# Digital Transformation of the Educational Process in University in the Context of Globalization

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**Abstract** As a result of the research the following spheres of influence of virtual environment on the university were defined: professional, environmental, functional. Exogenous and endogenous factors of information and communication technologies affecting universities were identified. In order to increase the efficiency of the educational process in the university it was proposed to introduce SMART-complexes of disciplines. The structure of SMART-complexes of disciplines is established, consisting of the following modules: definition of the level of learning, assessment of learning efficiency, content for adaptive learning, tasks for adaptive learning, a set of databases for storing learning profiles, a knowledge base with a mechanism for logical output. Detailed components of the educational SMART-complexes guide students in their learning activities to correctly find the tasks that are most appropriate and necessary at present, to effectively define strategies and methods of learning, taking into account their personal factors. A methodology for assessing the digitalization level of a university based on fuzzy logic as a tool for managing processes of the digital transformation of the educational process is proposed. The following groups of indicators were identified to assess the digitalization level of the university: digital literacy of teachers, digital literacy of students and digitalization of the educational process. Assessing the digitalization level of the university will reveal the strengths and weaknesses of the educational process, justify the necessary effective management decisions. The main directions of state policy for digitalization of education have been defined. The need to create a comprehensive national system for the development of digital literacy, combining the efforts of academic and non-formal education on the basis of public-private partnership has been stressed. The most important function of traditional higher education institutions remains

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the socialization of students, so in order to improve the quality of education, it is appropriate to use mixed learning through various forms of education.

**Keywords** Digital transformation · Education · SMART-education · SMART-complexes · Soft-skills

**JEL Codes** A2 · O3

## 1 Introduction

The world community at the beginning of the third millennium is characterized by a number of features: the increasing importance of intellectual work, the use of information resources on a global scale; rapid exchange of data among experts, social and professional groups, communities of people, etc.

In accordance with the needs of our time, rapid growth of knowledge requires the introduction of new approaches to the organization of education and the search for innovative forms of transfer and acquisition of knowledge and competencies. Accelerated development of digital technologies stimulates the creation and introduction of innovative forms of education capable of keeping up with changes.

## 2 Methodology

The study analyzes various sources devoted to the problems of digital transformation in higher education, integration of SMART-education technologies into higher education, which include journal articles in leading peer-reviewed Russian and foreign periodicals, Internet resources.

The works of domestic scientists are devoted to the problem of assessing the digitalization level of universities and the readiness of Russian higher education for the digital economy [1, 2]. The use of fuzzy methods for assessing the digitalization level of universities requires further development.

## 3 Results

Today, both educational systems and employers are faced with the fact that digital age children will soon be applicants and job seekers. Generation Z and Millenials are connected to the global Internet and will be one of the first full-fledged users of the results of the Fourth Industrial Revolution. Thus, the impact of digitalization on universities is worth considering in three planes:

- Professional—new professions, new competencies;

- Environmental—a new worldview, a new lifestyle;
- Functional—new forms and methods of training.

At this, each of the areas presents challenges and opportunities for higher education institutions. Soon mass open online courses with certificate system will create serious competition for diplomas and certificates. In any case, it is worthwhile to model the relationship between employers and employees in the future when planning transformations in the education system.

According to a report by DELL Technologies and the Institute for the future "The next era of human-machine partnerships: emerging technologies" "impact on society & work in 2030" [3], it is expected that instead of waiting for staff to do most of the work, "work" will choose the best resource to complete it. Reputation assessment systems, data visualization and intelligence analytics will make it possible for people and businesses, institutions or organizations to find the best option at the discrete level of the work task.

All these tendencies cause and actualize new challenges for higher education, which should provide students with: synthesis of formal and non-formal (distance education), multidisciplinarity of specialties; constant updating of the content of academic disciplines and implementation of new tools and approaches to improve the quality of teaching; formation of a system of knowledge "soft skills", research skills, development of their own careers and the like; disclosure of cognitive abilities to learn; the engagement of world-renowned mentors in the learning process.

Analysis of the vacancy base and CVs [4] showed that there are 5 most common soft-skills. They overlap in both vacancies and resumes. These are personal characteristics and skills: creativity, willingness to learn, stress resistance, multitasking, ability to work in a team.

The most demanded quality specified in vacancies is resilience. It, as an important personal characteristic, was mentioned by companies in 37% of cases. Managers are also interested in 131 employees who know how to work in a team and can think creatively. If we talk about soft-skills in terms of professional fields, the ability to work in a team, as well as stress resistance is most often expected by employers in the retail sector. Multitasking is equally demanded in such industries as senior management, IT, marketing, human resources management and sales [4]. The question remains whether modern educational programs meet the needs of employers. After all, in the curricula of many educational institutions little attention is paid to the acquisition of soft-skills. This is often neglected, with particular attention to the cycle of profession-oriented disciplines. The analysis of foreign experience [5–7] in the implementation of educational activities has shown the expediency of involving stakeholders in the development, implementation and execution of educational programs. The result of such close cooperation will be the preparation of higher education standards for all first and second level higher education programs, which are an integral part of the system of internal quality assurance of educational activities and quality of higher education, and take into account all recommendations and requests of practitioners in training graduates. Such systematic integration of efforts of teachers, scientists and practitioners will contribute to the development and content of curricula according

to international standards, as well as to further professionalization of educational programs of the university.

In today's information society, expectations and requirements for higher education and universities are changing. The exogenous (external) factors of ICT influence on modern universities include the following:

- new expectations from universities, particularly the development of new competencies needed in the information society and critical thinking skills;
- the rapid growth of knowledge about society, nature and human;
- dynamism of knowledge, emergence of new professions and skills lead to the need to acquire knowledge throughout life;
- emergence of mass online courses that can be taught both at a specific university and outside it, but which, in essence, constitute an alternative to traditional university education and challenge it with their ultra-short lectures and interactive communication of participants;
- rating of universities, given their presence on the Internet and the citation of scientific works;
- strengthening of control over the activity of higher education institutions (applicant databases, database of graduates who received diplomas; online information on licensing of educational institutions, etc.);
- internationalization of the educational space and international mobility of subjects of the educational process (conferences, professional forums, working and training internships, training, exchange of experience).

Among the endogenous (internal, such as those related to pedagogical technologies) factors of ICT influence on modern universities, we will highlight the following:

- change in the formats of correspondence education, which is becoming a distance education, supported by the latest technologies: webinars, online lectures, the use platforms that allow to publish educational materials, control students' knowledge in the pedagogical process (for example, MOODLE, Blackboard, etc.);
- fast distribution of knowledge and growth of plagiarism cases (the so-called copy-paste) that demands application of programs to check the uniqueness of texts; access to unlimited educational resources creates for students a temptation to re-rewrite reports and other writings;
- formation of so-called clip thinking in young people and undeveloped skills of reading long texts. Scientists [2, 8–15] speak about the formation of digital (electronic) pedagogy and the transformation of subject-to-subject relations in higher education, the emergence of new education standards, changes in axiological approaches to higher education.

Although there are some limitations: not all universities can adequately respond to the new challenges and provide students and teachers with the tools and resources they need for digital pedagogy. These changes require academic staff not only to be computer literate and able to use modern platforms for disseminating knowledge and

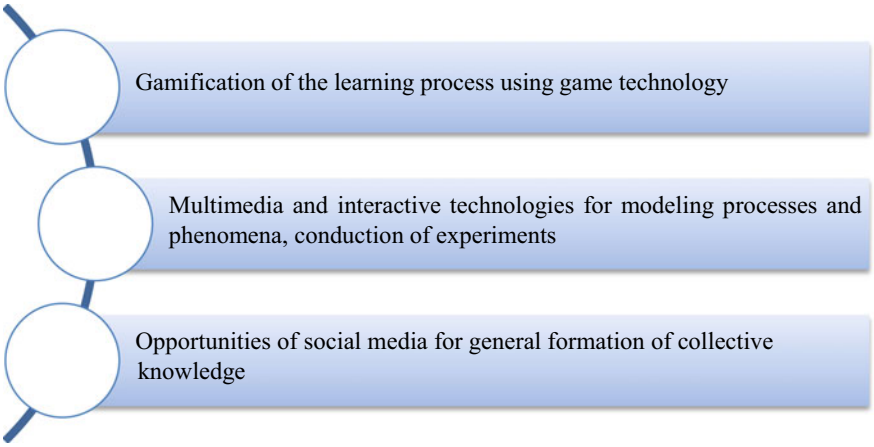


**Fig. 1** The most commonly used pedagogical tools in the learning process

their own scientific developments, but also to reflect on the new realities of higher education.

At the current stage of development and global changes in the information society there is an intensive development and use of information in all spheres of society, particularly in education. The process of formation of a digital society with relevant components: smart city, smart army, smart culture, smart education, smart health care is now taking place all over the world. Smart education is the implementation of educational activities on the Internet based on common standards, technologies and relationships established between the network of an educational institution and the team of teachers and students. In the process of smart education, an important role is played by interactive learning technologies, which facilitate interaction between the teacher and students (Fig. 1).

In our opinion, it is now necessary to develop methods for the design and implementation of SMART-complexes of disciplines in the educational process in order to improve the efficiency of learning further. We will SMART-complex to mean an electronic textbook of a new type with features encoded in the SMART abbreviation.

SMART attributes of the educational complex are implemented in the following structure (Fig. 2).

According to the data in Fig. 2, the structure of educational SMART-complexes consists of the following modules:

1. The module for determining the level of training. This module defines the real level of the student (his or her level of training).
2. The module for assessment of learning effectiveness—assesses and records students' learning effectiveness by conducting tests online or in their real world. For the purpose of true testing, students may be asked to find the answer to the control question by observing or interacting with real-world objectives (i.e. real

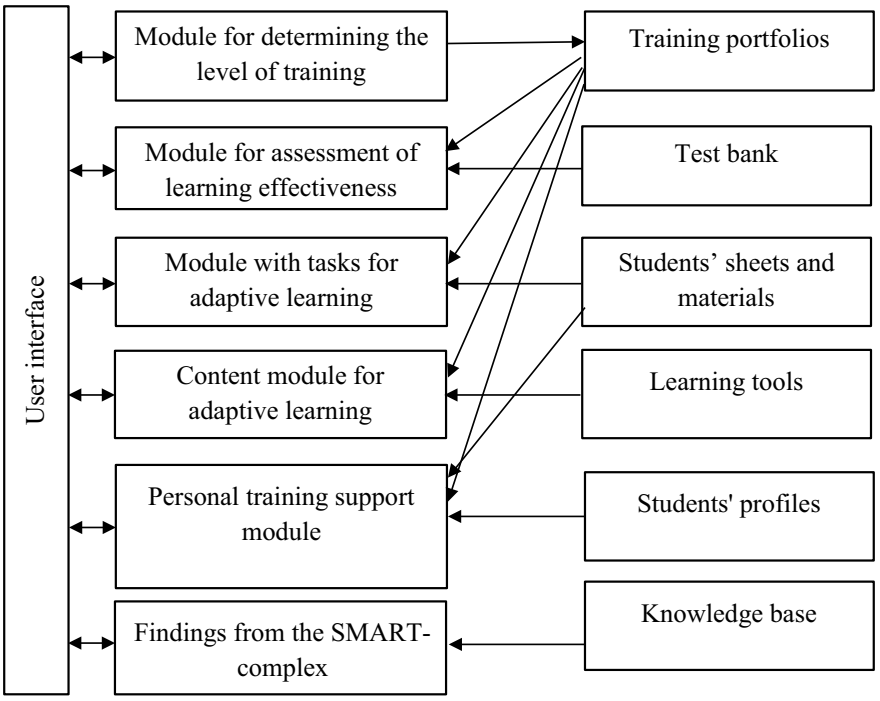


**Fig. 2** Structure of the educational SMART-complex

objects related to the learning objectives, e.g.: conditions for the development of cereal plants in a given region, etc.).

3. The module with tasks for adaptive learning. This module assigns tasks to students according to their academic success, performance, personal factors and learning objectives in all disciplines. An assignment can be expressed in the form of an online task—students can be asked to search for information on the Internet or in a real situation; the task can involve observing real objects, searching for additional material from the Internet or in the environment; students can also be asked to give answers to questions. At this, students are involved in the most appropriate and important tasks at the right place and at a convenient time for them, taking into account their learning status and personal factors.
4. The content module for adaptive learning. This module provides learning materials for students. Based on the progress of learning, productivity, personal factors and the status of particular students in the real world, the learning system recommends and organizes the delivery of learning materials, and adapts the interface to meet the needs of particular students. There are now quite a few adaptive (AHA!, MONAP-II, ELM-ART, CALAT, WITS, MLTutor, WebCOBALT, Belvedere, etc.) and intelligent learning systems (Miracle, FLINT, SQL Tutor, ELM ART, etc.). These systems take into account the learner's level of learning and carry out adaptation using different technologies: building a sequence of training courses,

intellectual analysis of solutions, interactive support in problem solving, adaptive hyper-media technologies, etc.

5. Personal training support module. It supports students' learning process based on their learning needs. Learning support can be a reference point for learning purposes or content, a recommendation for a particular assignment and feedback, thus helping students to learn in an effective way. In order to determine what kind of support a student needs, especially in the performance of creative assignments and intellectual tasks, personal factors and the real learning status of students, as well as the effectiveness of their learning should be considered and taken into account.
6. A set of databases for storing learning profiles, portfolios, study letters, training materials, test assignments and information on sustainable learning tools. The data provided in these databases are very relevant to the learning system in terms of providing appropriate support to students (in the right place at the right time). For example, the learning portfolio database stores: students' schedules, their study progress, completed homework, assessment results and the comparative aspect of peer evaluations. Through the analysis of learning portfolio entries, the SMART learning complex offers information to individual students on the feasibility of learning objectives with recommended strategies and tools.
7. A knowledge base with the inference engine for identifying the 'value' of learning objectives, strategies and tools, as well as possible combinations, may also contain rules for decision-making based on case studies of both success and failure. The inference engine is a computer program based on "precedent" technology, which simulates decision-making based on the analysis of the situational state.

In order to formulate and adjust strategies and plans for digital transformation of the educational process, we offer a methodology for assessing the digitalization level of a university based on fuzzy logic.

Assessing the digitalization level of the university will reveal the strengths and weaknesses of the educational process and justify the necessary effective management decisions.

The methodology is based on the analysis and evaluation of the following aspects:

- factors of the digitalization of the university;
- the level of use of information and communication technologies for the digital transformation of the educational process.

Statistical observation of using digital technologies in the educational process with delay responds to new models of using digital technologies, which is insufficient for an adequate assessment of the situation. Therefore, it's necessary to take into account a number of own indicators obtained as a result of expert surveys (Fig. 3).

The following groups of indicators were identified to assess the digitalization level of the university: digital literacy of teachers (A), digital literacy of students (B), digitalization of the educational process (C). In each group, indicators and terms for evaluation are presented, presented in Table 1.

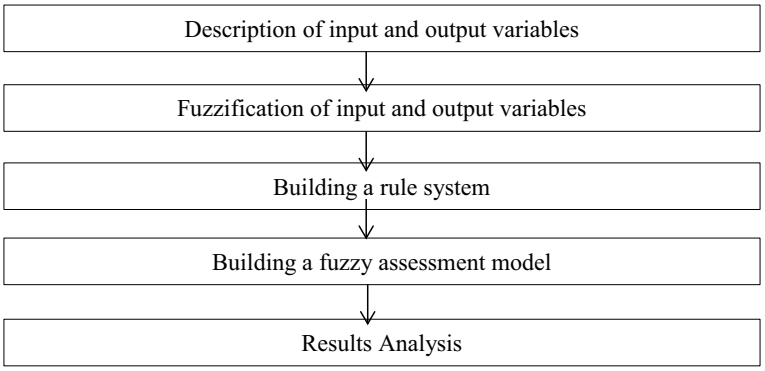


**Fig. 3** The stages of the digitalization level of the university based on fuzzy logic

**Table 1** Indicators and terms for assessing the digitalization level of a university

| Factor code | Name | Universal set | Terms for Evaluation |
|---|---|---|---|
| A1 | The use of digital technology in the educational process | 1–10 points | Inadequate (in), Low (l), Medium (m), High (h) |
| A2 | The ability to create and share digital resources and materials | 1–10 points | Inadequate (in), Low (l), Medium (m), High (h) |
| A3 | Continuing Professional Development Using Digital Technology | 1–10 points | Inadequate (in), Sufficient (s) |
| A4 | The ability to develop students' digital literacy | 1–10 points | Inadequate (in), Low (l), Medium (m), High (h) |
| A5 | Number of R&D publications | 1–10 points | Low (l), below average (ba), medium (m), high (h) |
| Б1 | Providing students with access to digital resources | 1–10 points | Inadequate (in), Low (l), Medium (m), High (h) |
| Б2 | The degree of student involvement in active work | 1–10 points | Low (l), below average (ba), medium (m), high (h) |
| C1 | The number of online courses in Russian posted on the portal | 1–10 points | Low (l), below average (ba), medium (m), high (h) |
| C2 | The number of online courses in a foreign language posted on the portal | 1–10 points | Low (l), below average (ba), medium (m), high (h) |
| C3 | Number of computers per student | 1–10 points | Inadequate (in), Sufficient (s) |
| C4 | Number of applications in digital services | 1–10 points | Inadequate (in), Sufficient (s) |

The digitalization level of the university acts as an output variable. To evaluate the initial variable, the following qualitative terms were identified: L—low level indicator, M—medium level, H—high level indicator.

At the next stage, for each value of the term of a linguistic variable, a membership function is constructed.

Decision rules that will indicate a low level of digitalization of the university in terms of fuzzy logic will be determined as follows: «IF the value A1 is insufficient And the value A2 is low And the value A3 is insufficient And the value A4 is low And the value B1 is average And the value C1 is below average And the value C3 insufficient, THEN the level of digitalization of the university is low».

The surface visualization of fuzzy inference is used to analyze the developed fuzzy model for assessing the digitalization level of a university. On this surface, it's possible to establish the dependence of the digitalization level of the university on the input variables. This will reveal the strengths and weaknesses of the educational process, justify the necessary effective management decisions.

## 4 Conclusion

Thus, reform of higher education should meet the needs of the development of the digital economy, digital society, innovative and creative entrepreneurship and are the main tasks of a competitive country in the context of globalization. We will define the main directions of public policy for digitalization of education, namely:

- creation of educational resources and digital platforms supporting interactive and multimedia content with common access for educational institutions and students, including tools to automate the main processes of educational institutions;
- development and introduction of innovative computer, multimedia and computer-based learning tools and equipment for creating a digital learning environment (multimedia classrooms, training and research laboratory STEM-centres);
- provision of broadband Internet access to students and students in classrooms and auditoriums in educational institutions of all levels;
- development of distance learning using cognitive and multimedia technologies;
- use of SMART-complexes of academic disciplines;
- regular monitoring of the digitalization level of universities.

Thus, to sum up, it is worth noting that digital technologies make the learning process mobile, differentiated and individual. Under such conditions, the priority is to modernize the higher education system in order to provide conditions for the development of digital skills of citizens.

Therefore, in the current conditions, it is necessary to create a comprehensive national system of digital literacy development, combining the efforts of academic and non-formal education on the basis of public-private partnership by developing a list of digital skills and competencies for target audiences of individual industries, development of quality educational content, harmonization of regulatory framework

with European and world scientific initiatives, creation of technical conditions for the use of ICT in education.

In the context of globalization, the introduction of information and communication technologies into educational processes contributes to the individualization of learning, the expansion of access to educational resources and the realization of the possibility of learning without limitations on spatial and temporal characteristics with minimal disengagement from professional duties. However, the socialization of students remains a crucial function of traditional higher education institutions—something that no online or offline courses can adequately provide. International experience shows that in order to improve the quality of education, it is appropriate to use blended learning through different forms of learning.

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