Use of digital educational equipment experiment as a current problem of environmental education

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Abstract. Already today, the spread of the IoT network is gaining momentum. The obvious benefits of connecting IP in the daily life of society are monetized in a significant reduction in costs, and therefore relevant. In addition, the use of such technologies leads to the actualization of certain skills of IoT users, the emergence / development of new competencies, the formation of which, in our opinion, can be done at the first year of higher education or even secondary education. The article gives examples of the use of digital measuring computer systems Einstein, LabDisc, Pasco, Relab, L-micro, FourierEdu – NOVA Link, NOVA 5000, COBRA 4. The advantages of working with digital equipment for teachers and students are identified. The ways of IoT development, as well as the implementation of his ideas in the educational process are outlined.

Keywords: IoT, digital measuring computer systems, environmental education

According to [4, 13, 14], the need for expert analysts in 2020 will be 1.5 million people, the process automation software market will reach $10 billion, the share of B2B services (electronic business model Business-to-Business) – 70%, the number of connections using mobile devices in the world by 2025 will grow to 75 billion. Under these conditions, the coverage of the Internet of Things (IoT) will rapidly expand, although today the distribution and use of IoT are considered modern trends [1]. In Ukraine, there are projects at the national level aimed at the development of this network [2, 7, 12].

Application examples of IoT sensors cover almost all spheres of society: intelligent measurements of housing and communal services (meters for electricity, gas, water, household waste, heating), smart home, sensors in the automotive industry, sensors in medicine, sensors in the field of health and beauty, location without GPS, smart street lighting, smart security, agricultural instruments, environmental sensors [3, 15, 16].

The obvious benefits of IP connectivity in everyday life are monetized into significant cost savings. Thus, the effect of the introduction of IoT is expected in the automotive industry (data exchange between vehicle nodes, remote software updates, unmanned vehicles), transport (monitoring of moving objects, smart parking, smart lighting), healthcare (online patient monitoring, microchip technology), security environment (monitoring air quality), agriculture (processes of fertilization, distribution of seed sowing, reducing the consumption of fuels and lubricants,

DEEU 2018: V International Conference on Digital Education at Environmental Universities, October 17–18, 2018, Kyiv, Ukraine

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monitoring natural parameters) and many other areas and industries.

LPWAN (low-power wide-area network) is a long-distance wireless technology for transmitting small data over long distances, designed for distributed telemetry networks, "machine-to-machine interaction" and the Internet of Things [10]. LPWAN is one of the wireless technologies that provides a data collection environment for various equipment: sensors, meters and sensors. The advantages of LPWAN are long range, high permeability, low power consumption, low cost, high capacity, high scalability, security, geolocation.

Along with this, the use of such technologies entails the *actualization of certain skills of IoT users*, the emergence / development of new competencies, the formation of which, in our opinion, can be carried out both at the level of the first years of higher education institutions and senior classes of K-12 schools [9].

The current curricula in physics (we consider as an example, but are not limited to) define the subject content of the key competencies of students; teachers (teams of researchers, methodologists) select educational resources for their formation [11]. For example, the components of digital competence include the ability to use modern digital devices as a means of measurement; work with digital equipment of virtual laboratories; use computer models of physical processes and phenomena [5, 8]. Electronic educational and information resources, digital laboratories, measuring complexes are determined as resources for the formation of the allocated skills (we consider as an example) in accordance with the capabilities of the educational institution and the readiness of teachers.

Various modern digital tools make it possible to carry out a teaching experiment, modeling, emulation without requiring additional special equipment. These tools include virtual and digital laboratories, digital measuring computer systems. Digital measuring computer complexes are currently included in the standard list of teaching aids and equipment for educational and general purposes for classrooms of natural and mathematical subjects in general educational institutions and should provide, subject to their use, an improvement in the quality of both the process of teaching natural disciplines, and students performing practical/laboratory work. However, not all schools are provided with the necessary equipment and qualified teachers. Therefore, the use of digital measuring systems and individual tools should be used in the first years of higher education institutions, for example, when studying certain disciplines (in this case, we consider physics), conducting alignment courses for first-year students, and also when conducting career guidance work with high school students [6].

The use of digital measuring computer complexes in the educational process is aimed at:

- increasing the level of motivation and cognitive activity of students,
- formation of students' readiness to use their knowledge in real life situations (to study the real world by modeling various processes),
- implementation of the tasks of intellectually directed pedagogy as a means of development and self-development of students in an ICT-saturated environment,
- changing the ways of interaction between students and teachers in the course of joint activities.

Among the main advantages of a *teacher*'s work with digital equipment, it is worth highlighting: reducing the time for preparing and conducting laboratory and practical work in physics (if the teacher has sufficient experience working with digital devices), expanding the range of laboratory and practical work on various topics as part of lesson planning and extracurricular educational activities, the possibility of developing author's projects of laboratory work and demonstration experiments. For *students*, this is an opportunity to unlock their creative potential in the study of the disciplines of the environmental cycle, as well as in research activities.

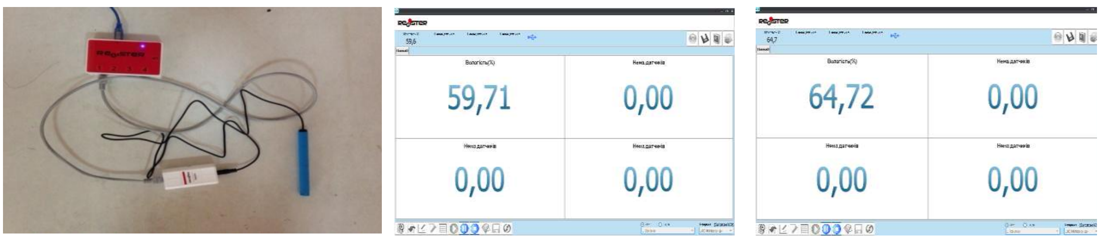
Popular today digital laboratories and measuring complexes: Einstein, LabDisc, Pasco, Relabm L-micro, FourierEdu – NOVA Link, NOVA 5000, SAC "AFS" ("All For School"), TsIKK based on the data logger Register Data Logger COBRA 3 and COBRA 4 showed high efficiency of use in schools of physics and mathematics profile and institutions of higher education.

The use of digital laboratories and measuring complexes with digital sensors allows teachers and students to conduct a wide range of research, demonstration and laboratory work, as well as to carry out research projects that contribute to the solution of interdisciplinary problems.

Let us give examples of the use of digital laboratories and digital measuring computer systems in the performance of laboratory work and educational projects in physics. As an example, consider the laboratory work "Measurement of relative humidity", performed using digital sensors based on the Register Data Logger.

The instruction for the laboratory work contains the topic, purpose, equipment (personal computer / laptop with the RegisteriLab v.8.0 software installed; Register data logger; sets of connecting wires for sensors; humidity sensor), theoretical information, installation description, work progress, control questions.

Having assembled the experimental setup according to figure 1a, the student observes automatic data recording (sensor readings are displayed on the screen in real time), fixing the value of the relative humidity in the room (figure 1b) and outdoors (figure 1c). The student compares the obtained values of relative humidity indoors and outdoors, draws conclusions.



a *b* *c*

Figure 1: Experimental setup and sensors' data.

Interesting and informative is the interdisciplinary project "Checking drinking water", during which the conductivity of different water samples is determined and compared (with Cobra4: the conductivity sensor is connected directly to the Cobra4 wireless line, Cobra4 Mobile Link or USB-Link Cobra4 with the appropriate software). The measurement data are transferred to a computer for analysis, displayed on the screen in real time, and a graphical display of the data is made (figure 2).

Students may be asked to measure and compare the conductivity value of drinking tap water samples in different locations; compare with bottled drinking water; try to explain the reason

Figure 2: Investigation of the conductivity of different water samples.

Figure 3: Measurement of conductivity values of drinking water samples at home.

for the difference in the obtained values of the conductivity of water samples. This experience shows how drinking water can vary from place to place in the same region. Research can be carried out both in a school laboratory and at home (figure 3).

Determining the ways of development of IoT, as well as the implementation of its ideas in the educational process, is very important for the informatization of education in general and the development of an open information and educational environment in particular.

Further psychological and pedagogical research requires the use of various components of the Internet of Things in the educational process: digital devices, including mobile-oriented ones, services, networks and cloud computing.

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