Development of digital transformation technologies for university practical learning in industrial area

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Abstract. We describe the development results of digital transformation technologies for university practical learning within environmental economy. While research, we used: Foresight technologies, theory of decision making under uncertainties, risk management approach, methods of data bases constructing in case of digital educational platforms, web-technologies and virtual reality tools. Analysis shows that the ways of university practical learning have distinct features of digital transformation, due to new concepts of obtaining and presenting educational materials. Preference is given to the use of digital educational platforms, which integrate heterogeneous hardware and software resources with the use of web-technologies in distributed networks and wide application of cloud services. Now, Moodle and Sakai are most popular digital educational platforms but we propose to use most recent Google Classroom. We consider the issues of digital content creation within university practical learning. We present the enlarged groups of practical works in this area. We propose to divide practical training into two stages. The first, preparatory stage, in which students learn with virtual reality tools. The second, applied stage of practical training takes place in the field. While research, we used platform https://www.researchgate.net/profile/Valery_Abramov2/ for data exchange and preliminary discussion.

1. Introduction

Recently, the global economy is developing in a digital transformation, dubbed Industry 4.0, during which the trends of widespread introduction of information technologies are planned and implemented [1-4]. The rapid development of information technologies leads to serious structural changes in established business processes in various industries [5-8], which requires the development of digital transformation technologies for university practical learning (UPL) in industrial area.

In the article, the authors describe the development results of digital transformation technologies for university practical learning (UPL) in geo-information management area [9-14] in large industrial projects [15-17] within environmental economy [18-20], including marine pipelines construction, for example, Nord Stream 2 [21, 22]. Significant attention in the implementation of such industrial projects should be paid to geo-information support of natural risk management [23-27] in the context of climate change [28-32], including the issues of information collection [16, 30, 31] and data processing [15-17]. The UPL technologies discussed in this article take these factors into account.
2. Methods and data

In research, we used: Foresight technologies, theory of decision making under uncertainties, risk management approach, methods of data bases (DB) constructing in case of digital educational platforms (DEP), web-technologies and virtual reality tools. From the point of view of geo-information management, we structured geo-space to allocate the interconnected components of the solution space [9-14].

3. Results

Our analysis of the state of UPL at universities shows that in the last five years the ways of UPL in industrial area development have distinct features of digital transformation, due to new concepts of obtaining and presenting educational materials. Preference is given to the use of digital educational platforms (DEP) that integrate heterogeneous hardware and software resources with the use of web-technologies in distributed networks and wide application of cloud services. The advantages of DEP in UPL are economic benefits and additional conveniences for learners. Essential expenses necessary for the course creating and timely updating of materials, are generated by a small group of highly skilled professionals, while life support (technical support, system checks commissioned works, maintaining records and issuing of certificates) may be less well-paid employees, which significantly reduces the cost of the educational organization. For students, DEP usage allows to work with the system at any time and from any device (personal computers, tablets, smartphones), which made the user more flexibly in plan training and combine it with other activities. Moreover, the training course within DEP can be held simultaneously by hundreds and even thousands of students without the need for the educational organization to provide the flow with the necessary technical means and educational spaces, which also significantly reduces costs.

Consider the prevalence of modern DEPs, their main features and disadvantages. Until recently, the most popular DEP was Moodle. According to the main website of the project, this system is used in 228 countries around the world, and the total number of courses exceeded 18 000 000. Developed in August 2002, Moodle has undergone almost no qualitative changes and looks outdated today. It is also worth noting the presence of a large number of functions in the basic set, which are more focused on foreign educational organizations than on Russian ones. Moodle is widely used in many Universities in Russia and the CIS, including Russian State Hydrometeorological University (RSHU), where authors worked with it as course developers and teachers.

The second most popular DEP is Sakai. In total, there are about 350 organizations in the world that use this system. This system is installed in RSHU also. Just like Moodle, Sakai is a free web application with open source software that allows to modify these complexes for the needs of a particular organization. Sakai can integrate with Bigbluebutton, an open-source web conferencing software. The main disadvantage of Sakai is the weak information support of the product, which significantly slows down the commissioning and support of operability.

Both of the above systems have to deployed on the educational organization's own servers, which leads to the need for their maintenance by the organization itself. As variant, the organization can rent a server with a pre-installed Moodle system from a third-party organization, and to deal only with the content and support of the educational process.

As commercial solution worth mentioning iSpring system, which basically meets the needs of large companies such as Yandex, Sberbank, Johnson & Johnson, Philips and etc. It worth to note, that iSpring offers a wide range of opportunities for accounting student activities and reporting, and comes complete with software iSpring Suite allows you to upload presentations directly from PowerPoint. The system of creating and editing texts is also implemented with the help of iSpring Suite. The platform has versions for Android and iOS, perfectly supported, however, an annual subscription to the service will be quite expensive.

April 2017, Google Classroom became available to a wide range of users. Just like iSpring, Google Classroom can run on Android and iOS platforms, allowing to use mobile devices while learning. Google has combined in this DEP almost all of its services, aiming them at solving specific educational problems:

- Google Drive to create, store, and share educational content;
Google Docs, Google Sheets, and Google Presentations to create and showcase content;
- YouTube to watch video lectures and tutorials;
- Google Mail for communication and group mailings;
- Google Calendar for schedule coordination;
- Google Hangouts for webinars. In the basic version, up to 10 people can participate in the video conference, in the extended version - up to 25. You can also use Google Hangouts as a chat (up to 150 participants).

The main advantages of this platform are its free of charge, ease of use, universal access from different devices and flexible feedback system. Using the Google Classroom platform eliminates the need for the organization to maintain a system administrator (all processes are performed on Google servers) and a content Manager (each teacher is responsible for the content of his course). In our work, we have opted for Google Classroom.

Let’s move to the issues of digital content creation within UPL. The preparation of practical courses in the framework of environmental economics is characterized by a certain complexity system description of the processes, performed at different stages of geo-information support. We proposed to use the decomposition as a technique in the preparation of the methodological basis for practical works content development within UPL. On Fig. 1, we present the enlarged groups of practical works, which are our decomposition result within UPL. Those enlarged groups we use while practical training on geo-information decision support for large industrial business projects within the environmental economy:

1) problem statement,
2) field works on data collection,
3) processing and analysis of the data,
4) preparation of geographical information system (GIS) layers and creating digital maps,
5) decision-making in the framework of geo-information support of industrial business projects.

**Figure 1.** Enlarged groups of practical works while UPL for practical training on geo-information decision support in environmental Economics

Digital content of practical works within groups 2 and 3 can be prepared quite easily, using any screen recording program (for example, freely distributed CamStudio), a microphone and a camera to record the teacher explaining the individual sections. All preparatory work can be carried out by the teacher outside the University, providing at the end of the rough material for processing and registration to the Executive editor of the course.

4. Discussion
The most difficult task is to teach students the practical aspects of measurement and work with instruments, which requires a developed practical base. We propose to divide practical training into two stages. The first, preparatory stage, in which students need to undergo training on working with devices and being in expedition conditions by virtual reality usage. The general idea of working with measuring equipment is conveniently reflected with the help of panoramic videos supported by the YouTube platform. A special camera is used for production, and for viewing can be used as a normal computer (mouse changes the position of the camera), and virtual reality glasses (Fig. 2).

**Figure 2.** An example of viewing a panoramic training video using virtual reality glasses (the image is divided for the left and right eyes)

The measurement process can be displayed as interactive videos on YouTube (Fig. 3), where at the end of each passage the student is asked to make a choice about the further action of the operator of the measuring instrument. If the correct answer is given, the video continues, if the student made a mistake, an explanation is given.
Figure 3. An example of the end of an interactive training video on working with CTD-probe, where the student is asked to choose the following action

The second, applied stage of practical training takes place in the field. It is expected that at this stage, students will make significantly fewer mistakes due to training during the first, preparatory stage, and cases of damage to equipment will be reduced.

5. Conclusion
In the article, we present the results of digital transformation technologies development for university practical learning (UPL) in industrial area. We paid the main attention to the UPL, which are useful for goals of geo-information management to large industrial projects within the environmental economy while climate change. When choosing a digital educational platform (DEP), the authors prefer Google Classroom. We developed digital content by methods of creating virtual reality, using carefully selected application packages from the public domain. We point out that the application of the developed UPL technologies will significantly reduce the cost of training of technical specialists, partially replacing the expensive stages of training with virtual reality simulation. The right combination of virtual reality simulation and usual practical training activities will improve the teaching quality and the training level for university students.

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