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Using digital educational resources to improve the effectiveness of the educational process in the training of hydrologists

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Abstract. The article defines the content of the training process of hydrologists and the need to develop and use digital resources in it. The main difficulty in the realization of such an approach is the complexity of the processes under study due to their hard-to-predict changes in states under the influence of many heterogeneous factors, duration in time and the scope of consequences. The solution to this problem is the use of digital resources, which are based on simulation models capable of recreating the behavior of a real object in a virtual environment and predicting changes from the given conditions of external influence with a certain accuracy. Based on this, a model of the learning process has been developed. It includes digital resources that implement scenarios of water object behavior in addition to traditional methods and means of training. The use of such tools provides a practice-oriented approach to training and efficient use of resources for educational activities.

1 Introduction

A hydrologist is a specialist who studies water, including its properties, water cycles, distribution of water resources and interaction of water with the environment [1]. In an educational organization, the training of such a specialist can be divided into general and specialized parts.

The general part includes mastering of educational disciplines related to general hydrology, meteorology, topography, geomorphology with the basics of geology, earth science, landscape science, soil science, biogeography and economic geography, while specialization includes hydrology of rivers, lakes, reservoirs, river outlets and marshes, hydrogeology, hydrometry and safety engineering, hydrochemistry, hydraulics, hydromechanics, water engineering surveys, hydrological calculations and forecasts, channel processes, hydrophysics, water management calculations and water ecology (Geography Faculty of M.V. Lomonosov Moscow State University, https://www.geogr.msu.ru/education/vo/programs/mag/g).

Testing of the formation of professional competencies is executed in expeditions, during which the direct study of water bodies is carried out [2]. In addition to such verification during expeditions, data collection with the help of modern technologies and devices takes

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place. The obtained information serves as a basis for experimental works, statistical processing during laboratory and desk works [1]. In addition, data for processing are obtained by means of remote observation and measurement methods using locators, aerospace imagery, automatic hydrological posts on rivers, and images from space or unmanned vehicles.

The results of processing such data make it possible to clarify information on natural objects, improve research methods, and conduct educational and scientific activities. The relevant work in this direction became actively realized with the development and wide application of computer technologies [3]. Their application allowed to process large arrays of heterogeneous data, to form data and knowledge bases in automatic mode, to create digital twins of water objects, which are used to forecast changes in their states depending on external influences, etc. [4, 5].

Digital transformation of the processes occurring in hydrology determines the development of training courses for basic educational and additional professional programs with the use of digital educational resources. Thus, the aim of the study is to create a methodology for the development and implementation of digital educational resources in the educational process.

The object of the study is the educational process in the training of specialists in the field of hydrology. The subject of the study is didactic processes of forming the content of specialized training disciplines.

To obtain the results corresponding to the set goal, the following tasks are required: to establish the structure of the subject of the study; to determine the rules of formation of professional competencies in the students of the object of the study; to create educational models, considering the digital transformation of the subject of the study.

The theoretical significance of the study lies in the systematization and unification of the processes that determine the content and conditions of the implementation of educational programs, also considering their digital transformation. *The practical significance of the study* lies in obtaining a universal methodology that allows creating practice-oriented educational programs regarding current demands of society and employers, operational management of their content in accordance with changes in the labor market, technology and the market of specialized software and hardware.

2 Methods

Studies related to digital transformation of processes are carried out according to a similar scheme. All key objects and their qualitative and quantitative characteristics are established. Processes affecting the change of their states are determined. The obtained results are formalized. The concept of changing the parameters of processes in accordance with the set goal is developed and a model or methodology that corresponds to the concept is created [6, 7].

In order to establish objects, processes and their characteristics in the study the method of structural analysis was used. The step-by-step decomposition of the research subject with the allocation of key elements allowed obtaining key aspects of the problem area description.

The formalization of the obtained results was carried out with the help of Business Process Model and Notation (BPMN) methods. It graphically reflects the sequence of actions in business processes, reflects the logic of their realization and connection with the corresponding objects of the subject area [8]. Such method is actively used in studies related to educational process organizations [9, 10].

3 Results

Monitoring the states of objects and processes related to water resources is a process that requires the integration of intellectual, information and technological capabilities. The obtained data are the basis for predicting changes in the states of objects. To improve the accuracy and reliability of such a forecast, it is necessary to have not only such data, but also means of their processing. Such specialized software tools perform their work on the basis of digital models reflecting the behavior of real objects [5, 11]. At the same time, to control processes, develop managerial decisions or refine the model, the data obtained not only from sensors or stations located in fixed places, but also data from people who use software tools in their activities when interacting with natural objects [12-14] are used.

Structural analysis of the educational process has shown that it is necessary to systematically use digital resources in order to meet the requirement of practice-oriented processes. Those allow not only organizing and supporting all participants during educational process implementation, but also objectively assessing the formation of professional competencies. At the same time, such tools cannot be autonomous, i.e. they should not receive data only from the ecosystem of the educational organization. This means that the developed digital resources for a particular educational organization should be integrated either into a common system containing the maximum possible amount of data on water resources and processes, which are updated in real time or with a certain periodicity, or having access to different geoinformation systems.

If an educational organization has a system that provides access to training resources, reference materials and control of task performance, then the developed resources based on simulation models should be integrated with such a system. In this case, the process of practical task fulfillment from the student's point of view will look as shown in Fig. 1.

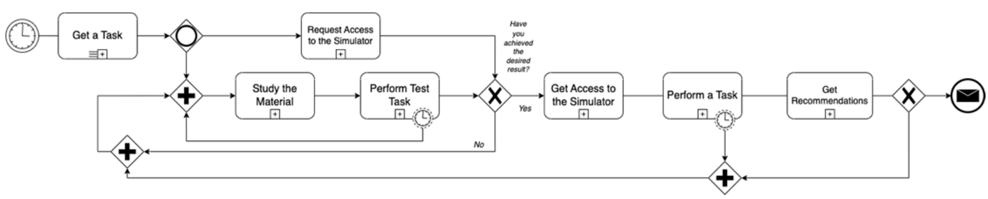

Fig. 1. The process of performing a practical task using simulation models

When developing digital simulators based on simulation models of water objects, it is necessary to take into account the periodicity of data updating. It can be performed in the background when new additions appear or with a certain periodicity. In any case, it should update the reference resources and training tasks.

The student gets access to each section only after a certain event has occurred: a certain competence has been mastered, a grade has been received, or a date match has occurred. After that, a request to test the mastered competencies on the simulator should be generated. The necessity of such a request is determined by the limited number of resources and different speed of mastering the material. While waiting for the application to be approved, all theoretical material must be mastered and the test task must be completed. If the control task is completed at a low level, the student will not be admitted to the simulator and will need to retake the theoretical training. This will happen until a "passing" result of the control task is obtained. After admission to the practice-oriented task, the student will be given a task related to a specific water body and its condition. He/she will have to develop and implement in virtual space a set of measures, for example, to preserve the object. The expert system used by the simulator will model the changes that occur from the student's actions over time.

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The digital resources can be used as training material, regardless of the due date of the work. The student is not required to apply for the use of the resources, as no specialized equipment is required to perform the work, and the functionality can be used using a browser without installing additional plug-ins. It is possible to study the properties and behavior of an object in an interactive way with the help of such resources.

From the teacher's point of view, the educational process becomes "transparent", as the activity of each student in the system is visible. It is possible to make operational changes in the content of educational material, and to correct individual learning curves of students with the help of such information.

4 Discussion

Digital resources are an integral part of the educational process. The creation of such software products is preceded by the design stage, at which all categories of users and the processes of their interaction with each other are defined. The obtained results are presented in the form of models that correspond to generally accepted notations and demonstrate key aspects of the subject area. This is peculiar designing information systems from different domains [6, 8, 10, 13]. If the obtained results of the design phase of the conducted study are compared with the results of related studies, the similarity of the use of methodologies and the nature of the obtained process implementation models may be established.

The engineering of simulation models is required when developing concepts for the implementation and use of specialized software tools that control complex processes in ecosystems of companies, changes in the states of which depend on a variety of parameters (including random) [5, 12, 13, 15]. With their help, it is possible to form professional competencies with minimal use of consumables and other resources, while reducing the injury hazard when performing certain types of complex work [9]. This approach to the organization of the educational process is used in the conducted study, as hydrology is the field that uses complex equipment, prolonged research, etc.

5 Conclusion

Hydrology studies natural waters, phenomena and processes in them occurring within the hydrosphere. A special object of study in hydrology is the degree of influence of human activity on the hydrologic cycle, management of the water bodies regime and water regime of territories. Based on this, the assessment and forecast of the state and rational use of water resources is formed. The listed processes are complex, depending on many parameters, changing during different time interval and affecting the state of objects and other processes.

Training of specialists in the field of hydrology is an important process that ensures careful and rational impact and consumption of water resources in everyday and economic activities of humans. The complexity of control and management of processes related to water resources determines the use of specialized software and hardware in the educational process to simulate the behavior of water objects in virtual space. This provides an opportunity to conduct full-scale experiments of various complexity in educational laboratories of an educational organization, to process a large number of heterogeneous data and to establish links between events and their consequences.

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