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PEDAGOGICAL EXPERIENCE OF APPLYING INNOVATIVE TECHNOLOGIES IN NATURAL SCIENCES IN WARTIME

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Abstract: *The presented materials reveal the peculiarities of the use of innovative technologies in the natural and exact sciences, in particular, distance learning technologies, platforms for improving skills and self-development (Future Learn, Canvas Network, Prometheus, EdEra, TED conferences, etc.) and individual pedagogical practices for popularising the knowledge of modern Ukrainian scientific research. For students of general secondary education who are outside their permanent place of residence, namely internally displaced persons (IDPs) or refugees, the All-Ukrainian Online School (AOS), online seminars on natural sciences for teachers and high school students, video lessons for students in grades 5-11, creative online camps for schoolchildren, and environmental and naturalistic out-of- school education institutions continue to organise creative leisure activities. Throughout Ukraine, educators and scientists are creating interactive science education centres to promote science as the basis for the development of society. On the basis of 32 years of teaching experience, the author outlines a list of promising topics that should be covered in future research.*
Keywords: *natural sciences, distance learning technologies, specialised online platforms, interactive science museums.*

As of 2023, more than 90% of Ukrainian schools continued to operate under martial law. In 2024, 3798 educational institutions in Ukraine suffered from bombing and shelling, 365 of which were completely destroyed [1]. It is clear that science education does not stop, even in such incredibly difficult conditions. What would you like to focus the attention of science teachers on in terms of teaching in general secondary education institutions (GSEIs) in Ukraine?

Distance learning and natural sciences

Since the introduction of martial law in Ukraine as a result of the Russian Federation's aggression on 24 February 2022, distance learning platforms have been

created, including more than 20 online schools that have provided free access to science courses. These include well-known online schools such as Optima (over 100,000 students), Atmospheric School, Learn Easy, mobile operators Kyivstar TV, Vodafone, and other platforms such as Prometheus.

For students of general secondary education who are outside their permanent place of residence, such as internally displaced persons (IDPs) or refugees, the **All-Ukrainian School Online (ASO),** which currently has users from 134 countries, is a significant support. How can I use the online resources of the School effectively? In our opinion, it is best to recommend watching video lessons within 10-15 minutes of class time. As a rule, students can concentrate on the learning material in this period of time. Therefore, video lessons longer than 10-15 minutes can be recommended for high school students. Below we provide you with links to video lessons from the *YouTube video hosting service* according to the current geography curriculum (second semester).

7th grade North America

7th grade. Geography. Population and States of North America https://www.youtube.com/watch?v=gmUqtVp-4u0

Eurasia

7th grade. Geography. Eurasia: geographical location, discoveries https://www.youtube.com/watch?v=sbs-SDb3zMs 7th grade. Geography. Eurasia: tectonic structures, relief and minerals https://www.youtube.com/watch?v=kZZn-C5_nlk

7th grade. Geography. Eurasia: climate https://www.youtube.com/watch?v=jhv_mK5qs4w

7th grade. Geography. Eurasia: waters of the Earth https://www.youtube.com/watch?v=eguutkX79dg

7th grade. Geography. Eurasia: natural zones, altitude zones https://www.youtube.com/watch?v=cohMIDfjZvc 7th grade. Geography. Eurasia: population https://www.youtube.com/watch?v=1x58sYhQGOM

7th grade. Geography. Eurasia: countries of the continent https://www.youtube.com/watch?v=NA0TxsbMu8M 7th grade. Geography. The largest countries of Asia https://www.youtube.com/watch?v=rEY_xP_XWnU Geography. 7th grade. Eurasia. Population. The largest countries of Europe and Asia. Connections of Ukraine https://www.youtube.com/watch?v=frnPYJ2v7hU

Oceans

7th grade. Geography. The Pacific Ocean https://www.youtube.com/watch?v=niuZQRn5Jw8 7th grade. Geography. The Atlantic Ocean https://www.youtube.com/watch?v=GUtwSN6P9GM

8th grade

8th grade Geography. Nature Reserve Fund of Ukraine https://www.youtube.com/watch?v=kPYALfGmZCM Grade 8. Geography. Patterns of distribution of vegetation and animals in Ukraine https://www.youtube.com/watch?v=5DNc2KE2j4Y

8th grade Geography. Landscape as a spatially integral system. Map "Landscapes" https://www.youtube.com/watch?v=LFeOOsA3VDM

Grade 8. Geography. Landscape as a spatially integral system. Mixed forest zone https://www.youtube.com/watch?v=l24bdvcqGV4

Grade 8. Geography. The zone of broadleaf forests. Forest-steppe https://www.youtube.com/watch?v=Fhrt-AtEIUE Grade 8. Geography. Steppe zone https://www.youtube.com/watch?v=K2fm7yKOZg4

Grade 8. Geography. Mountain landscapes of the Ukrainian Carpathians https://www.youtube.com/watch?v=RyUCFp- pY5E

Grade 8. Geography. Mountain landscapes of the Crimean Mountains https://www.youtube.com/watch?v=q9VuH2j80

Grade 8. Geography. The Black and Azov Seas https://www.youtube.com/watch?v=-PnKO_ukLt0 Grade 8. Geography. Nature management https://www.youtube.com/watch?v=VpRbCKPOYAc&t=435s

Geography. Grade 8. Nature Reserve Fund of Ukraine https://www.youtube.com/watch?v=kPYALfGmZCM&t=370s Grade 8. Geography. Number, natural movement, gender and age composition of the population https://www.youtube.com/watch?v=IYLhMM2V-g4

Grade 8. Geography. Gender and age composition of the population https://www.youtube.com/watch?v=ws0Q0URdSg

Grade 8. Geography. Population migration. Demographic and migration policy https://www.youtube.com/watch?v=zE2LIzTuZbc

Grade 8. Geography. Gender and age composition of the population of the world and Ukraine https://www.youtube.com/watch?v=2Vt51w0-ZDU

Grade 8. Geography. Settlement. Population density https://www.youtube.com/watch?v=fmB3sD6SDIA Grade 8. Geography. Urbanisation https://www.youtube.com/watch?v=N8R57xVJlEM

Grade 8 Geography National composition of the population https://www.youtube.com/watch?v=6FQlnyWRr1U Grade 8. Geography. Religious

composition of the population https://www.youtube.com/watch?v=e3qQRgs36fs 8th grade Geography. Labour resources https://www.youtube.com/watch?v=JIBkFwmSnzc
8th grade Geography. Kyiv, the capital of Ukraine https://www.youtube.com/watch?v=0l2-k57wm2Y

9th grade

SECONDARY SECTOR OF THE ECONOMY

9th grade. Geography. Vehicle production in the world and in Ukraine https://www.youtube.com/watch?v=hz3HMRspIBs
9th grade. Geography. Mechanical Engineering of the World https://www.youtube.com/watch?v=xsr_xV0Ped8 9th grade. Geography. Tourism in Ukraine https://www.youtube.com/watch?v=3qtj1v-vlQ0
9th grade. Geography. Science, education, healthcare https://www.youtube.com/watch?v=s6tTxYrTqpM 9th grade. Geography. Production of fabrics, clothing, footwear in Ukraine and the world https://www.youtube.com/watch?v=iLZ0x1wlsjU
9th grade. Geography. Food and beverage production https://www.youtube.com/watch?v=Zpj7CzgmRTI 9th grade. Geography. Food production in the world https://www.youtube.com/watch?v=IrzRzzlnqBM

TERTIARY SECTOR OF THE ECONOMY

9th grade. Geography. Transport in the world economy https://www.youtube.com/watch?v=sNZeHyoVbXA 9th grade. Geography. Financial services https://www.youtube.com/watch?v=4-aYp0M87Ys
9th grade. Geography. Scientific activity https://www.youtube.com/watch?v=9lAXpVQQ1Ag
9th grade. Geography. Global issues of humanity https://www.youtube.com/watch?v=yirLG0_LmCk

Indirectly, some online forms of education for GSE students include online seminars on natural science issues for teachers and high school students, video lessons for students in grades 5-11 called "Learning without Borders" (launched on 13.03.2022), a creative online camp for students called "Creative Camp: We are from Ukraine!", and out-of-school environmental and naturalistic education institutions continue to organise creative leisure activities for IDPs. More recently, the "Support a Child" channel was launched (from 7 March 2022) and the Ukrainian Online Academy for displaced schoolchildren was created (from 6 April 2023), etc.

2. **Platforms for improving skills and self-development in the natural sciences.** www.futurelearn.com Future Learn is an educational platform of the Open University with 40 years of experience in distance learning and online education. For example, you can join the *Earth Science Courses*:

- Planet Earth: Understanding and protecting our environment https://www.futurelearn.com/courses/planet-earth
- Extreme geological phenomena https://www.futurelearn.com/courses/extreme-geological-events
- Atmospheric chemistry: planets and life beyond Earth https://www.futurelearn.com/courses/atmospheric-chemistry-planets-and-life-beyond-earth
- Tracking the hurricane using satellite data https://www.futurelearn.com/courses/hurricane- tracking-satellite-data
- Renewable energy: achieving sustainability through bioenergy https://www.futurelearn.com/courses/renewable-energy-achieving-sustainability-through- bioenergy
- Artificial intelligence (AI) for Earth monitoring https://www.futurelearn.com/courses/artificial- intelligence-for-earth-monitoring

skills.

- Causes of climate change https://www.futurelearn.com/courses/causes-of-climate-change
- IUCN Red List of threatened ecosystems: A global standard for ecosystem risk assessment https://www.futurelearn.com/courses/global-standard-for-assessing-risks-to-ecosystems

A series of 19 courses has been developed to help participants specialise their

For science teachers, a variety of innovative courses designed for different ages of pupils, students and teachers, and ordinary people who want to improve certain skills or further develop themselves will be extremely valuable.

www.canvas.net The Canvas Network project is distinguished by a wide variety of courses taught by people of different backgrounds and fields of activity: doctors of science, managers, writers.

The courses do not have a single approach to teaching. The specifics of each course can be found in the description. They last for 2-3 weeks and are announced a month in advance, which allows those who wish to pre-register. Canvas Network offers free, partially free, and paid courses. Partially free courses require the purchase

of additional learning materials (manuals, literature), while paid courses allow you to earn credits in the continuing education system.

- INTEGRATION OF STEM: FROM START TO FINISH (K-12) https://www.canvas.net/browse/tennessee-tech/courses/integrating-stem
- THE ART AND CRAFT OF DISTANCE LEARNING(HE) https://www.canvas.net/browse/ucriverside/courses/art-and-craft-of-remote-teaching
- THE GROWTH MINDSET: HOW TO HELP YOUR CHILD LEARN, GROW, AND THRIVE (K-12) https://www.canvas.net/browse/iwe/courses/growth-mindset and others.

prometheus.org.ua Prometheus is a Ukrainian free online education platform established in 2014. Among its partners are the best higher education institutions in the country. Prometheus provides a free opportunity for universities, leading teachers and leading companies to publish and distribute courses.

Each course consists of video lectures, interactive assignments, and a forum where students can ask questions and communicate with the teacher. Successful completion of the course will result in an electronic certificate confirming the knowledge gained. Prometheus courses are available online at any time, and the platform also offers a mobile app for Android and iOS.

- In-service training of teachers: new requirements and opportunities https://courses.prometheus.org.ua/courses/course-v1:Prometheus+PPK101+2020_T1/about
- Information hygiene. How to recognise lies in social media, on the Internet and on TV https://courses.prometheus.org.ua/courses/course-v1:Prometheus+IH101+2021_T3/about
- Successful Teaching - Simple Recipes for Everyday Life https://courses.prometheus.org.ua/courses/course-v1:EWC+DS101+2021_T1_3/about etc.

www.ed-era.com EdEra (Education Era) is an educational project that aims to make education in Ukraine accessible and affordable. All courses are free of charge, but upon completion, everyone can give back to the project. The lecture (short videos, questions, and tasks for better learning) is accompanied by supporting material - a synopsis with illustrations and explanations. Students do homework every week and take an exam at the end of the course. You can study at any convenient time, and your success is confirmed by a certificate.

- Valuation without impairment https://study.ed-era.com/uk/courses/course/410

- Key skills for the 21st century https://courses.ed-era.com/courses/course- v1:British_Council+BC1+2020/about
- With students about education and careers https://courses.ed-era.com/courses/course- v1:EducationUSA+CO2502+2020/about
- Non-discriminatory approach to education https://courses.ed-era.com/courses/course-v1:EdEra- Studena+Inc+1/about
- Geography: General Geography https://courses.ed-era.com/courses/EdEra/g102/G102/about

www.ted.com A non-profit project that annually brings together scientists, businessmen, politicians and activists from around the world in Edinburgh and Long Beach is called the TED conference. The purpose of the conference is to spread unique and interesting ideas among the public. After the conference is over, their speeches and presentations appear on the TED website. The site offers more than 2,000 videos, most of which are subtitled in Ukrainian, and some are even dubbed in Ukrainian.

Fig. 1. Museum of Science in Kyiv. Photo by the author

- Playlists https://www.ted.com/playlists

vumonline.ua OUM (Open University of the Maidan) is a distance civic education platform. The online project offers more than 30 topics for free education. The courses are composed of video lectures, practical tasks and test questions. A

forum provides an opportunity to communicate with other students and teachers. Lectures are delivered by leading lecturers from business schools, the civil sector, business and social practice. The courses are related to the following areas: personal development, realisation of potential, entrepreneurship, and the formation of an open society in Ukraine. Upon successful completion of the chosen course, you can download a certificate.

- Sustainable Development Strategies for Cities and Communities: Practical Advice https://vumonline.ua/course/sustainable-development-strategies-for-cities-and-communities/
- How to properly handle household waste.Workshop of a conscious citizen https://vumonline.ua/course/how-to-deal-with-household-waste/

Geography of modern Ukrainian scientific research.

Despite active military operations, educators and scientists across Ukraine are creating interactive science education centres to promote science as the basis for the development of society. One of the most significant events of the last academic year was the opening of the **Museum of Science and Innovation** in Lviv, located at 7 Sichovykh Striltsiv Street, which features interactive exhibits designed for all ages, starting from 3 years old [2].

There are currently two interactive science museums in Kyiv, which is a great opportunity to distract students from stress and engage them in learning science in an unconventional way (Fig. 1).

Another interesting aspect of promoting natural and exact knowledge among students is the study of **Ukrainian Antarctic research**. In particular, about the research ship Noosphere, which returned to Chile on 21 April 2022, having brought Ukrainian and Polish expeditions from the Antarctic (Fig. 2).

Fig. 2. Ukrainian research vessel Noosphere

Photo by the Ministry of Education and Science of Ukraine

For the first time in the last 20 years of research in this region, we have resumed geological studies, and the National Antarctic Centre has joined the European Polar Council. Young researchers, ordinary citizens of Ukraine, who learn about their country and the world by studying earth sciences, should really know about this [3].

Promising topics to be explored in the future relate to **science education in wartime** and include the following:

- to provide students with skills for their safety during martial law;
- complex issues of the status of internally displaced persons and refugees;
- military assistance provided to Ukraine by various countries of the world;
- studying natural sciences abroad;
- projects that will help overcome the consequences of the war.

Promising topics to be explored in the future relate to **wartime education** and include the following:

- psychological support for students, teachers and parents;
- return to the Strategy of Educational Assessment;
- monitor the educational achievements, skills and losses of GSE students;
- develop a methodology for supporting teachers during martial law.

Refereces

1. 7 million children of war in Ukraine. Previous version [online]. Kyiv : MES of Ukraine, 2024 [cited 27.04.2024]. URL: https://saveschools.in.ua/
2. Museum of Science and Innovation. Previous version [online]. Lviv, 2023. [cited 03.04.2023]. URL: https://tsus.lpnu.ua/museum
3. YATSENKO V. S. Practical advice on popularising scientific knowledge about Antarctica. Vseosvita - National educational platform. 30 c. Previous version [online]. Kyiv: Vseosvita, 2024 [cited 11.05.2023]. URL: https://vseosvita.ua/library/praktychni-porady-z-populiaryzatsii-naukovykh-znan-pro-antarktydu-678931.html