INSTRUCTIONAL DESIGN OF TECHNICAL DISCIPLINES IN THE IMPLEMENTATION OF DISTANCE EDUCATION IN TULA STATE UNIVERSITY

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ABSTRACT

The paper reviews the structure of Tula State University Internet Institute. It defines the challenges and the issues of legal and practical nature that place limits on the use of a number of tools for content creation in e-learning.

The authors describe the methodology for developing an efficient online course content design for engineering specialties to be used in e-learning at Tula State University Internet Institute.

The main challenge that the authors face is how to adapt and integrate the engineering subjects into e-learning, as they are not so easy to grasp; the online courses should not only include the minimum and fully informative theory, but also a set of practical tasks to solidify the theoretical knowledge gained.

To make the online courses student-friendly their developers try to present the lectures and tutorials in a more demonstrative and systematized way; explanation of the terms and notions goes together with visual support, texts are replaced with multimedia; scenarios for visualization of education modules are also being developed in order to make learning more dynamic, get the best use of the information on the screen and involve the emotional memory of students.

Theory is presented in the form of space-effective interactive schemes and tables with clickable buttons to go for more detailed description; the hyperlinks allow going to the other sites to get extracurricular information on the subject studied. Online courses are supported not only with student-friendly colorful and vivid images, but also with 3D models, animation, Flash- and video clips, which give the fullest idea of how some processes and some complex engineering systems work.

To solidify the gained theoretical knowledge the online courses are supplied with “multimedia lab work” with Flash- and video clips providing instructions on the lab work; this fact allows transition from a real lab work (sometimes quite dangerous and expensive) to on-screen one where all physical effects are demonstrated.

Apart from the theory online courses contain references and links to regulatory documents (National State Standards, Construction Norms and Specifications, etc.) which help the students study without wasting time on searching for the standards and give the opportunity to timely get the current reference data.

Knowledge assessment is organized in several e-learning forms which allow the students not only doing “multimedia lab works” and getting the feedback on results and accuracy, but also the final testing.

The paper also provides some managerial solutions on how to approach the challenges and solve the tasks of developing an efficient online course content design for engineering specialties to be used in e-learning.

KEY WORDS: Adaptation of technical disciplines, Educational learning resource, E-learning, Instructional design of technical disciplines, Internet-Institute

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Today the Internet has already become a cross functional information and communication environment with a set of its specific information technologies; this fact enables us to speak about education via the Internet (e-learning), which is understood as implementation of Internet-technologies into educational activity and formal and organized education for different social, national and age groups. As a result, the educational ties between different countries and universities are becoming closer.

According to the Federal Law on Education in the Russian Federation, the process of education and training in different educational institutions is being organized in various forms: intramural, on-site and off-site, extramural education and external studies. While choosing the form, such aspects as student's requirements, his/her individual type of character, the ratio of classroom work within a curriculum, etc. are taken into consideration. Educational institutions have the right to use and implement e-learning and distant educational technologies when training the students according to their educational programs. Nowadays it is possible to combine various forms of learning and teaching. The unified Federal State Standard for Higher Education specifies and regulates all forms of learning and teaching in the frames of a general or professional educational program/syllabus.

In the modern world e-learning is one the most fast-growing spheres of education. The effectiveness of any educational technology is proportional to the time which is devoted to the interaction between the tutor and the student. From this point of view, e-learning takes “an in-between” position among the traditional full-time, part-time and extra-mural education. As a result of information and communication technologies development, the extent of information which goes from the teacher to the student has grown significantly in comparison with all other existing patterns of traditional correspondence (extramural) training. It happens so because of the use of interactive and online features within the online course of study: online exercises and tests, forums, chats, etc. It is worth while mentioning that these features not only help conduct a dialogue between the teacher and the student, but also facilitate communication among the students studying one and the same major. It is exactly the interactive and online features in the course of study that encourage students’ self-guided and independent work (out of classroom); this fact speaks in favor of e-learning implementation in all educational forms.

The advantages of e-learning are as follows:

- quality of educational services, which is characterized by extensive knowledge database, non-stop syllabus renewal, full and complete set of educational and methodological resources, and access to the tutor;
- adaptability, which includes the unique chance of adaptive education (flexibility of training tempo, possibility to study from any geographical location, possibility to study at any time of the day convenient for the student) together with the simplicity of enrollment, comfort of the process of study, and opportunity of taking exams without leaving the place of residence;
- costs effectiveness, which means a critical reduction of educational costs.

At the same time to the general advantages of e-learning implementation in Russia can be added the following ones:

- national potential creation and development;
control of students’ number going to study abroad;
increasing of Russian Education “weight” on the international level;
creation of prerequisites for information society development;
provision of regional economy with highly-skilled specialists;
prevention of economically-active population and workforce drain from the regions.

In a related move, for the recent six years Tula State University (TSU) has been carrying out an empirical research directed towards design and simultaneous implementation of distance online educational technologies with the use of the Internet potential. The research is being conducted on the basis of TSU Internet-Institute. The structure of Internet-Institute is represented by four departments (Figure 1).

**Figure 1. Internet-Institute structure**

Communication and coordination department is responsible for the communication with the students. Information resources department is in charge of creating multimedia and on-line versions of teaching materials together with education syllabus and programs. Technical support department is responsible for administration of Internet-Institute site and its learning platform. It also maintains the hardware operating capability. International department works with international students.

The main function of this structural subdivision is the development of the educational environment allowing to implement e-learning that results in individualization and informational support of the educational process and also in:
• development and implementation of innovative teaching methods into the educational process at all levels of non-stop life-long education (vocational, higher, post-graduate and extended education);

• realization of higher professional education syllabus and programs on the basis of intramural, on-site and off-site, and extramural education with the use of open-source learning platform MOODLE, the Internet and blended technologies in order to fully satisfy the need of society and the government in highly-skilled specialists with higher education.

However, Internet-education presupposes some organizational difficulties; the main of them are:

• the absence of legal, statutory and regulatory basis for educational process in e-learning;

• the problem of how to organize and manage the educational process in conditions of e-learning use.

In Tula State University Internet-Institute the organizational side of the educational process together with rights and duties of the participant of the educational process are brought under regulation in accordance with the legislative acts of the Russian Federation in the sphere of education and Tula State University Charter. There are also additional specification documents (regulations, instructions, etc.) which bring under regulations the educational activity of Internet-Institute. They were developed at Tula State University according to the legislative acts of the Russian Federation in the sphere of education.

Internet-Institute provides higher education according to licensed higher education professional programs in different specialties, which are defined by the state license giving Tula State University the right to conduct the educational activity in accordance with the State Educational Standards and their requirements. By now it has been opened 11 specialties of Bachelor's training (Design, Management, Technology of Transport Processes, Technosphere Security, Economy, Physical Education, Electrical Energy Industry and Electric Engineering, Civil Engineering, Hotel Business, Customs, Jurisprudence) and 4 Master's specialties (Jurisprudence, Physical Education, Management, Design).

The active use of distant educational technologies together with their implementation into the educational process give the student an opportunity to study the lecture material, prepare term-papers, do current tests and go through the final testing in MOODLE via the Internet on the independent basis at any comfortable time and place. Moreover, the review sessions with the tutor are possible both in MOODLE (forums and chats) and with the help of such communication media as Skype. It should be also stressed that the student has the right to come to an on-site review session and meet the tutor face-to-face.
THE STAGES OF DEVELOPING AN EFFICIENT ONLINE COURSE CONTENT DESIGN FOR ENGINEERING SPECIALTIES TO BE USED IN E-LEARNING

The main didactic unit in the light of the abovementioned technologies is the online multimedia course which is an online multimedia teaching resource (electronic learning resource) composed on the basis of a peculiar technology, specially-designed at Internet-Institute.

One of the main difficulties in adapting academic subject areas to being used in e-learning is concerned with creating the electronic learning resources of such engineering specialties as “Engineering Graphics”, “Performance of Construction Materials”, “Electric Engineering”, “Machine Components”, “Material Engineering”, “Fundamentals of Energy Engineering”, “Ventilation”, “Air Conditioning”, etc. Since these academic subject areas are quite difficult for understanding, the electronic learning resources should include not only lecture courses, but also the sets of tests, lists of topics for term papers, self-study tasks, and tasks for virtual laboratory-based work, because these types of learning activities can help the students solidify acquired theoretical knowledge.

To optimize the processes of understanding and acquiring the knowledge, the developers of electronic learning resources convert the traditional teaching materials into a vivid, demonstrative and systematized form. The process of converting is done with the help of a tutor who is a specialist of teaching in this or that particular major. It has a number of steps:

- the way of content presentation of defined,
- the texts, schemes, graphs and illustrations are singled out in order to be replaced by the multimedia ones,
- the scenarios of module visualization are developed (it adds more dynamics to the process of education, allows to put more stress on the emotional memory of the students and helps to get rid of the bulks of texts on the screen).

The result of collaborative work of the tutor and information resources department is the educational on-line learning resource containing visual and functional components which helps the students of engineering specialties study the course material independently at any time and place comfortable for them.

VISUAL CONTENT COMPONENTS FOR E-LEARNING

The student gets the preliminary idea of an academic subject area watching a video-presentation prepared by the tutor. Video-presentation is a 30-40-second video-clip where the tutor reveals the subject matter, its aims, goals and tasks are revealed (Figure 2).
To provide the best understanding of theory, the electronic learning resources are supplied with full-color graphic presentations, stimulating the interest for the subject studied (Figures 3, 4, 5).

Figure 2. Video-presentation of the electronic learning resource made by the tutor

Figure 3. Illustration of a technically-complicated equipment in the electronic learning resource “Gas Supply Systems”
Figure 4. Illustration in the electronic learning resource “Workplace Safety”

Figure 5. Illustration in the electronic learning resource “Workplace Safety”
The resources contain large amounts of theoretical data supported by hyper-links which let the students go to the third-party Internet sites for more profound conversance with the subject matter under consideration (Figure 6).

To reach the aim of demonstrativeness and clarity the theoretical data are presented in the form of compact interactive schemes and charts where it is possible to click on any element to get more detailed description (Figures 7, 8).
3D-models, animation (Figure 9), Flash- and video-clips are also used while designing electronic learning resources in order to meaningfully demonstrate a peculiar complicated engineering system in operation.

For instance, the use of 3D-models and Flash-clips in electronic learning resource “Engineering Graphics” allows the students to visualize in 3D the sequence of steps in making a drafting projection and understand the methods of solving engineering tasks, that is rather difficult to do using 2D textbooks (Figure 10). Visualization and better understanding affect the accuracy and time of graphic work performance favorably.
In the resource “Gas Supply Systems” and “Air Conditioning” the theoretical schemes explaining how different power plants work and how the air is conditioned were replaced with Flash-clips demonstrating in detail the principles of various power plan components work performance and substance circulation (Figure 11).
Virtual laboratory-based work in e-learning can replacing the “real” laboratory-based work (sometimes expensive and even dangerous) in such majors as “Open-Pit Mining” where, for instance, in order to conduct an experiment it is necessary to demonstrate explosive processes. In our case the student can do a virtual experiment/simulation, which fully demonstrates all those effects that can appear in the course of a “real” experiment.

To increase the quality of students’ performing the tasks of virtual laboratory-based work, such resources as “Electric Engineering” and “Performance of Construction Materials” have instructional guidelines in the format of scored Flash- and video-clips. They explain the students the preparatory procedures, the plan and the steps of virtual laboratory-based work itself (Figure 12).

![Figure 12. Virtual laboratory-based work](image-url)
Apart from theoretical data, the electronic learning resources also contain hyper-links to the regulatory documents and reference data; these materials help the students study the course without using supplementary sources data and immediately get the current reference (Figure 13).

The electronic learning resources designed by us also have functions of searching according to key words and making marks and “bookmarks” while reading (Figure 14).
The resources are supplied with the lists of highly-specialized terms (glossary). Navigation is also user-friendly and lets the students study the academic subject area in a mode comfortable for them.

**Monitoring and Testing Knowledge and Skills in E-Learning**

It is very important not only to give the students the knowledge required, but also to monitor and check the results of learning. For this purpose Internet-Institute specialists have also developed a tool of assessment: it is a program which allows checking the correctness of current theoretical and practical tests and virtual laboratory-based works and organizing final testing distantly and remotely.

The use of electronic learning resources in MOODLE presupposes that the students choose the strategy and pattern of studying the course independently and by themselves. It is necessary to add that the database saves all the attempts of data input (either correct of incorrect); this fact gives the tutor a possibility to differentiate the assessment of each work depending on the number of attempts.
CONTENT QUALITY CONTROL IN ELECTRONIC EDUCATIONAL RESOURCES AND EVALUATION OF INTERNET-INSTITUTE PERFORMANCE BY THE STUDENTS

The student questionnaire survey on a permanent basis is being conducted in order to assess the quality of the on-line educational learning resources and the performance of the Internet-Institute staff. The results of the student questionnaire survey demonstrate quite a high rating of Internet-Institute performance (Figure 15).

Figure 15. Student questionnaire survey results
CONTENT QUALITY CONTROL BY INDEPENDENT EXPERTS

To assess the quality of on-line educational learning resources is possible due to collaboration with independent accreditation and certification agencies. Thus, in order to form and develop independent quality assessment system, provide education quality guarantees according to the Bologna Declaration and the best examples of the world educational practice, Tula State University went through a procedure, which preceded the international accreditation within the program “UNIQUEe European Quality Mark” by “European Foundation for Quality in e-Learning (EFQUEL)” (Figure 16).

The main result of this program implementation was a visit of the expert commission of the foundation who prepared a expert report due to which Internet-Institute and Tula State University got some definite recommendations on how to organize high-quality e-learning in the future. In September 2011 Internet-Institute received a certificate of the program UNIQUEe European Quality Mark by European Foundation for Quality in e-Learning (EFQUEL).

In 2013 Internet-Institute commemorated 5 years since the moment it was established (Figure 17).
In 2013 Internet-Institute successfully went through the procedures of external audit in the frames of Quality Management System for Educational Establishments of Higher professional Education.

CONCLUSION

The electronic educational learning resources developed by us provide the students with the necessary educational material. The use of the resources while studying at engineering specialties does not presuppose the search for and use of any additional information sources. The implementation of the educational content, specially designed for e-learning, gave us a chance to present the learning material in a more demonstrative, dynamic and vivid way; such an approach accelerates the processes of understanding, memorizing and acquiring the knowledge and increases the quality of education. Multimedia educational learning resources for engineering specialties meet all the up-to-date educational requirements for e-learning. From the point of view of the content, they can be easily enriched on tutor's demand. These resources can provide the impartial assessment of knowledge and skills, which the student acquired in the course of independent studying.

The electronic educational learning resources developed by us are used in intramural, on-site and off-site, extramural education and external studies on the basis of e-learning and distant educational technologies. Students living in 24 countries are currently taking a course at Internet-Institute (Figure 18).
Therefore, working “no breach of laws” in the sphere of education, implementation of innovative technologies, cooperation with independent accreditation and certification agencies give a chance to overcome all the above-mentioned difficulties, redefine e-learning in Russia and cooperate internationally.
REFERENCES

Gryazev Mikhail, Satarov Alexander (2013), Modern information and communication technologies at Tula State University, Collection of reports of Russian participants of the I International Conference “The I International workshop conference “Modern information and communication technologies in higher education: New education programs, pedagogic with the use of e-learning and education improvement”, April 3-4, 2013, University of Rome La Sapienza, pp. 110-113
