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Elena V. Dostovalova, Pavel S. Lomasko,
Alexander A. Maschanov,
Elena M. Nazarenko, Anna L. Simonova
Russia

Teaching in a Continuously and Dynamically Changing Digital Information and Learning Environment of a Modern University

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Abstract

The article is devoted to the problem of specification of approaches to the design and implementation of electronic educational courses in conditions of continuously and dynamically changing digital information and learning environment of the modern university. Based on the results of the content analysis of the digital infrastructure and regulatory documentation of the Siberian Federal University and the discursive analysis of the leading trends in the field of digital education, necessary conditions for a successful professional pedagogical activity are described. On the basis of smart education principles, possible solutions to the problems of teaching at university, such as personification of teaching, project-oriented courses and initiating the launch of mechanisms for students' informal self-education are synthesized and justified.

Keywords: *quality of teaching, digital information and learning environment, dynamically changing conditions of pedagogical activity, digital learning technologies, e-courses design, digital education, smart education, project oriented courses*

Highlights

The digital information and learning environment of the modern university represents a continuously and dynamically changing infrastructure, which is caused by the rapid development of information technologies and the nondeterministic expansion of the global telecommunication environment.

Teachers of the modern university need to learn to instantly change the ways of solving professional problems in the new conditions, to effectively use educational management systems, telecommunication services, and learning technologies in particular.

To increase the effectiveness of projecting and implementation of educational activities by means of digital information and learning environment it is necessary to take into account cognitive specific features of the "digital natives", approaches to the design of personalized eCourses, current trends in digital learning technologies, the current state and trends in the transformation of the global telecommunication environment.

Personification of training, implementing the principles of smart education and initiating the mechanisms for students' informal self-education may become possible options for improving the quality of teaching in the new environment.

1. Introduction

1.1 University teaching in the digital world

Over the past few years, along with the already prevailing ideas about the ways and means of designing and implementing the learning process in the digital environment, there have been less clarified aspects related to the qualitative characteristics of digital educational content, the psychological and pedagogical requirements and the organizational conditions that provide the effectiveness of training by means of eCourses, which are on the one hand part of learning management systems, on the other hand are integral elements of the digital information and learning environment of a modern university. From the theoretical point of view, it should be noted that there are different approaches to the definition of meanings of the main terms related to teaching in an environment saturated with modern information technologies; it borders with the ambiguity of the organizational and pedagogical conditions worked out on the basis of the terms mentioned above, the conditions that contribute to the achievement of the expected educational outcomes of a particular program.

There is already a well-known definition of the term "quality of teaching" and agreeing with I. Koroleva (Koroleva, 2012), the quality of teaching is understood as the demonstrated level of the teacher's educational activity characterized by high results of students' outcomes, able to meet the needs of all participants of the educational process in accordance with the current conditions and requirements of the emerging smart society, the basis of which are the e-learning technologies.

Analyzing the state of development of pedagogical thought in the area connected with improving e-learning systems, one should turn to the already known and well-grounded provisions. First of all, it should be noted that modern students are representatives of the class of "digital natives". This has been repeatedly substantiated in the papers by M. Prensky (Prensky, 2001, 2010), G. Kennedy (Kennedy et al., 2008), P. Thompson (Thompson, 2013), S. Wang (Wang et al., 2014) and others. Such belonging essentially determines the peculiar features of cognitive processes and facilitates the success of the technology-based educational and cognitive activities. Particularly convincing arguments in favor of transforming the educational paradigm taking into consideration the realities of the information technologies development and the global communication environment have been proposed by leading researchers (Siemens et al., 2015; Gee, 2013; Kampylis et al., 2015). G. Siemens (Siemens, 2005) offers a new philosophy of education — connectivism.

What exactly should be taken into account when designing and implementing training in the digital environment, aiming at reaching the educational outcomes by modern students, especially late teens and 20–30-year-olds? Having analyzed a large number of scientific publications, including the papers by A. Arguel, L. Lockyer (Arguel et al., 2017), M. Horn (Horn, 2013), N. Kucirkova, K. Littleton (Kucirkova & Littleton, 2017), B. Sorensen, K. Levinsen (Sorensen & Levinsen, 2015), H. Beetham, R. Sharpe (Beetham & Sharpe, 2013), K. Tyner (Tyner, 2014) and others, the authors of this paper have identified the basic prerequisites for improving education systems when learning in the digital environment.

1.2 Specific features of modern teaching conditions

It becomes more and more obvious that the modern stage of the development of education systems of different countries determines the need for such a complex of digital tools that would allow for creating conditions for solving educational tasks regardless of time, place, environment by means of a terminal device (a smartTV, mini-computer with HDMI, smartphone, tablet, laptop, desktop computer, and in the foreseeable future a portable gadget such as "smart glasses" or devices of augmented and virtual reality) and, positively, high-speed Internet access.

The second significant change is that in the digital age learning involves different patterns of education and ways of cognitive activity, as described systematically in the papers by A. Manuti, S. Pastore and others (Manuti et al., 2015). After closer examination, it appears that the educational processes in the digital age can be implemented in the following styles.

1. Formal education, in particular in Russia, where education is acquired within the framework of accredited educational institutions and is determined by the state policy of a particular country in the field of education. In this case, the forms of training are still full-time studies such as lectures, seminars, laboratory and practical work.
2. Non-formal education, defined to a greater extent by the systems of additional education and professional development, private centers and schools, as well as by individual or group coaching technologies. At the same time, the prevailing types of cognitive activities are: training, video lectures, multicasts, screencasts; participation in webinars, surveys, virtual forums and seminars; studying specially designed training materials (presentations, scribes, mental maps, interactive timeliners, etc.); fulfilling control papers and working independently on various activity elements implemented within the framework of the specific LMS/LCMS/TMS; as well as informal educational events such of hakathons and meetups.
3. Informal education, carried out by means of self-controlled search and analysis activities in electronic libraries, videohostings, topical communities of social networks; entering into consultative communication and discussions with members of virtual communities; as well as self-initiated digital story-telling, blogging, reposting by means of hash tags; generation of digital content (video streaming, screencasts, infographic, diagrams, presentations, articles) regarding the issue under study or the task of the educational activity being solved.

The third change has occurred due to the expanding access to information (the so-called "knowledge clouds" and "communication clouds") and the rapid changes in educational technologies, as evidenced by the papers of W. Bowen (Bowen, 2014), J. Ramaley (Ramaley, 2014), F. Fatkullina, E. Morozkina, A. Suleimanova (Fatkullina et al., 2015), P. Altbach (Altbach, 2013), and others. It should be noted that due to the rapid development of information technology, modern teachers working in higher education face the necessity to adapt the existing educational practice without having clear instructions that take into account students' topical needs and the potential of new technologies and means. The availability in the existing theoretical knowledge of a wide range of approaches and means needed

for modernization of education have caused considerable difficulties in the work of teachers and methodologists, who should design ecourses in accordance with the curriculum requirements.

The fourth important factor, apart from the colossal opportunities offered by digital educational technologies and resources of the global telecommunication environment, is the need to provide personification of the educational process. One of the global values in teaching in the 21st century is humanism and the creating conditions for maximum consideration of students' individual characteristics and needs. The general principles of the transformation of education systems towards personalized learning today are reflected in the concept of smart education. This fact is confirmed by the papers of H. Ronghuai (Ronghuai, 2014), T. Kim, J. Cho, B. Lee (Kim et al., 2013), V. Uskov and his co-authors (Uskov, et al., 2016), M. Coccoli, A. Guercio (Coccoli *et al.,* 2014), V. Tikhomirov, N. Tikhomirova and many others, the discursive analysis of topics of scientific conferences and symposiums over the past five years also supports the abovementioned.

Thus, at the present stage, higher education teachers face many unresolved problems and issues requiring careful scientific consideration. It is not possible to find in the existing scientific knowledge a full answer to the question of what exactly determines the high quality of teaching within the developed digital information and learning environment of the university, which justifies the relevance of this article.

Summarizing the introduction, it is necessary to define the scientific problem of this study, which is to determine ways to improve the quality of teaching in higher education in the design and implementation of eCourses that take into account students' learning styles and the opportunities offered by information and communication technologies to ensure students' learning outcomes in conditions of the transformable digital information learning environment of the modern university.

The goal of the research is the theoretical grounding of the conditions required for the successful professional activity of university teachers in the area of development and implementation of educational eCourses in the transformable (continuously and dynamically changing) digital information and learning environment of the modern university.

In order to achieve this goal, the authors of this article aimed at finding answers to the following fundamental questions:

1. What components of the digital information and learning environment are required for quality teaching?

2. What should be the optimal structure and content of the eCourse, ergonomic and didactic characteristics of the separate elements of the digital educational content that would take into account the learning styles of modern students, their individual needs and abilities?
3. What exactly should the teacher take into consideration when developing and using the eCourse which involves a combination of students' formal, non-formal and informal learning styles in order to provide flexibility, variability, reproducibility and adaptability of the educational process (defined as key principles of smart education)?

2. Materials and Methods

1.1 Components of digital environment as factors of the quality of teaching at the higher education institution

The first stage of the work was to identify the components of the digital information and learning environment of Siberian Federal University, Krasnoyarsk, taking into account the needs of the teacher's professional activities in conjunction with the opportunities they are provided as necessary for organizing effective teaching. The components were identified by means of the content analysis method applied to the existing infrastructural entities and Internet services by questioning 45 experts among the faculty of SibFU, who studied eLearning at the professional development courses delivered by P. Lomasko and A. Simonova within 2016 and 2017. As criteria for content analysis the following were identified (Table 1).

Table 1. Criteria for content analysis

Code	Criteria	Points (1–10)	Use (P/N)
A	Usability		
B	Instant user adaptation		
C	Variety of tools		
D	Collaboration abilities		
E	Ubiquitous access		
F	Mobile usage		
G	Adaptive interface		
H	Personification		
I	The need to use		
J	Management		

Code	Criteria	Points (1–10)	Use (P/N)
K	Impact on teaching quality		
L	Feasibility of using in teaching		

Experts assessed the components of the above criteria on a scale of 1 to 10, indicating the degree of their influence on the quality of teaching: 1 point – minor, 5 – significant, 10 points – significant. At the same time, the following information resources and infrastructure were subjected to content analysis and expert evaluation as components:

1. University e-Learning system, eCourses (e.sfu-kras.ru), which uses Moodle 3.1 platform and is intended as LMS.
2. Personal account at i.sfu-kras.ru, working on the Bitrix-24 platform and intended to provide employees with individual information, corresponding to their work at the university as a CRM.
3. The digital environment of the SibFU Scientific Library (lib.sfu-kras.ru), which is designed to provide access to the book fund and part of the electronic learning resources.
4. SibFU video conferencing service (webinar.sfu-kras.ru), which works on the basis of the Mind platform and is intended for organizing webinars.

Additionally, the experts were interviewed about using Internet services which provide free and relatively free opportunities for solving teaching problems. Among such services, the following were singled out:

5. The service for creating Mindomo mental maps (mindomo.com), which allows for creating demonstration maps-presentations, organizing students' joint activities and interactive assignments.
6. Service for creating zoom-presentations, Prezi Next (prezi.com), which allows for creating interactive and non-linear online presentations enriched with multimedia content.
7. Free online timeline maker (time.graphics), which can be used to demonstrate any processes in time and also provides opportunities to compare and analyze any data.
8. Service for creating concept maps, Coggle (coggle.it), which allows for composing a structured and compact system of concepts in the selected knowledge area.
9. The digital storytelling service, Powtoon (powtoon.com), which provides opportunities to create and demonstrate scribe-videos and presentations.

10. LearningApps (learningapps.org), which is a web-based application that provides learning and teaching processes with small interactive modules – learning exercises and didactic games.

In addition, experts were asked questions about the prospects of using these components in teaching practice, which they marked by the code P (1) – perspective and containing more advantages which can be determined by the quality of teaching; N (0) - non-perspective which contains more risks and disadvantages both for the teacher and for the study process.

It should be separately noted that in the situation where an expert is not familiar with the component of the information environment or the service offered in the survey, all the criteria were indicated with zeros. This approach allowed for drawing additional conclusions about the university teachers' degree of awareness of the tools offered by the information and learning environment of the university and additional opportunities for its expansion.

3. Results

The results of the expert survey of using the components of the digital information and learning environment of Siberian Federal University in the teachers' professional activities presented in the form of modal values for each criterion (Figure 1) indicate that the eCourses e-learning system (e.sfu- kras.ru) in combination (by some criteria) with the services offered by the personal account (i.sfu-kras.ru) and the university electronic library (lib.sfu-kras.ru) are most sought-after. The SibFU videoconferencing service (webinar.sfu-kras.ru) is less popular, which can be justified by the teachers' low readiness to use it and the "closeness" of the service due to the information security policy.

Similarly, the results of the survey of external web services for educational purposes were processed. The results are shown in a diagram (Figure 2). The results of the survey indicate a low degree of the teachers' awareness in the field of Internet services for creating visualization tools and interactive content, the principles of working with them, accessible tools, the opportunities of embedding and integrating them with electronic learning courses. This explains the low demand for additional services as an extension of the LMS of the SibFU e-learning system, eCourses, which significantly reduces its opportunities to develop electronic learning courses that meet the modern requirements for multimedia, interactivity and activity-based learning.

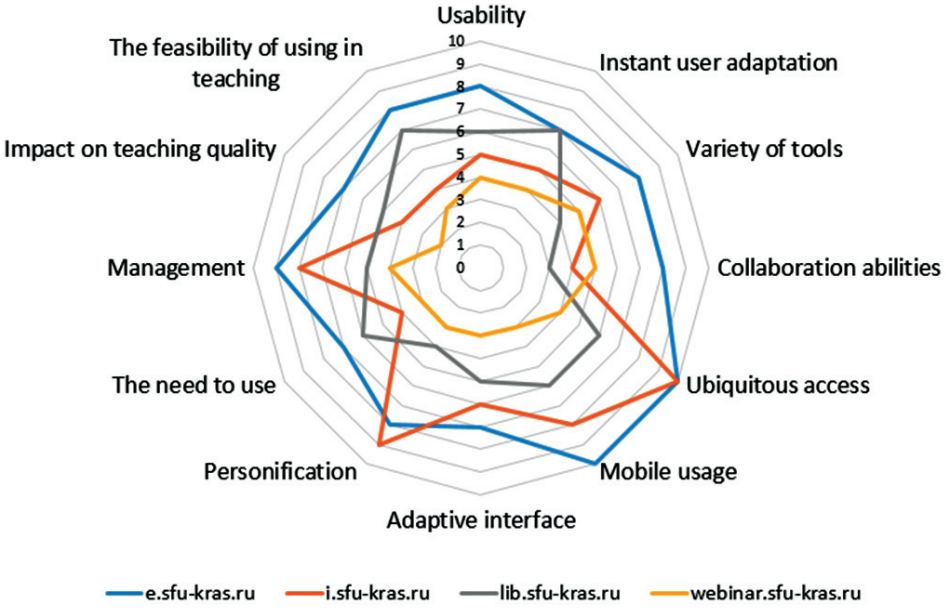

Figure 1. Results of content analysis of SibFU infrastructure

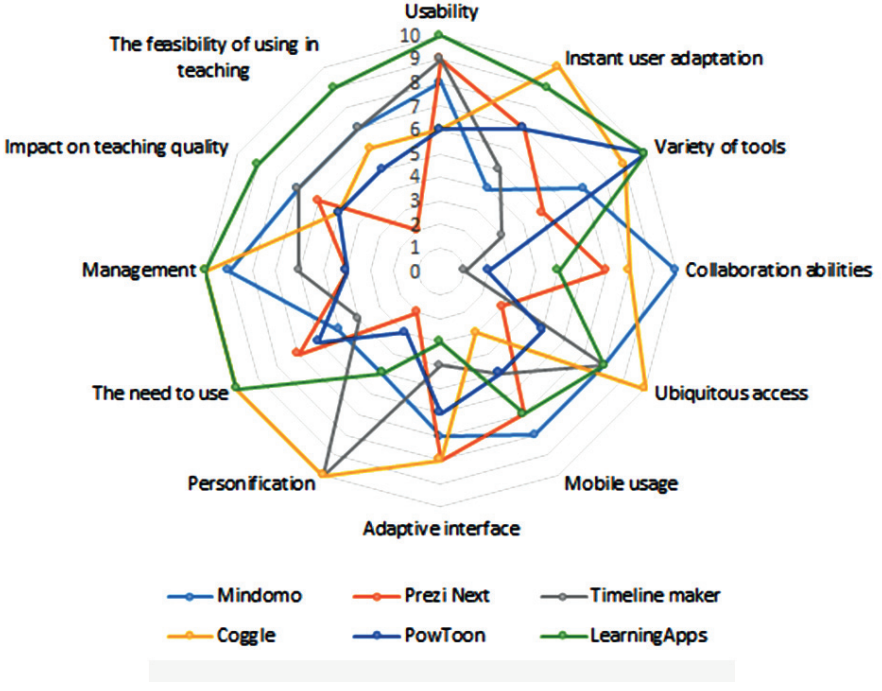

Figure 2. The results of the content analysis of educational web services

The prospective use of learning services was estimated by 45 experts in accordance with the dichotomous scale (0 – non-perspective, 1 – perspective) and then summed up in the overall indicator. The sum of the values made it possible to determine the rating of external Internet services influencing the quality of teaching. This rating shows the positions which allow for expanding the range of cognitive activities within the e-learning system being implemented (including the mixed e-learning model).

Table 2. Rating of external Internet services influencing the quality of teaching

Position	Sum	Object
1	42	LearningApps
2	40	Coggle
3	39	Mindomo
4	37	Timeline maker
5	30	Prezi Next
6	28	PowToon

Thus, on the basis of the obtained results the following conclusions can be drawn.

First, the main tool of the SibFU teacher at the moment is the eCourses e-learning system based on LMS Moodle 3.1, with a standard set of tools provided by this platform.

Second, the conditions and tools provided by the university information and learning environment are necessary for the professional activity of the modern university teacher, but they have an impact on the quality teaching when the teacher is properly informed about its functional opportunities and ways of using them.

Finally, additional educational means and resources are rather popular in the teacher's professional activity when the teacher understands the specific features and needs of modern students – consumers of educational content in the form of eLearning courses and ways to meet them.

4. Discussion

The results of the study confirmed the obvious fact that one of the main means of implementing eLearning is an eCourse, the quality and relevance of which determines the effectiveness of training carried out with its use.

Correlating the ideas of classical pedagogy with the modern conditions of the digital environment shows that in the design, development and implementation of e-learning it is necessary to create conditions that ensure the observance of general didactic principles, as well as consistency of the internal learning process of mastering the knowledge which includes the stages of perception, comprehension, generalization, consolidation, and use, taking into account the learning styles of modern students'– representatives of the z-generation. The characteristic features inherent in the z-generation are described in the papers of researchers (Brunner J.L., Wallace D.L., Reymann L.S., Sellers J.J. and McCabe A.G.) (Brunner et al., 2014) on the basis of the provisions of the theory of generations (Strauss & Howe, 1992). Individualism, a clear ranking of priorities, clip thinking and, as a consequence, the capability of multitasking and hyperactivity were defined as such.

The above-mentioned features require observance of certain techniques in teaching and learning that contribute to improving its effectiveness (Wilson & Gerber, 2008). The examples include: a clear statement of the problem (simple and concise, but at the same time interesting and individually significant), division of labor and distribution of responsibility, individual motivation, the presence of clear instruction (preferably in printed form with visualization elements); the availability of clear criteria for assessing the results of the work performed (Sapa, 2014). Taking into account these criteria, it is advisable to adopt the technology of complete assimilation (Bloom, 1976) as psychological and pedagogical grounds for developing an electronic course and its content.

The technology of complete assimilation sets a unified (minimum) level of mastering knowledge, abilities and skills, but makes the time, methods, forms, and working conditions variable for each student. For this technology, the planned learning outcomes are determinative, the outcomes should be achieved by all students – this is the standard of complete assimilation.

The standard is given in a unified form by means of taxonomy of goals, i.e., a hierarchically interrelated system of pedagogical goals developed for the mental, sensory and psychomotor spheres. The goals of the forthcoming activity, the exact actions and operations are identified for the student to perform in order to achieve the described standard. The levels of students' achieved outcomes are as follows: knowledge (remembered, reproduced, learned); understanding (explained, illustrated, interpreted); application (applied the studied material in specific conditions and in a new situation); generalization and systematization (singled out parts from the whole, formed a new entity); evaluation (determined the value and the significance of the object of study). The development and presentation of

the eCourse elements with this technology consists of dividing the content into separate educational units that are complete in meaning (content integrity), small in size, and presented in various forms.

Control and measuring materials are prepared for each of the units. For each educational unit, correctional didactic material is also developed, intended for additional elaboration of the material which has not been mastered, which differs from the original way of studying it and enables the learner to choose suitable ways of perception, comprehension and memorization.

Taking into consideration psychological and pedagogical characteristics of the younger generation, it is possible to designate a system of principles for developing and implementing a modern electronic course in relation to its structure, the manner of presentation of the educational content, ways to organize the learner's activities with the content, monitoring and evaluation tools and activities.

When developing the structure of an eCourse and choosing the methods and forms of presentation of its educational content, it is necessary to observe the principles of modular teaching, clipping (distributing the material into parts), "min-max", taking into consideration the activity-based and learner-centered approaches to its implementation. The modular teaching approach involves splitting the course into separate modules or sections with the described specific learning outcomes and the form of activity for each of them. Inside the module, the material in accordance with the clipping principle is presented in the form of small "portions" – elements, mastering of which requires no more than 15 minutes.

Educational content elements should be presented in various forms and types with regard of the student's personal characteristics in accordance with the leading channel of information perception (auditory, visual, and kinesthetic). The "min-max" principle assumes splitting the information within a module into blocks for compulsory mastering (min) and additional material for deepening into the subject area (max).

Such an approach allows for initiating the manifestation of non-formal and informal types of students' cognitive activity. Each content element should be presented in the form of an activity with an indication of the outcome that will be obtained by the learner in the process of performing this activity, while providing for the variability in the choice of the content of activities in accordance with personal preferences, which will provide flexibility and personification of the learning process.

Designing ways to organize the learner's activities in the process of mastering an eCourse, ways to manage the learner's activities as well as monitoring and evaluation activities imply compliance with the principles of a systemic approach,

distribution into levels, and interactivity. The principles of the systemic approach and distribution into levels require a system of methods applied to the learner's activities in accordance with the technological stages of complete assimilation and observance of the sequence in reaching the levels of learning outcomes, i.e., according to Bloom's taxonomy (Bloom, 1976). Such a sequence will determine the increasing level of interactivity elements of educational content from a nominally passive approach to an active one, based on activity and research (Osin, 2007).

The implementation of these principles also needs specifying clear requirements for the student's learning outcomes, the form of presenting the learning outcomes and evaluation criteria. Motivation to perform the activities within an electronic course can be provided by including game elements, self-control, quick feedback of the resultant and consulting character, and by means of constructing an internal, conditionally closed course environment by means of integrating all its elements to ensure that the learner's attention is focused on a particular type of activity.

An electronic educational course developed in accordance with the principles described above, implemented by means of modern LMS provided by the university infrastructure, integrated with the electronic library and communication environment, as well as a varied set of external Internet services makes it possible to implement both blended learning (using "inverted class" technology) and distant learning, combining students' formal, non-formal and informal cognitive activities, which provides flexibility, variability, reproducibility and adaptability of the learning process. Thus, it allows for asserting that these are characteristics of smart education.

5. Conclusion

To sum up the results of the research, it is necessary to indicate the main outcomes and conclusions.

First, it should be noted that when studying the specific features of teaching in a continuously and dynamically changing digital information and learning environment of the modern university it was discovered that the quality of teaching is directly related to the satisfaction of the needs and demands of a new stage in the development of civilization – a smart society. At this stage, education as a process exists in the global telecommunication environment saturated with digital resources and information systems.

Thus, to ensure the proper quality of teaching it is necessary to use a wide range of digital devices, including various gadgets and portable electronics to a greater extent for both formal and informal education. However, to do so it is necessary to change the approaches to the design and implementation of the digital learning content – taking into account the current trends in the field of digital education (technologies of blended and flipped learning, digital storytelling, mindmapping, augmented reality, etc.).

Second, within formal education the electronic course remains the basic element of the university digital information and learning system realized on the basis of learning management system platform (LMS/LCMS/TMS). For quality teaching by means of electronic courses, it is necessary to take into account the whole set of factors influencing its effectiveness. First and foremost, these are cognitive specific features of the new generation – the "digital natives" such as clip thinking, the state of being gadget-focused, visual thinking prevalence, mobility, full immersion in the global telecommunication environment, but at the same time the expressed demand for the teacher's individual approach and instant feedback. These features should be taken into account for the development of electronic courses in general, their design, and the content of their individual elements. Training the new generation in accordance with its requests implies provision of flexibility, adaptability, variability and reproducibility to the educational process.

The third result of the study is laying the grounds for the request from the faculty for, on the one hand, more active incorporation of the infrastructural elements of the university information systems into the educational process, and on the other hand, the need to extend the variety of learning and cognitive activities in the digital information and learning environment by means of external Internet services of educational character. In particular, the technologies of mind-mapping, construction of digital concept-cards and visual products, and interactive learning exercises are most promising.

Finally, the abovementioned suggests that the proper quality of teaching at a new stage in the development of society should be ensured by the transformation of the digital information and learning environment by expanding it, by launching and supporting the mechanisms of cognitive activities in various modes of formal, non-formal and informal education, respecting the principles of smart-learning, which are designed to provide self-direction, mobility and motivation, adaptability, relativity and timing for the student's individual needs.

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