of each field of study at the university (table 1). The matrix served as a guideline for determining the «necessity» for certain content components (courses, modules) being included in the educational programme. The design of this matrix was carried out in conjunction with leading employers in the field of study, who determined not only the rating of the prospective graduate's competencies being in demand in the labor market, but also gave recommendations on creating the content for the practical part of the educational programme. In order for the students to determine the process of understanding the results of their own «customized» education, the matrix was widely discussed at seminars and workshops.

Table 1 – The designed matrix of competencies

Competencies of the educational programme	Year 1 (modules)	Year 2 (modules)	Individual achievements	Ranking (level of achievement)
Competence 1				
Competence 2				
Competence 3				
Competence 4				
Competence 5				

As a result of the work undertaken, we faced a rather difficult problem in the ability and desire to make a choice. While articulating their demands and interests, setting the rating of competencies achievement, the student is faced with the need to make decisions on this choice, which significantly complicates it. Fig. 1 shows the synergetic essence of the choice process, which highlights a complex scheme for constructing and designing an educational programme, taking into account the individual choice of courses and modules by students.

The second stage of our research, being the development of a digital platform, was aimed at significantly multifaceted and diverse work on organizing the student's choice of courses, monitoring their development and taking into account the results of the implementation of the individual curriculum. The digital services of the platform were supposed to provide conditions for the implementation of a large number of processes. The latter include:

1. Diagnostics of educational and personal achievements of students with the construction of educational and extracurricular rankings.

2. Support for the organization and management of the educational process with drawing up a schedule grid, conducting online and offline lectures, conferences, seminars, regulating the teaching load; selection of classrooms and premises for independent work of students, laboratories for scientific and research work; formation of groups and streams of students for project work and mass lectures.

3. Control of the achievement of competencies in order to create an individual student portfolio to reflect not only educational results (academic performance in courses, modules, practices), but also personal achievements in research, cultural, educational, volunteer and Physical Education activities.

4. Management of interactions of all actors (being subjects of activity) of the educational process in various schemes: *student – teacher*; *student – teacher – employer*; *student – employer*; *student – student*; *a group of students – a group of teachers*, etc.; management of the choice by students, teachers and employers.

The implementation of the listed processes took place on the specifically designed platform called «Spectrum», constructed with the help of artificial intelligence technologies, which made it possible to:

– organize the receipt, processing and presentation of a large amount of data (testing and assessment for each stage of the achievement of competencies, final assessments, teaching materials, etc.);

– adapt the educational process to the needs and individual characteristics of the student (setting the mode of learning, time for completing assignments, deadlines, choosing the types and forms of assessment tools, forms of conducting individual classes, etc.).

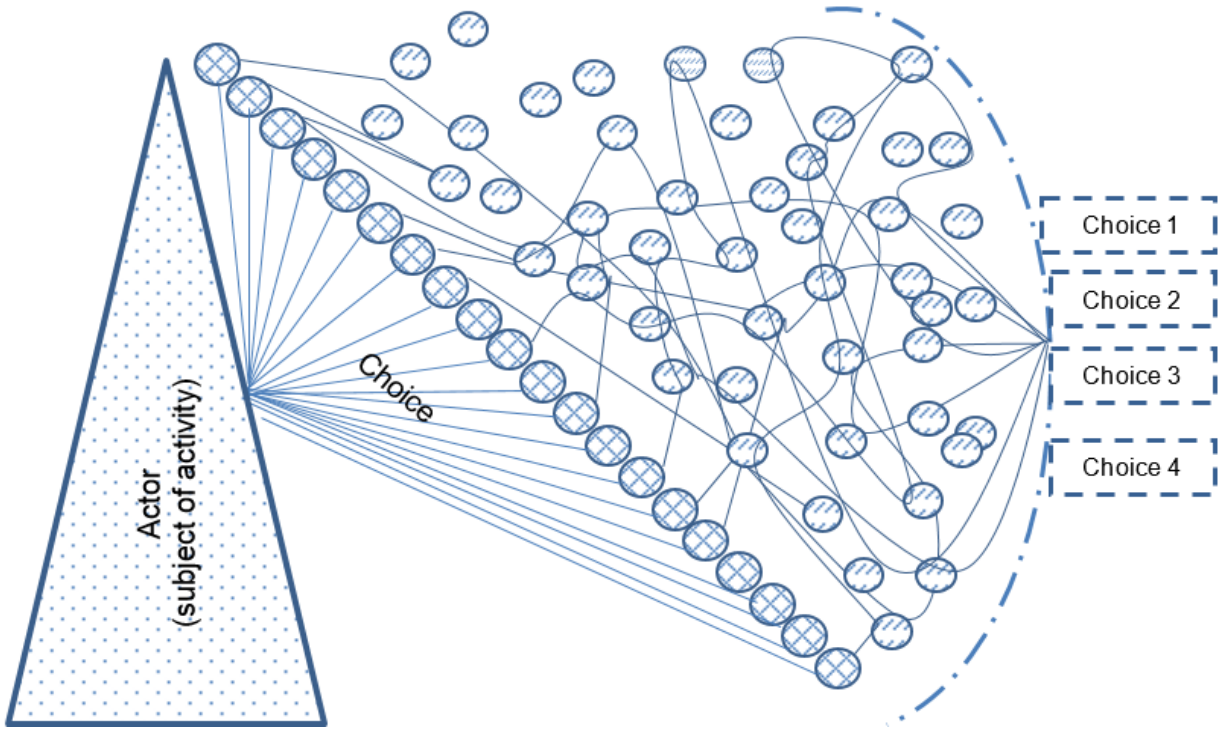

Figure 1 – The synergetic essence of the process of choice

The next stage of the research was a complete reconstruction of the educational process, taking into account the available software and with the aim of designing and implementing a customized educational itinerary for the student. At this stage, the tasks related to rethinking the functional roles of the teaching staff were solved; organization of educational and personal spaces of the university «without walls»; creation of a model of advanced individual development of both the student and the teacher; creation of new consolidated fields of knowledge as industries that allow the student to specify and develop their abilities as well as their intellectual and individual potential.

The teacher, along with the student, is the main actor (subject of activity) in the educational process at the university. In the context of digital transformation and a change in leading approaches to the educational process towards real individualization, the teaching staff faced many problems. Having studied and generalized them, we identified several types: 1) lack of time for educational, methodological and scientific activities; 2) digital gap between teachers and students in the level of IT competencies; 3) personal characteristics associated with the laboriousness of adaptation processes to «changes» in professional activity (psychological and psychophysiological antagonisms of transformation processes).

These problems were solved by us by switching to the actor-network model of management of pedagogical activity and highlighting the role of the teacher as the «bearer of the content» in the programme, the moderator as a methodological construct to determine the individual characteristics of each student in advanced ascending development, the tutor as an «assistant» to the student in the passage of a customized life-long educational itinerary. The proposed «human resources scheme» was introduced by us quite recently in 2019, but it already shows efficiency in terms of solving the problems of freeing up the teacher's time for research activities, the possibility of continuous professional development in the chosen field of study, in relation to IT competencies, and in possession of modern teaching methods and techniques (benchmarking, case studies, STEAM-practices, etc.). The range of activities of a moderator and a tutor is aimed at tackling the following challenges, which are extremely important for the implementation of a customized life-long educational itinerary of a student, related to: jointly setting a personal learning goal with a student and determining individual educational results for each individual; a clear understanding of the purpose of each structural unit of the educational programme and its conceptual content; scaling educational practices and pedagogical methods and techniques that provide real individualization of education.

Discussion of the results

A customized educational itinerary also involves «erasing» the boundaries of the educational and living space of each student. To achieve this, we made an attempt to completely change not only the content of education, the form of its implementation, human resources environment, but also the «landscape» of the educational environment within the walls of the university. We will not dwell on the features and specifics of creating open educational spaces, but we will say that they provide the construction and implementation of a customized educational itinerary with conditions for project work, «logistic» educational activities, scientific research and socially significant experiments. Comprehensive work on the design and implementation of a customized educational itinerary led us to redefine the concept of the educational programme be transformed into this route in the future, acquiring an exclusively individual focus. Then it becomes necessary to determine not only the areas of training for «filling» the labor market with graduates, but to form areas of knowledge in which the graduate will

independently «find oneself». We called these areas «industries», the cognitive characteristic of which is technological adaptation and orientation in the subject area of knowledge. We have made an attempt to define the «industries» of the future higher education, incorporated into the spheres of human activity in the world, as follows.

1. Industry of cognition, thinking and design.
2. Health industry / industry of health preservation.
3. Industry of knowledge.
4. Neuro industry.
5. Industry of management.
6. Industry of law.
7. Industry of culture.
8. Industry of hospitality.
9. Industry of territories.
10. Industry of high technologies.
11. Industry of logistics.
12. Industry of production systems.
13. Industry of resource conservation and efficiency.
14. Industry of research.
15. Industry of knowledge transfer.
16. Industry of social initiatives.

1. Industry of cognition, thinking and design

Shaping a direction associated with Industry of Cognition, Thinking and Design is determined by global goals in the field of changing attitudes and approaches to cognitive and creative human activity, such as production and reproduction of knowledge and ideas, processing, interpretation, accumulation, broadcast and retransmission of information, management of mental processes, etc.

2. Health industry / industry of health preservation

Within the framework of the *Nature-Body* Cluster, due to the consolidation of the scientific and educational potential of fields of study and areas of training in natural sciences and the created classical system of medical training, the university will ensure the transformation of the basic training modes of qualified medical workers aimed at creating conditions for shaping competencies in the field of personalized medicine during the course of study. Cascades of multidisciplinary educational programmes in natural sciences will create a supportive basis for the development of human resources capacity-building framework of Health Preservation Industry. At the same time, the university will continue to train physicians and health-care workers to meet the needs of the region in qualified specialists for practical health care.

3. Industry of knowledge

The integration essence of inter-subjectivity within the field of study «Education, Pedagogy and Psychology» will be provided by the STEAM-approach, which acts as a functional integrator of the holistic educational process, ensuring its adaptability and allows for designing new educational environments. The approach is based on a five-core structure, which includes the content of disciplinary fields, such as Natural Sciences, Technology, Engineering, Arts and Aesthetic Development, and Mathematics.

4. Neuro industry

The strategy for the development of educational activities at the university involves the effective use of scientific and educational resources from the standpoint of poly-disciplinarity. In the framework of the *Nature-Body* Cluster, the integration of the educational core of the basic fields (Biology, Bioengineering and Bioinformatics, Chemistry) and a gamut of interdisciplinary links will allow for addressing a fundamentally new approach in the development of a pool of meta-competencies in the field of neurosciences in the course of study.

Cascades of multidisciplinary educational programmes will provide a supportive carcass for the development of human resources capacity-building framework for Neuro Industry that is being created in the region. At the same time, the university will continue to train biologists, chemists and bioengineers to meet the needs of the region in qualified specialists in the natural sciences.

Cascades of multidisciplinary educational programmes in the field of Neuro Industry will arise due to the addition of the programmes mentioned above (Biology, Bioengineering and Bioinformatics, Chemistry) with the content of inter-subject fields included in the Clusters of *Human-Mind-Society* and *IT-AI*, and will be represented by large subject field '*Anthropos'*.

5. Industry of management

The conceptual core of the scientific and educational area of study in the Industry of Management will be the subject field «Economics and Management», being the main unit that determines the further professional activities of graduates of all levels. Based on the needs of the region associated with reaching a leading position at the federal level in attracting investment, the university sets the task of transforming the regional management system, taking into account the transition to digital management models. Cascades of educational programs should ensure the formation of a new type of managerial elite not only in the public sector of the economy, but also in business, its management and logistics. Interdisciplinary links in the field of Management and Economics will be formed at the intersection of the areas of training in Economics, Management, Sociology, Psychology, Advertising and Public Relations.

6. Industry of law

As one of the goals of the university in terms of influencing the socio-economic development of the region, it will be the development of a new approach to ensuring human resources in the field of Law. The University should create a new type of training programmes for specialists in the field of Jurisprudence and create the Industry of Law in the region. Taking into account the increasing automation and digitalization of legal activity, the division into social and legal statuses traditional for the sphere of Law and related activities (advocacy, notaries, etc.) must be transformed into a new type of activity such as an in-house lawyer.

7. Industry of culture

The development of the field of study related to the Industry of Culture is due to modern challenges in the sphere of Culture in the context of globalization and «glocalization», taking into account technological changes and new ethical problems associated with them. These are activities in the field of protection and use of cultural heritage, dialogue of cultures, representation of cultural values on a regional and global scale, etc. To be included in the current world agenda, the university will form cascades of educational programmes in the field of Industry of Culture within the framework of two large interdisciplinary fields: 1) Ecology of Culture and Global Challenges; 2) Digital Technologies and Cultural Design.

8. Industry of hospitality

As part of the implementation of the federal university mission related to the development of the economic potential of the region, its attractiveness for potential investors, as well as its integration into the macro-region, the Baltic Sea Region with the Baltic 'Big Sea' Strategy, the University plans to develop a fundamentally new approach to the principles of creating a competitive Industry of Hospitality within the mentioned framework through the development of the human capital. To achieve this goal, the university will design cascades of educational programmes in the field of Industry of Hospitality within two large interdisciplinary fields: 1) Tourism and Hospitality / Integrated Tourism Clusters and their identification in the Big Baltic region; 2) Health-saving Technologies in Hospitality / Transfer of Health-saving Technologies in the Big Baltic region.

9. Industry of territories

Within the framework of the *Nature-Body* Cluster, by combining the existing scientific and educational potential of natural sciences and the created system of areas of training in the field of Ecology and Environmental Management, the university will be able to implement the synergy of the classical education system and the increasing digitalization of society, which, in turn, will create the basis for the development of the scientific and educational framework of the Cluster '*Region – University – Russian Academy of Sciences'*. Thus, a multidisciplinary field with a polycentric approach to the objects and phenomena under study will emerge. In the near future by 2030, experts in the field of Ecology and Environmental Management will need to acquire competencies not only in natural sciences and humanities, but also in programming, drone piloting, design, 3D modeling and 3D printing, and the use of gaming technologies, which will lead to the development of the inter-subject field «Geos».

10. Industry of high technologies

In the context of the implementation of the transformational model of training in the field of AI-IT Technologies, the university defines the object of research and professional activity of graduates as «the ability to work with complex systems».

The essential characteristics and specificity of the object of professional activity necessitate radical changes and integration of various approaches to the design of educational programmes in the field of AI-IT Technologies. The active introduction of technologies and systems of Artificial Intelligence 'forces' to change the functional content and technological support of educational programmes. In these conditions, educational content is formed within the framework of new subject and interdisciplinary fields, as well as areas of activity. At the same time, the main characteristic of a graduate is not so much the number of the competencies being developed, but the experience of quick and flexible adaptation to the implementation and application of professional competencies in different, including non-related, areas of professional activity.

The projected model of training in the field of IT-AI will determine the results of the implementation of educational programmes as one dominant competence, being «the ability to work with complexity», which will significantly expand the scope of the graduate's professional activity, ensure their competitiveness and demand in the labor market.

11. Industry of logistics

As part of the implementation of the mission of the federal university, related to the development of the economic potential of the region, its attractiveness for potential investors, the university plans to develop a fundamentally new approach to the creation of a competitive environment for the development of human capital on the basis of engineering, scientific and educational area of training. To achieve this goal, the university will design cascades of educational programmes for the Industry of Logistics within the framework of two large inter-subject fields: 1) LogTech solutions in transport and logistics activities. 2) Digital Services in the management of engineering networks.

12. Industry of production systems

The conceptual core of the subject field «Artificial Intelligence, Intelligent Digital Ecosystems and Industry 5.0» will become the subject field «Artificial Intelligence, Intelligent Digital Ecosystems and Industry 5.0» based on the engineering and technical area of the Industry of Production Systems, as the main unit that determines the further professional activities of graduates for educational programmes of all levels and degrees. Based on the needs of the region associated with reaching a leading position at the federal level, the university must ensure the development of human resources framework for the production and industrial sectors in order to transform it into the Industry of Production Systems. Interdisciplinary links will be formed at the intersection of Philosophy, Business Informatics, Economics, Applied Mathematics and Informatics, Information Security, Service and Mechanical Engineering.

13. Industry of resource conservation and efficiency

Within the framework of the *Nature-Body* Cluster, due to the consolidation of the scientific and educational potential of natural sciences and the created classical system of training in the field of Bioengineering and Bioinformatics, Biology and Chemistry, the university will ensure the transformation of the basic training model and create by 2030 the basis for the development of the region of the human resources framework of the Industry of Resource Conservation and Efficiency. Cascades of multidisciplinary educational programmes within this industry will arise due to the addition of the subject areas of Biology, Chemistry, Bioengineering and Bioinformatics with the content of inter-subject fields included in the Clusters of «Human – Mind – Society» and «IT-AI», and will be divided into two large inter-subject fields, being «Eikos» and «Biotechnologies».

14. Industry of research

The development of the field of activity formed within the framework of the Industry of Research is due to the need to condition synergy within the framework of the research protocol. With this approach, synergetics becomes an essential characteristic that provides the process of creating new knowledge, and allows the integration of science as a phenomenon into education and innovation. Industry of Research must create conditions for triggering in the human mind the need to move from ignorance to knowledge, from incomplete or inaccurate knowledge to more complete and accurate activities carried out with the help of research tools. The mechanism for the implementation of this function will be the parti-

cipation of students in the implementation of scientific projects at the university. The conceptual core of the cascade of projects created within the Industry will be their functional focus and significance on the trans-region scale. The scope of the projects will be seen as layers of competencies, shaped through participation in the implementation of project initiatives. Within the Industry of Research, project cascades will be created incorporated into two large subject fields, being «Cognitive Sciences» and «Advanced Research».

15. Industry of knowledge transfer

The development of the sphere of activity created within the framework of the Industry of Knowledge Transfer is due to the development of 'exponential technologies', the necessity for specialists who are able to develop ideas, projects in the new economy, build up teams and attract funds for growth, and work in the paradigm of the digital economy. The meaningful characteristic of entrepreneurial activity is manifested through the interaction of the actors (subjects of activity) with the business environment, which is based on the process of creating new and developing existing projects by the students as stakeholders, transforming the subject of activity through constant development and search, not through the implementation of plans. The Industry of Knowledge Transfer will take on the function of shaping the leaders of the new economy and developing a new culture of consumption. The mechanism for the implementation of this function will be the participation of business entities in team and project work. The conceptual core of the cascade of projects created within the Industry will be their innovative and entrepreneurial significance on the scale of University – Region / Trans-Region. The scope of the projects will be seen as layers of competencies, shaped through participation in the implementation of project initiatives. Within the framework of the Industry of Knowledge Transfer, project cascades will be created within the subject field «Intelligent Business Management».

16. Industry of social initiatives

The development of the sphere of activity formed within the framework of the Industry of Social Initiatives is due to the presence of an individual need for social activity. The meaningful characteristic of social activity is manifested through the interaction of the subject with the social environment, which is based on the process of transforming the subject through constant development and improvement of the environment. The Industry of Social Initiatives will assume the function of adapting the psychophysiological and personal characteristics of an individual to the existing level of development of the social environment. The mechanism for the implementation of this function will be the participation of the subjects of activity in the project work. The conceptual core of the cascade of projects created within the industry will be their social significance on the scale of University – Region / Trans-Region. The scope of the projects will be seen as layers of competencies, developed through participation in the implementation of project initiatives. Within the framework of the Industry of Social Initiatives, project cascades will be created within two large subject fields, being «Social Invention» and «Human Being and Techno Evolution» («Human Being and Digital Culture»).

Conclusions

In conclusion, it is necessary to outline a number of objectives for the higher education system, which, in our opinion, are extremely important to solve today. First of all, it is necessary to provide conditions for a flexible and mobile transition from the development of standardized competencies of a university graduate to the creation of an individual competence profile of a student. This is one of the most difficult tasks for the management of the university and its faculty, which requires not only integration and interdisciplinarity in approaches, but also the consolidation of all the intellectual potential. Secondly, it is currently significant to solve the problems associated with changing the functional purpose of the educational process as the main 'supplier' for the creation and implementation of new technologies for teaching, upbringing and development of the future generation.

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