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## Перспективы цифровой трансформации инженерно-экономического образования

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**Аннотация.** Стремительные изменения, которые охватывают страну и весь мир, предполагают обязательную интеграцию бизнеса, науки, образования с цифровым пространством. Такой серьезный шаг для российских организаций любой области деятельности требует комплексной готовности всей системы. Настроенность организации на системную трансформацию должна быть обеспечена не только склонностью руководителей к эксперименту и решительным переменам или энтузиазмом подчиненных. Неподготовленность важных элементов системы и связей между ними оборачивается серьезными затратами, превращающими цифровую трансформацию в тормоз развития организации. Цель статьи — обсуждение различных факторов, оказывающих влияние на эффективность цифрового перехода. В исследовании были применены следующие методы: 1) опрос представителей бизнеса и образования с дальнейшей обработкой и анализом собранных данных; 2) контент-анализ ответов на вопросы, в которых раскрываются индивидуальные точки зрения участвовавших в опросе экспертов. В числе задач исследования — выявление и анализ препятствий, возникающих на пути цифровизации экономики и инженерно-экономического образования. При рассмотрении образования как ведущего фактора социального и технологического развития запрос на осуществление цифровизации обращается, прежде всего, к образованию. Исследование поднимает проблему отсутствия на данный момент обоснованной и убедительной научной психолого-педагогической концепции цифрового обучения, которую невозможно без ущерба для базовых субъектов обучения использовать как основополагающую. В статье рассматриваются результаты опроса студентов инженерно-экономических и управленческих специальностей, согласно которым необходимо расширение профессиональных компетенций современных менеджеров за счет цифровых навыков. Поднимается проблема приемлемого и разумного включения в образовательные программы инженерно-экономического вуза дисциплин, согласующихся с реальными социальными потребностями.

**Ключевые слова:** наука; экономика; инженерно-экономический вуз; цифровое образование; цифровое образовательное пространство; педагогическая концепция обучения; знание; цифровые инструменты; цифровая грамотность; препятствия цифровизации

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Original article

## Prospects of digital transformation of engineering and economic education

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**Abstract.** Rapid changes that cover the country and the whole world require the mandatory integration of business, science, education with the digital space. Such a serious step for Russian organizations in any field of activity requires the comprehensive readiness of the entire system. The organization's readiness for systemic transformation must be ensured not only by the leaders' inclination to experiment and decisive changes, and not only by the enthusiasm of subordinates. The unpreparedness of important elements of the system and the links between them turns into serious costs that turn digital transformation into a brake on the development of the organization. The purpose of this article is to discuss the various factors that influence the effectiveness of the digital transition. The following methods were used

in the study: 1) a survey of representatives of business and education with further processing and analysis of the collected data; 2) content analysis of responses to questions that provide individual points of view of the experts participating in the survey. One of the objectives of the study was to identify and analyze the obstacles that arise in the way of digitalization of the economy and engineering and economic education. When considering education as a leading factor in social and technological development, the request for digitalization refers primarily to education. The study raises the problem of the current lack of a substantiated and convincing scientific psychological and pedagogical concept of digital learning. It is still impossible to use it as a fundamental one without prejudice to the basic subjects of learning. The article presents the results and analysis of a survey for students of engineering, economics and management specialties. They reveal the need to expand the professional competencies of modern managers through digital skills. The problem of acceptable and reasonable inclusion in the educational programs of an engineering and economic university of disciplines that are consistent with real social needs is raised.

**Keywords:** science; economics; engineering and economics university; digital education; digital educational space; pedagogical concept of learning; knowledge; digital tools; digital literacy; digitalization barriers

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## Introduction

Today we can talk about digitalization not just as a fashion trend. It becomes a mandatory success factor in the market of any socio-economic system, and educational organizations are no exception [Henriques, 2020]. The emergence of a number of projects within the markets of the National Technology Initiative is evidence of the understanding that digital transformation is indispensable today. The implementation of this large-scale project at the state level is possible only with the support of science, business, and education [Lokuge, 2019].

In February 2022, as part of the activities of the State University of Management Boiling Point platform, aimed at designing educational trajectories for students and teachers, at expanding the university's capabilities to develop the necessary digital competencies in students, a study was conducted on the topic: «Business, science, education resources for implementation of the digitalization program».

The participants in the joint search were the creators and users of educational online content. During the development of the research program, firstly, a range of problems proposed to businessmen and entrepreneurs was identified to assess their relevance in modern market conditions, in particular:

- readiness of business for digitalization;
- application by business of the latest digital technologies;
- barriers faced by business on the way to transformation.

Secondly, the creators and users of educational content — teachers and students involved in online learning — were offered the following topics for discussion:

- vectors of development of the modern educational environment;
- today's understanding of digital literacy;
- resources of modern management education to provide personnel for the transition of the economy to digitalization.

Exploring the processes of digitalization in education, it is quite natural to discuss the formation of the foundations of digital literacy. The complication of the information space, the exponential development of digital technologies now require the institute of primary education not so much to form the fundamental principles of basic literacy (reading, numeracy, writing), but to expand the knowledge and skills of using information and communication technologies. Scientific and technological progress inevitably modifies and otherwise fills the concept of «literacy» [Romanova, 2020].

Digital literacy today is knowledge of the basics of computer programming, the ability to create content using digital technologies, mastery of skills in working with information, and free communication of users with professionals [Haseeb, 2019]. Here it is necessary to take into account all the time: in this blurred framework of the minimum necessary for initial digital literacy, new skills and abilities that are already suitable for a new level of development will penetrate like an avalanche.

The environment of continuous growth of knowledge, permanent assimilation of huge volumes of diverse information should be useful for an infinitely unique person — the subject of learning, that is, to develop it, and not serve as a source of ongoing stress [Genisaretsky, 2010].

### Research methods

Digitalization, which is developing as a national project, needs support from science, education, and business. Based on this, the study attempts to identify the problems of using digital technologies by representatives of these institutions. Three research hypotheses were formulated.

1. The main problem that hinders the introduction of information technologies in business is the low level of digital literacy of business leaders; insufficient formation of digital competencies among managers and specialists.

2. The professional competencies of future managers should be expanded and supplemented with knowledge and skills in the field of digital technologies.

3. The main obstacle to the effective use of information technologies in the university is the lack of a convincing scientific psychological and pedagogical concept of digital learning, which could be relied on by the subjects of the educational process as fundamental.

In the study, methods were applied in the following sequence: 1) a survey of representatives of business and education with further processing and analysis of the collected data; 2) content analysis of answers to questions that present the position of an expert, his individual point of view.

The text of the questionnaire for representatives of the real sector of the economy contained a number of open questions regarding digitalization in their organizations:

1. What digital technologies are already in place in your organization? Does the company have a digitalization plan?

2. What are the obstacles that you had to face in the process of business transformation.

The students of management specialties of the State University of Management were asked to answer one question: «Name the digital technologies that you will need for your professional activities in the near future».

The questionnaire for respondents who are creators of online content, professors at State University of Management and other universities included four open-ended questions:

1. What are your ideas about the factors that influenced the «fascination» of the whole world (including Russia) with digital learning?

2. In what areas are information technologies used in the educational process?

3. How do you assess the possible contribution of online education to the development of managers of the future?

4. Are digital technologies useful and productive in the form in which they are being introduced (voluntarily or involuntarily) in education today? What are the problems? How to improve efficiency?

### Research results

#### *Analysis of the results of a survey of business representatives*

The applied content analysis of 55 questionnaires of businessmen made it possible to draw the following conclusions. Indeed, large Russian companies have embarked on the path of digitalization, based on the understanding that the introduction of digital technologies will be able to increase labor productivity, cover costs, prepare an influx of investments, etc. At the same time, organizations that have begun the systematic implementation of projects in the digital sphere are not lot. The heads of firms that have planned and are implementing pilot transformation projects have named the difficulties associated with this.

In their responses, the respondents name, of course, the lack of financial resources and the slow return of funds invested in digital projects as an obstacle (29 % of those who worked with the questionnaire). Of course, many aspects of economic activity, according to entrepreneurs, can be improved with the help of digital technologies, for example, communication with customers and advertising, improving the quality of the product and its means of delivery, automating internal business processes, simplifying interaction with government agencies [Beiravand, 2017; Hansen, 2016]. At the same time, there is an inadequacy of digital solutions for already formed business processes (36 % of respondents), a discrepancy between digitalization plans and adopted strategic business plans, in such cases more serious restructuring measures are required, and they also need investments [Shpak, 2019].

The responses indicate fears associated with the risks of the experiment (9 % of experts), a low degree of enthusiasm necessary for qualitative transformations (12 % of respondents), inefficient horizontal interaction (13 %), and the weakness of the infrastructure that facilitates the assimilation of digital solutions (15 %), about the low level of economic and information security of the business (18 %), about the lack of a comprehensive digitalization program for the company (19 %).

As we assumed at the beginning of the study, the respondents in their answers focus on the insufficient level of literacy of managers in the field of information technology (43 %), on the weak formation of digital competencies among managers and specialists (39 %).

Since the information was obtained in a study organized at a management university, it can be perceived as an invitation to revise the educational programs of the university in the direction of strengthening them with such courses that will allow students to navigate the professional digital space [Blinov, 2020].

#### *Analysis of student survey results*

At this stage of the study, 193 students of 2-4 courses of the State University of Management took part, mastering the educational programs «Organization Management» and «Anti-Crisis Management».

In their answers to the question «Name the digital technologies that you will need for your professional activities in the near future», students indicated a number of programming languages, databases, organizational IT systems, data analysis tools, marketing tools for promotion through social networks, non-linear search, analysis, forecasting tools, Machine Learning tools [Ren, 2018].

An indicator of the perceived need for information competencies for professional activities is the following moment: in their answers, students emphasized that they are already making attempts to independently study some digital tools. Therefore, the question naturally arises of the reasonable inclusion in these educational programs of disciplines that correspond to real needs [Danilova, 2021; Merenkov, 2021].

#### *Analysis of the results of a survey of university professors*

Almost without exception, the respondents (69 teachers of higher education were interviewed) state that digital technologies, already operating in many areas of our life, are invading the educational space with an unrestrained onslaught. Network access, the possibility of remote meetings via video conferencing, shared learning content, systematization of knowledge control, assessment automation, work with smart devices, cloud computing, augmented and mixed reality, and simply the dynamism of classes resonate with students and many teachers. But all of these blessings have a downside.

Since modern digital solutions are ousting from production those workers whose labor operations are performed by smart technology without quantitative

and qualitative losses, education absolutely cannot turn into a mass conveyor on which identical specialists are «stamped». There is no need for these workers in the era of the dominance of numbers, the economy is severely freed from them even now [Danilaev 2021]. «Non-series» training of professionals with high social and personal mobility, with a unique development trajectory, with the skills of self-motivation, self-planning, and research reflection is becoming relevant. Can information and communication technologies (in the form in which they now appear in economic education) lead in the complex development of people with such competencies?

Experts in the field of online development note that the «captivity» of world education by digital learning (and Russia was no exception) was influenced by four parallel circumstances:

- the development of informatics, as well as engineering and cognitive psychology, representatives of these areas of knowledge in unison started talking about the applicability of the «computer metaphor» for the actions of the machine and the activity of the human brain;
- the development of digital learning on the basis of programmed tracing paper, that is, today we are dealing with the reproduction of a technological approach to managing the educational process;
- development of the mass industry of personal computers, software and various digital devices;
- the search for markets for digital goods, which were mentioned above, and the field of education for this purpose is a coveted space without borders.

Higher education teachers state that the use of computers in the educational process is observed in the following areas: 1) in the simulator mode, that is, when minimal systematization and working out of the material already covered is required; 2) as a tutor: the task is clear, the conditions are unambiguous, there is only one solution; 3) as a modeling tool, this tool «immerses» the student in the problem, makes it possible to solve it independently. «Simulators» and «tutors» quickly gained popularity in schools and universities at the beginning of the era of computerization [Bryanskaya, 2021]. These forms of exploitation of electronics for educational purposes significantly increase the pace of work with information. But, admittedly, the «speed fever» quickly passed when they discovered not just the absence of qualitative positive changes in the thinking of students, which they expected, but the loss of independence in solving complex problems, the loss of the «nonlinearity» of the search [Rozin, 2020].

Modeling (the third form) is currently fraught with tremendous variability, since the student in the simulation model acts on his own, has many positive characteristics and gives odds to learning without computer simulation. The mode of such a game is definitely promising, since in the created learning environment there is room for creative thinking to unfold.

The following expert opinions are of interest. In training, there is often a mixture of fundamentally different concepts — «information» and «knowledge». The computer in its current form is not yet suitable for translating information into knowledge, meaning into meaning. Such transformations are purely mental processes explained by psychological laws. They are unique to humans. The translation of information circulating in the classroom (especially with the use of electronics) into meanings, and then into specific practical actions, is a huge problem. Successful transformations of such a plan are a pedagogical victory. Therefore, one must remember about a reasonable balance of using the exceptional capabilities of a computer and live human communication, about the limits of applicability of the «computer metaphor».

Adherents of digital learning see the ideal of minimizing the live interaction of the subjects of the educational process. Is it really necessary to strive so fiercely for this? After all, the role of perception in meaning formation has not needed scientific evidence for a long time. And the possibility of a full-fledged thought process without an active reflection by a person of people, phenomena, events, situations — this point of view of total e-learning enthusiasts still needs to be scientifically established. The degradation of live speech (in its usual sense), fragmentation, discreteness of thought, lack of concentration on one object, superficiality, unsubstantiated judgments, preference for a visual message over a text message, a text message over a human conversation, are the peculiarities of the psyche of the new digital generation [Ardabackaya, 2021].

At the same time, experts assure, there are no long-term observations on the consequences of the large-scale introduction of electronics in educational institutions, psychophysiological, clinical, health, and psychological standards for the use of gadgets in the educational process have not been developed. Electronic textbooks, interactive technology, multimedia gadgets do not have strong and satisfactory justifications for their harmlessness to children's health. Violated vision and hearing, metabolic processes and the state of internal organs, develop early

scoliosis, muscle weakness, psychosomatic diseases. And the consequences of the thoughtless introduction of digital tools in schools and universities are still poorly understood. In fact, there is no substantiated psychological and pedagogical concept of digital learning that could be used by the subjects of the educational process as a base (48 % of respondents spoke about this).

Experts discuss the circumstances that have shaped the radical changes in the educational environment that are observed today. Educational institutions are combined into complexes, the number of levels of the system of primary, secondary and higher education is increasing. There is an increase in competition between educational organizations for consumers of services, for orders for research and development, for qualified personnel. At the same time, educational platforms are being improved, which can now compete with many universities in terms of the quality of information resources and services. The possibilities of artificial intelligence are developing, which has every chance to be introduced into the educational process. The range of paid educational services is expanding, and distance learning options are being formed. Education becomes a business: services are sold, promising skills are bought with the aim of further profitable capitalization. It makes no sense to respond to these trends emotionally, evaluatively and fragmentarily, they jointly influence the situation in education and form a common vector of development.

### **The discussion of the results**

In the conditions of cybersocialization of all public institutions, continuous education becomes the norm, even a condition of existence. In a situation where there is an active digitization of educational content, the development of educational online platforms, experts are seriously concerned about how ready students and teachers are for transformations, whether there are necessary internal resources and pedagogical tools for their formation.

In general, the problems of digital learning can be divided into problems of a temporary plan and immanent, characteristic only for this type of learning.

The development of electronics inevitably leads to the restructuring of the educational market. The main actors will be those structures that generate fresh knowledge, successfully develop fundamentally new educational benefits, and train personnel [Bajborodova, 2021]. As a result of «natural selection», large universities will gradually come to the forefront, then — companies producing digital educational products, and leaders-transmitters of educa-

tional benefits to consumers, that is, global educational platforms that have proven their power. In the meantime, we are faced with weak and / or dishonest operators. In the colossal in terms of volume and speed of development of the online education market, it is sometimes difficult to distinguish high-quality products and services from a surrogate (31 % of those who answered the questionnaire). This is due to the lack of user experience, the qualifications of specialists involved in the creation of educational content, the lack of expert assessments and systematic control, intrusive advertising that guarantees success and reliability (29 % of respondents). Educational products are a typical type of trust commodity. This means that the consumer is forced to rely on quality without being able to evaluate it in an expert way. As a «filter» that would be installed before the product is placed on the online platform, for example, peer review can act. Here you can try the possibilities of artificial intelligence.

Experts talk about problems unique to online education. First of all, this is a craving for imitation of full-time education, a kind of inertia of consciousness (15 % of experts). As a result, a high-tech copy is often inferior in terms of impact on the user in comparison with the original created in the offline world. Just as books, documents, films, being digitized, «lose connection» with the era in which they were created, so faceless «digital twins» in education are sometimes poorer than their classical prototypes.

Weak interactivity is another «pain area» of online education (19 % of respondents). Here, e-learning repeats the mistakes of the traditional one and puts its hopes on artificial intelligence. At the moment, the problems of the activity of subjects of education are conditionally solved, for example, with the help of specialized forums. And, in general, remote communication in the electronic environment is already quite successful, including in real time. But there are questions of socialization, cultural inheritance.

Even if the creators of the online course care about interactivity, the problem of reproducing the norms, rules, and values accepted in the community remains. In our study, the problem of socialization is actively discussed by experts (14 % of respondents). Formal rules can indeed be broadcast remotely, in electronic form. However, in this way it is impossible to adapt the neophyte to life and activity according to the laws of the institutional environment. The transfer of conventional skills and abilities occurs only in real interaction — face to face, hand in hand.

The student needs the power of the teacher's personal example, the potential for emotional contact, and psychological support in order to form the zone of proximal development [Vygotsky, 1984]. It requires playing roles, living according to the model, familiarizing with customs that allow participants to feel each other, understand, and act together. Perhaps it is the function of education that will be entrusted to the online teacher of the future. The transmission of information is an issue that has long been resolved, but the problem of sociocultural inheritance will continue to be felt more and more acutely.

The problem of transferring «implicit knowledge» is consonant with the previous one (8 % of experts). Implicit knowledge (transmitted only from teacher to student) is not just informal and redundant information, but an obligatory basis for logical forms of knowledge. Although «peripheral» knowledge, according to M. Polanyi's classification, does not have a discursive design (because it is a product of sensory and intellectual intuition), they form the basis for formal scientific theories [Polani, 1985]. The authors and carriers of this useful knowledge are specific people. They, in fact, act as a strategic intangible resource of the organization, its intellectual capital, custodian, translator and center of reproduction of the way of thinking through joint thinking. And also — visions of the world, methods of working with information, culture of discussion, the art of creating, generating ideas. These things are inseparable from a person and are transmitted only in joint action. Today, according to experts, there is an inappropriate narrowing of the area of traditional reproduction of knowledge.

The problem of transferring implicit knowledge has something in common with another — the problem of primitivization of skills, or automatic simplification of competencies (12 % of respondents). The mass exploitation of electronic devices — spellers, calculators, navigators, etc., supposedly designed to facilitate human work, catastrophically reduces the user's motivation for independent search. Moreover, being without «assistants», he is unable to perform a function, to make an emergency decision.

The listed symptoms form a sad diagnostic picture in total. Even now reformers in the field of education are short-sightedly discussing the separate preparation of «generators» that produce new knowledge, and «operators» who own ready-made programs. And, in this sense, for designing a society of ordinary consumers and producers of an elementary line of goods and services, an economy without competitive advantages, a test type of education that

streamlines the backlog on a regular basis is the best fit.

### Conclusion

Today, there are several possible positive forms of digitalization of the educational space:

- Transformation of ready-made educational materials into a digital environment. Many lecture courses, textbooks and teaching aids, problem books, presentations, collections of assignments for independent work, test tools, etc. have already been digitized.

- Development of fundamentally new educational tools that do not duplicate already familiar forms. Naturally, in order for educational content to acquire not just visual, auditory, but also kinesthetic and digital resolution, it must be structured differently.

- Improvement of interactive digital space for useful interaction and communication of all subjects of the educational process. For example, it can be more instrumental and content-rich electronic classrooms for teachers, network discussions, discussion forums, webinars, voting forms, etc.

- Creation of super-new teaching aids tuned to the transfer of methods of thinking in the «here and now» mode, and not to the inefficient way of transmitting facts and information about the methods of thinking (after all, thinking itself is richer than knowledge about it). This can be done, among other things, using the achievements of gaming, simulation modeling.

- Involvement in the educational process of the useful capabilities of artificial intelligence.

In the educational environment of schools and universities, the first three forms are used to varying degrees with varying degrees of success. This makes many educational materials more accessible, reduces the meaningless, routine work of teachers, and expands the range of online educational services. The latter process will have a positive result only for those educational organizations that can offer the market remote services with continuously improving quality, with a distinctive e-learning language (22 % of experts said that it does not yet exist). Otherwise, the Russian education system, which accepts the challenge of digitalization, may find itself on the periphery of the global educational environment.

Business, we must give it its due, quickly masters digital technologies [Sellitto, 2019]. But there are also obstacles [Savage, 2019]. For example, difficulties in step-by-step transformation planning, weak infrastructure for the assimilation of new technologies. Representatives of the real sector of the econ-

omy call the problem of insufficient digital competence, literacy in this area, both managers and specialists of companies, as the main one. In total, 82 % of respondents to the research questionnaire speak of such barriers to digitalization. Therefore, the first hypothesis of our study can be considered confirmed.

After questioning students — future managers, the conclusion about the importance of mastering digital competencies for their real and potential professional activities is obvious. It confirms the second hypothesis of the study. The world creates a fundamentally new space for the life and work of people. Digital technologies are breaking into educational platforms. This implies a dynamic adjustment of educational standards in the direction of consonance of time, instrumentality, competitiveness, but most importantly (the third hypothesis of the study) is the development of a sound psychological and pedagogical theory with obvious evidence of the effectiveness of using digital tools in the educational process of universities.

Such a strategic benchmark is mandatory when designing university educational programs. Otherwise, there is a real danger: education, declaring its own priority and innovativeness, will turn from the main factor in the development of society into a service structure that satisfies the chaotically emerging needs of the economy for educational services.

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