PAPER • **OPEN ACCESS**

“Smart” nuclear cities and training

To cite this article: A V Putilov *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **740** 012014

View the article online for updates and enhancements.

This content was downloaded from IP address 121.232.52.40 on 21/05/2021 at 02:14

IOP Conf. Series: Earth and Environmental Science **740** (2021) 012014 doi:10.1088/1755-1315/740/1/012014

"Smart" nuclear cities and training

A V Putilov, V N Chervyakov and P I Kolykhalov

Faculty of Business Informatics and Integrated Systems Management, National Research Nuclear University MEPhI, Moscow, Russia

E-mail: AVPutilov@mephi.ru

Abstract. New innovative approaches to educational activities in “smart” nuclear cities are described. Examples of using the developed system of online control over student perception of materials of a particular discipline are given. Processing the results of monitoring the educational process allows you to draw preliminary conclusions about the abilities (giftedness) of students for certain types of activities, described, including in the course materials. The software and hardware complex can be used for other educational programs, which, depending on the subject area of study, allows you to form a kind of "digital portrait" of each student.

Key words: innovative teaching, students' abilities, nuclear energy, digital design, real-time control, assessment of students' creative abilities, sociology.

Back at the X International Forum ATOMEXPO-2018, the industry integrator of the State Atomic Energy Corporation Rosatom of the Smart City direction entered into agreements on strategic long-term partnership with a number of major banks. Cooperation involves financing investment projects aimed at creating, reconstructing and improving the management efficiency of housing and communal services in the cities where ROSATOM operates, which can be conventionally called nuclear cities. Since 2018, the implementation of pilot projects has begun in four cities - Sosnovy Bor (Leningrad Region), Sarov (Nizhny Novgorod Region), Novouralsk (Sverdlovsk Region) and Glazov (Udmurtia), which were included in the “smart city roadmap of the Ministry of Construction of Russia”. By “smart city” we mean the digital modernization of life support systems - water, heat and electricity, the creation of a digital urban infrastructure that ensures the efficient use of resources and management of all systems from a single center, transparent consumer control and the involvement of residents in interaction with urban systems. The Smart City solutions will be based on existing and promising technologies of nuclear industry enterprises.

Along with optimizing and increasing the efficiency of housing and communal services, the concept of a "smart" city includes a number of other indicators: transport and logistics, health care services, environmental, etc. But the most important thing in smart cities is personnel - those people who create, support and develop modern digital technologies in the urban economy ensure sustainable development of society in smart nuclear cities. It so happened historically that in most nuclear cities there is a separate structural subdivision of NRNU MEPhI - a branch that trains students both in the system of higher and secondary specialized education. At the Moscow site of NRNU MEPhI, to control the assimilation of course

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

materials by students in real time, it is necessary to use modern information technologies. On the basis of such technologies, the software and hardware complex was developed and tested over several years while improving the educational process of teaching the basics of the digital economy in the nuclear industry for senior students of engineering training. The technical principles of the formation of the complex make it possible to use it in almost any educational process. The development of digital university models is provided for by the direction "Personnel for the digital economy" of the state program "Digital Economy of the Russian Federation" [1]. The performance indicators of this program provide that by 2024 more than 120 thousand people will be graduated in ICT-related training areas by 2024, and 800 thousand graduates a year should have competencies in the digital economy at the global level. The software and hardware complex mastered at NRNU MEPhI makes it possible to improve the educational process, based on virtual contact in the Internet environment "student - teacher" both during lectures and during workshops. Without touching on the technical content of the hardware and software complex for monitoring the assimilation of material by students, which is quite simple and described in the literature [2], we can mention its effective use since 2016 at NRNU MEPhI. All engineering students have been taking the course "Economics of digital design and construction in the nuclear industry" for more than four years. In lectures at the Internet address given by the teacher, students answer five control questions (via a smartphone, laptop, iPad) with four possible answers, one of which is correct. At the end of the lecture on a laptop, the teacher has a sheet - the answers of each student to all questions to the nearest second. And at the workshops, after the teacher explains the way to solve a particular problem, all students carry out the final calculations on their own and enter the answer into their smartphone, where there are also four answer options, one of which is correct. For the acquisition of innovative competencies by students, the course examines the organization of network innovation processes in the design and construction of complex systems, in the optimization of technical solutions, in the selection of materials for elements and assemblies, ensuring the competitiveness of projects, construction of technologies for analysis and synthesis of management decisions for high-tech systems with a long life cycle , patterns of technological marketing [3, 4, 5, 6, 7].

In work with branches of NRNU MEPhI, the above-described principle of working with students has been used in full in recent years. The teachers of the Moscow site, arriving at the branches, read courses (for example, "Technology Commercialization", "Foresight Research in the High-Tech Sphere, etc.) using online control of students' assimilation of the materials of these courses. This additional information constantly helps the management of NRNU MEPhI branches located in nuclear cities to improve work with their student teams. The above-described approaches to improving educational activities in smart nuclear cities were recognized as a positive result by the management of NRNU MEPhI, and for 2020 a decision of a fundamental nature was made, reflecting the growing scale of online education.

Based on the fact that in 2020 the nuclear industry celebrates its 75th anniversary, using a large number of publications in the open press, in the spring of this year, a course in the discipline "Technological history of the nuclear industry" was developed and recorded on video. This course is intended for freshmen as an introduction to the specialty and contains 12 lectures with traditional control questions (five questions for each lecture, one of four answers is correct). As an experiment, a decision was made, formalized by an appropriate order, to study the discipline "Technological history of the nuclear industry" in all branches simultaneously - in the first three weeks of September. In total, more than 1600 first-year undergraduate and specialty students were involved in the study of the discipline - very recent school graduates who do not yet have training experience and stable ideas about the nuclear industry. Each of the students was sent instructions for studying the course, allowing these students to have free access to lectures at a convenient time for them, as well as a schedule of answers to control questions for lectures, which was lined up sequentially: answers to subsequent lectures followed answers to previous ones, which gave students the opportunity to show their competence in the studied materials sequentially: from simple to complex.

The experience gained in intensive training with daily control of the assimilation of the discipline material by students throughout the country at the same time, showed the high efficiency of modern information technologies in education. Out of more than 1600 students who have mastered the discipline "Technological history of the nuclear industry" more than 130 people received certificates "For knowledge of the history of the domestic nuclear industry" of three degrees (depending on the number of correct answers). The online control system itself also showed its stability: in three weeks, more than 70 thousand answers to the control questions of the course were analyzed in automatic mode. Some mistakes (incorrectly entered student surname, etc.) were corrected manually and did not cause difficulties in studying the discipline. Intensive training made it possible to present certificates to students on the "Day of the nuclear industry worker", which was celebrated on 28 September.

The above example of the use of online control systems for the assimilation of materials by students in real time allows us to go further and to assess the abilities of students in a wider range of tasks related to the development of smart nuclear cities. A model has been developed that makes it possible to draw preliminary conclusions on the abilities of students in a particular area, which consists of four assessment indicators. The analysis of "correct answer - speed of response" to questions for the course allows you to assess the level of abilities (giftedness) of students by two key characteristics:

- the ability to understand the essence of complex phenomena (indicator A);
- the ability to analyze the ratio of various factors (indicator B).

Of course, such assessments will require the development of both new training programs and new test and measurement materials. But for training personnel in "smart" nuclear cities, efforts should not be spared. The most recently issued decree of the President of Russia dated April 16, 2020 No. 270 "On the development of technology, technology and research in the field of atomic energy use in the Russian Federation" lists the most important priorities for the development of the nuclear industry. And these priorities will develop precisely in nuclear cities, based on human resources, which must be prepared in advance. In particular, two-component nuclear power with the closure of the nuclear fuel cycle will require a new set of competencies, and it will be implemented in nuclear cities, the first examples of new technical complexes have already been created in Seversk, Zheleznogorsk, technological complexes are also being developed in other nuclear cities [8, 9, 10].

The methodology described above, as well as the developed and tested software and hardware complex, is based on the technical task of comprehensive support for conducting training and control activities, consisting of the following subtasks:

- accumulation of comprehensive information about the knowledge, abilities, skills of students, taking into account the possible large number of them during classes (streaming lectures and workshops);
- on-line digital processing of the results of a large number of control and training activities, allowing multivariate systems for evaluating results;
- increasing the activity of students in the course of streaming events (classes) due to the need arising from them to demonstrate the knowledge, skills, and abilities they have and received during training or testing;
- -increasing student confidence in the assessment results, incl. due to the obvious verifiability of the results and the psychologically adequate technology for conducting control measures;
- providing an opportunity to characterize the ability of students to understand the essence of complex phenomena, the ability to analyze the ratio of various factors as a result, to numerically evaluate unfamiliar phenomena when explaining the assessment scheme, to predict conclusions from tasks based on previous analysis.

It is hoped that the development of new educational technologies, far beyond the possibilities of the examples given in this article, will constantly progress, which will make it possible to create points of technological growth on the basis of “smart” nuclear cities. There are already some examples of the

formation of territories of advanced socio-economic development, but large-scale efforts must be made to increase the human resources potential of "smart" nuclear cities.

Conclusion

Online educational technologies with continuous monitoring in real time of the assimilation of materials are very close to the technologies of sociological research. Specific methods in sociology are a survey in the form of a questionnaire or interview, content analysis, sociological test, sociometric survey. During educational activities in "smart" nuclear cities, it is possible to work with samples characterizing the general composition of the population (youth, additional vocational education with the working population, education of pensioners, etc.). At the same time, if some socially significant concepts are given in educational courses and control questions characterize their understanding and attitude towards them, then this online procedure can be considered a kind of interviewing in real time. Of course, the content and scope of such educational and sociological events have yet to be worked out and discussed repeatedly. But already existing and tested information technologies make it possible to do this work quickly and efficiently. Training in smart nuclear cities can be combined with the use of these personnel to conduct social assessments and monitor changes in the urban environment during the digital transformation of all control systems.

References

[1] Ivanov V V and Putilov A V 2017 Digital future: the next step in the development of nuclear energy technologies *Energy Policy* **3**, pp 31-42
[2] Putilov A V, Chervyakov V N, Kolykhalov P I and Smirnov D S 2020 An innovative approach to the formation of control complexes of the educational process in the economy of high technologies *Innovations* No. 4 pp 59-66
[3] Putilov A V, Strikhanov M N and Tikhomirov G V 2019 Training of personnel for the developing nuclear power industry *Izvestiya vuzov. Nuclear Energy* No. 2 pp 208-218
[4] Abramova E A, Apokin A Yu, Belousov D R, Mikhailenko K V, Penukhina E A and Frolov A S 2013 The future of Russia: macroeconomic scenarios in a global context *Foresight* **7** No. 2 pp 6-25
[5] Koptelov M V and Guseva A I 2013 Peculiarities of Risk Determination in Investment Projects of NPP Construction *Atomic Energy* **115** Issue. 3 pp 170-176
[6] Putilov A V 2017 Development of technologies and training of personnel for the digital economy in the energy sector *Energy Policy* **5** pp 58-65
[7] Ilyina N A, Putilov A V and Baranova I A 2016 Staffing of knowledge management in an innovative economy *Innovations* No. 10 pp 2-6
[8] Sidorenko V A 2012 On the strategy of nuclear energy in Russia until 2050 *Rosenergoatom* no. 6 pp 9–18
[9] Putilov A V, Vorobiev A G and Strikhanov M N 2010 *Innovative Activities in the Nuclear Industry. Book 1 "Basic Principles of Innovation Policy"* (Moscow: Publishing House "Ore and Metals") p 184
[10] Baranova I A and Putilov A V 2016 Investment in Human Capital - a Revolution in Education Financing *Journal of Modern Competition* **10** No. 4 p 90-98