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SMART-TECHNOLOGIES IN HIGHER ENGINEERING EDUCATION: MODERN APPLICATION TRENDS

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Abstract

This research is devoted to the identification of modern trends in the application of smart technologies in higher education system (HES). The focus on this topic is reasoned by the fact that smart technologies present one of the leading directions of social development, based on the synthesis of educational, scientific, technological, industrial and other practices. Nowadays many Russian universities are actively using separate elements of Smart-education and are exploring the possibilities of further expansion of their use. However, during the process of implementation of these projects, the barriers of administrative, financial, economic, industrial, scientific, technological and social nature occur. In this regard, it is important to follow the current trends in the development of Smart Technologies in a higher education system in general and in an engineering education system in particular. The study is based on modern research data in the field of smart technologies application in education. The authors come to the conclusion that the model of smart university represents a key point of the strategy for the development of higher education system of the future. Since the development of smart technologies in universities is related to the field of engineering, nowadays the most favorable environment for further transformations is created precisely in engineering universities, where these technologies will get better development.)

Keywords: Smart-technologies, engineering education, smart-education, smart-university, higher education system.

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1. Introduction

In the modern world smart technologies are one of the leading directions of social development, based on the synthesis of educational, scientific, technological, industrial and other practices. The peculiarity of this direction is that such technologies may be used not only as a material and technical basis for the development of society, but also form the basis of social practice, which presupposes the formation of new axiological and normative forms of organization of social interaction.

For Russia, this issue is of a strategic nature because it presents a matter of its survival as a country at least claiming the right to be considered as a modern one. It is obvious that in case when national higher education (engineering education) will not transform into a system of training such specialists who are able and willing to work in the direction of generation, development and introduction of Smart technologies into social practices, Russia may face a situation of further falling behind the leading global economies.

According to L. Connoley, the specificity of the definition of what we call Smart Technology (such as Smart City, Smart Networks, etc.) depends on the specificity of culture, society, the level of development of education, the level of economy, etc. (Connoley, 2013). Due to this reason, it is important to take into consideration social and cultural context when creating the conditions for the development, effective usage and even for successful borrowing of Smart technology.

For Russia, this approach creates a set of opportunities for the implementation of Smart Technologies, since the social and cultural diversity of Russian society present the environment for the generation and adaptation of a wide range of modern Smart technologies. The experience of modern Russia in the field of Smart technologies application illustrates this quite clearly (Makienko, Ardashkin, & Chmykhalo, 2017). In particular, nowadays Russian market has a significant number of companies offering a variety of Smart technologies for introduction into people's life. However, they are extremely expensive and not adapted to the infrastructure and needs of local population. Sometimes such Smart technologies are focused on meeting the Russians' needs, which have not yet formed (for example, Smart Apartments).

Thus, it becomes obvious that such issues should be addressed not only at a scientific and technological level, but also at axiological and educational levels.

2. Problem Statement

Many Russian universities, for example, Tomsk Polytechnic University already have some experience in the development of smart technologies in the field of educational, scientific and technological activities. In particular, the possibility of creating such systems as Smart Grid is actively studied; the elements of Smart-education are used. However, the process of implementing these projects may face certain administrative, financial, economic, industrial, scientific, technological, social and other difficulties.

With regard to above-mentioned aspects, we believe that the comprehension of the best international experience in the development of Smart technologies in educational environment (in the field of engineering education) may provide an additional impetus for the search for ways to transform Russian engineering education and society..

3. Research Questions

The research problem determined the formulation of the set of questions, the answers to which formed the content of this work; they are as follows:

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What is Smart Technology, what are the main components of its elements?

How does the concept of smart technology and education correlate?

What are the main directions of smart technologies application in education?

What are the main barriers in the development of smart technologies in educational, scientific, technological, social and cultural spheres?

4. Purpose of the Study

The purpose of our research is to determine modern trends of Smart-technologies development in the context of a higher education system in general and in engineering education in particular

5. Research Methods

In order to find the answers to the questions posed, the authors are planning to use the method of explication, which will help to clarify a number of key concepts and processes in the field of smart technologies application in the higher engineering education system. In addition, the authors intend to use the method of comparative analysis in order to demonstrate the specific nature of smart technologies in contrast to traditional technologies..

6. Findings

6.1. Theoretical grounds of the study of smart-technologies

In recent years, an increasing number of researchers are involved in the discussion of problems and prospects of the development of smart technologies. The society in which Smart Technologies develops in accordance with the English abbreviation (S-self-directed, M-motivated, A-adaptive, R-resource-enriched, T-technology) should function and develop as a self-directed, motivated, adaptive resource which is enriched and technological.

Different communities (EUA - European Universities Association, EU - European Union) and states (South Korea, Netherlands, and Australia) formulate strategies for the development of society in accordance with the development of Smart technologies; discuss key points and sources of state competitiveness formation.

This discussion is carried out within the framework of several main directions of research. Key directions among them are: Smart Society, Smart City, Smart Education, and Smart University.

The term Smart Society was proposed in the framework of an IP project funded by the European Union. The goal of the project is to understand how modern techno-social trends can be used to solve the problems of modern society. The researchers focus on various components of Smart-society. As a part of the research of British scientists Charles Levy, David Wong, devoted to the study of Smart Society formation in the UK, the following definition can be found: “Smart society is a society that successfully uses the potential of digital technologies, Internet networks and connected devices in order to improve people's lives”. In this case, the emphasis is on using different technologies in everyday life, as well as in production, management, in the formation of life infrastructure. The organization of human activity is represented in the studies of Charles Levy, David Wong by three components: life, work, game. It is

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assumed that these three components will be convergent, representing an optimal environment for the realization of human needs.

As part of another approach to understanding the phenomenon of Smart society, which is shared by Hartswood, Grimpe, Jirotka, and Anderson (2014), the attention is focused on how the increasing needs and limited resources can be reconciled in terms of the problem of increasing duration of life. The authors emphasize the need to use the integrative capabilities of a group and technology. In the framework of Smart Society, a group is seen as a source of experience that any member of this group can use, having access to it through computer technology. For example, various Internet platforms are used to organize travel or device applications that allow tracking traffic jams.

In the context of the approach proposed by Russian researchers V. Tikhomirov and N. Tikhomirova (2012), the Smart-society is defined as a new stage in the development of information society, which is characterized by new positive economic, social and other effects arising from the joint usage of various technical means, services and the Internet. The common trait is the following: in these presented concepts the Smart Society assumes the continuous creation and mastering of new technologies, requires to continuously develop and create knowledge and, accordingly, to create the environment and infrastructure for the production and transmission of knowledge.

Within the framework of the "Smart city" concept, the specificity of city life and the growing infrastructure issues associated with the growth of cities (Smart-city) is being comprehended. As R.P. Dameri (2017) notes, the discussion of the Smart City concept has now become a crucial topic in global scientific community.

Shapiro, Florida, Komninos et al. in their works noted the ability of a city to initiate innovations based on knowledge and creative human capital. Therefore, in many publications, the terms "smart city" and "city of knowledge" or "intellectual city" are often considered synonymous (Shapiro, 2003; Florida, 2003; Komninos, 2006).

An important role in the formation of smart city is played by universities and research centers that develop and test of innovative technologies in cities, study the cost of their implementation and estimate their benefits. For example, it was university environment which led the idea of "smart management" as an important component of successful implementation of smart city (Caragliu, De Bo & Nijcamp, 2009, Giffinger, 2007).

6.2. Theoretical grounds of the study of smart-education

Nowadays, it is possible to distinguish several different approaches to understanding of the notion of smart-education. One of such approaches is presented by experts from IBM (Smarter education with IBM). They define Smart Education as an interdisciplinary educational system focused on students, related to schools, tertiary education institutions (colleges, technical schools) and training institutions, which use (1) adaptive learning programs and portfolios for students, (2) collaborative technologies and digital training and resources for teachers and students, (3) computerized administration, monitoring and reporting of teachers on the results of classroom learning, (4) more information about students , (5) online learning resources for students around the globe.

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Other approach to understanding of Smart education is presented in the works of Coccoli, Guercio, Maresca, and Stanganelli (2014). They describe smart education as the type of education in smart environment supported by intelligent technologies, using intelligent tools and intelligent devices. Intelligent education is only the upper level, it also includes other aspects that must also be taken into consideration, namely: (1) communication; (2) social interaction; (3) transport; (4) management (administration and courses); (5) social security (safety and health); (6) management; (7) energy management; (8) data storage and delivery; (9) knowledge sharing; (10) IT infrastructure.

Also, in international literature, the term "technology-enhanced learning" (TEL) is used to describe the evolution of Smart Education. This concept is used to demonstrate flexibility in the mode of modern education. The technologies can be implemented through social media, network communication services or communication tools, their introduction into the content of education (Daniel, 2012), research, communication and collaboration (Bruce & Levin, 1997), in the creative self-expression of youth (Goodman, 2003), and evaluation of training programs (Meyer & Latham, 2008).

This concept emphasizes the situation that has developed in the educational sphere in connection with the development of mobile communications, communications means, personal home devices and other facilities with new software capabilities. In this context, mobile education has become the main paradigm of technology-enhanced learning (TEL). Mobile education emphasizes the use of mobile devices and focuses on student mobility, unlike traditional statistical modes of education. In addition, the support of pervasive technologies has led to further changes, namely the transition of education from mobile to pervasive education. Nowadays, education can be processed at any time and in any place without time, place or environment limits (Chan et al., 2006).

Another format of modernization processes occurring within the context of the modern system of higher education is presented in the framework of Smart University concept, which is reflected in the works of Tikhomirov and Dneprovskaya (2015).

The influence of smart technologies on the formation of Smart University and Smart education has led to the emergence of a complex of new technologies, such as smart boards, smart screens, as well as new conceptual ideas such as Smart Learning Environment, Smart Campus, Smart Teachers, Smart Learning Communities, Smart Classrooms, and others.

The concept of Smart Learning Environment is presented in the works of Hwang (2014). He defines this concept as a technology that adapts and provides appropriate support for trainees (guidance, feedback, tips or tools in the right places and at the right time, based on the needs of individual students, which can be determined by analyzing their education, behavior, productivity and online real-world contexts in which they are located). Intellectual educational environment is focused on the context of students' situation or the context of real environment where a student is located. An intelligent educational environment can offer instant and adaptive support to students by direct analysis of the needs of individual students from different perspectives.

A smart educational environment is able to adapt user's interface (ways of presenting information) and the content of education (for example, learning style) in accordance with the personal factors and individual preferences of individual students.

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A researcher from Hong Kong, Kwok (2015), defines Smart Campus as a new paradigm of thinking that relates to the holistic intellectual campus environment that includes several areas of university intelligence functioning such as holistic e-learning, social networking and communication for collaboration, the stability of information and communication technologies with the help of intelligent sensor management systems, protective and preventive medical care, intellectual building management with automated control and security oversight, as well as management and reporting of a campus.

In the work of Xiao (2013), a smart campus is presented as the result of the application and integration of cloud computing and IoT (Internet of things).

Smart Teachers are active participants of a smart campus. According to Abueyalaman (2008), the functioning of a smart campus depends on a strategy that includes people, facilities and ongoing support for teachers, as well as the effective use of technology. A smart campus demands smart teachers and provides them with smart tools and ongoing support to carry out their work, assessing their pedagogical effectiveness using intelligent evaluation forms.

The concept of intelligent learning communities captures the requirements of Smart Community. They are as follows:

1) reasonableness, the environment is perceived by sensors;
2) devices with a connected network bring information about perception to the network;
3) availability, information is posted in the Internet and is available to users;
4) ubiquity, users can access information via the Internet with the help of mobile phone at any time and in any place;
5) sociability, a user can post information through social network;
6) the object itself must be accessible and addressable;
7) visibility / complementarity, the hidden information becomes accessible (visible) by re-equipping the physical environment (Adamko, Kadek & Kosa, 2014).

The concept of Smart audiences, according to V. Uskov, J. Bakken and others is one of the widely developed aspects of Smart Education, the requirements for which are constantly changing due to the intensive transformations in the field of technical devices used in the educational process (Uskov, Bakken & Pandey, 2015).

Thus, the formation of the concepts and principles of Smart-University and Smart Education is developing in the context of the elaboration of this idea - as a key factor in the creation of innovative technologies and their integration into social, political, economic environment. It is argued that modern “smart education” can be provided only by new “smart university” in which qualitatively new processes lead to qualitatively new results in educational, research, commercial and other activities affecting the development of a person, society and the solution of their problems. This idea allows some researchers formulating the concept of Smart University as an independent one. However, among researchers there is no unity of views and approaches that allow expressing any unambiguous position on the existence of certain social, political and other barriers to the transformation of higher education in the context of the development of Smart technologies (Uskov, Bakken & Pandey, 2015). And as a result, there are no single recipes and strategies which can be applied in order to overcome those barriers.

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7. Conclusion

To conclude with, it is possible to say that one of the main trends in modern research thought is the conviction that the formation of Smart University is one of the most promising sources of modern technologies creation and problems solution in modern society. Smart University is a key point of the strategy for the development of the higher education system of the future.

Since the development of smart technologies in universities is usually associated with engineering training (regardless of the specialization of a university), it can be assumed that nowadays the most prepared environment for further transformations is represented precisely in engineering universities, where smart technologies will get further development.

In conclusion, it is necessary to note the main aspect - the presented concepts of smart university, smart education, etc. reflect the level of social, economic, technological development of the advanced countries of Western Europe and North America. The application of these ideas under the conditions of the Russian Federation requires a certain adaptation, the finding of those forms, conditions that could allow the Russian system of engineering education to use these concepts in the most effective way.

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