

EDUCATIONAL LOSSES OF STUDENTS OF BASIC SECONDARY EDUCATION: STEM IN CONDITIONS OF POWER OUTAGES

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Abstract. *The article describes the problem of educational losses and gains of students of general secondary education institutions with STEM, caused by power outages.*

Since the distance format was new for teachers and applicants for education, gaps in the knowledge and skills of applicants for education began to arise due to various factors (lack of gadgets, the internet, a separate place to study at home, etc.). The accumulation of gaps in knowledge and skills was cumulative and uneven in the context of different Educational Institutions.

To prevent the accumulation of educational gaps among applicants for education and minimize educational losses, it is advisable to organize the educational process so that subject and key competencies are fully formed. The flagship for digitalization of the educational process in Institutions of General Secondary Education is STEM education, which has also gained achievements in these difficult conditions. In particular, it was the knowledge of Natural Sciences, Mathematics, and Engineering that allowed educational applicants and their families to adapt to living conditions in the absence of stable energy supply.

Keywords: *educational losses; students of basic secondary education; STEM.*

The traditional course of the educational process first underwent significant changes in March 2020 due to the introduction of long-term quarantine restrictions caused by the COVID-19 pandemic. Quarantine measures introduced in Ukrainian schools until 2020, as a rule, did not last more than three weeks. The mechanism for compensating educational losses during such short-term quarantines was the intensification of the educational process, combining topics, and studying educational material in enlarged didactic units. At the same time, such compensation occurred when students returned to full-time education in a General Secondary Education Institution.

Quarantine measures introduced in the 2019-2020 academic year lasted until the end of the school year. In schools, the introduction of a remote form of organizing the educational process was intensively carried out. Students and teachers mastered digital technologies for organizing distance learning. It was planned to compensate for the educational losses of students that occurred in

the next academic year, according to the usual mechanism for compensating for educational losses that occurred during the summer holidays.

During the 2021-2022 academic year, quarantine restrictions continued in Institutions of General Secondary Education, depending on the incidence of COVID-19 in a particular region and educational institution, and a combination of distance learning with full-time education in Institutions of General Secondary Education was practiced. On February 24, 2022, martial law was imposed in connection with the military aggression of the Russian Federation against Ukraine, and the educational process switched to a remote format, which lasted until the end of the school year.

In the 2022-2023 academic year, educational institutions where the buildings of educational institutions have survived, taking into account the capacity of the shelter and the security situation, resumed training in full-time or mixed format. Missile strikes on critical infrastructure from October 2022 to March 2023 caused long-term power outages [1].

The educational environment of General Secondary Education Institutions has undergone significant changes due to the introduction of long-term quarantine restrictions and martial law. Since the distance format was new for teachers and applicants for education, gaps in the knowledge and skills of applicants for education began to arise due to various factors (lack of gadgets, the internet, a separate place to study at home, etc.). The accumulation of gaps in knowledge and skills was cumulative and uneven in the context of different Educational Institutions.

This has led to a decline in the quality of education, which uses a whole range of “terms”: educational losses, educational losses, educational losses, learning gaps, educational gaps, learning gaps, etc.

To describe losses in the educational process, we use the term “educational losses” and the term “educational gaps” to describe gaps in educational achievements individually for a particular educational applicant as a result of educational losses.

Educational losses – *gaps that arise* in knowledge and skills, due to a violation of the course of the educational process in comparison with its normative course.

Educational gaps – *gaps that have arisen* between the standards of education and the results of educational achievements.

The main mechanisms for compensating educational losses are: increasing the duration of education due to the reduction of vacations; introduction of a six-day school week; implementation of accelerated education programs, which involve the consolidation of educational material and focusing on the key issues of the program; adjustment educational programs in the form of individual classes for an individual student or group of students; adaptive learning technologies, in which the class is divided into separate groups that work

outside the main school hours to eliminate specific gaps in knowledge and skills in accordance with the educational needs of the students; short-term programs to make up for educational losses, aimed at additional processing of certain issues during extracurricular hours or during weekends, etc. [2].

In our opinion, the main focus should be on preventing educational losses, and not compensating for them in the context of disruption of the educational process caused by war and pandemic. The maximum permissible academic load on the applicant needs to be normalized, and mechanisms for compensating educational gaps should not cause overloading of the student.

To prevent the accumulation of educational gaps among applicants for education and minimize educational losses, it is advisable to organize the educational process so that subject and key competencies are fully formed. The flagship for digitalization of the educational process in Institutions of General Secondary Education is STEM education, which has also gained achievements in these difficult conditions. In particular, it was knowledge of Natural Sciences, Mathematics, and Engineering that allowed applicants for education and their families to adapt to living conditions in the absence of stable energy supply. This motivated educational applicants to master new knowledge, research new technologies that have become an integral part of the life of a child, family, and community in conditions of long-term power outages and centralized water and heat supply to homes.

In August 2015, the STEM-education department of Institute for Modernization of the Content of Education was established, which has a number of tasks. Scientists of the Department actively participated in the development of conceptual, regulatory, scientific and methodological foundations of STEM education. Since 2017, the process of teacher training within the STEM school has been launched, which takes place in a full-time or distance format. In 2023, the winter and summer sessions of the STEM school were held in a remote format, where experience is exchanged on implementing the best methods of organizing the educational process in STEM subjects. The work of regional institutes for advanced training of teachers is coordinated, in particular, Regional STEM schools operate in 5 regions (Dnipropetrovsk, Zaporizhzhia, Mykolaiv, Rivne, Sumy regions).

To share their experience, a group has been created on the social network Facebook, which conducts various activities for teachers and scientists. An example of such activity is the annual STEM-Spring Festival of ideas and projects, which publishes collections of the best projects.

The implementation of STEM-education ideas is carried out by involving students in various contests, competitions, tournaments. Thus, scientific picnics, robotics festivals, all-Ukrainian competitions “Robot traffic”, competitions on modeling of “smart” devices “STEAM-House”, programs-competitions “FIRST LEGO-league”, “FIRST LEGO-league-junior”, are actively held in Ukraine etc. [3].

We consider the creation of the Virtual STEM-center (Virtual STEM-center MANLab) in 2020 to be quite relevant. Today the Virtual STEM-center of the Small Academy of Sciences of Ukraine – STEM-laboratory MANLab offers distance and day professional methodical and technological assistance in the organization of STEM-training of student youth of Ukraine. Due to quarantine and martial law in Ukraine, most STEM events were held remotely.

We will specify educational losses and achievements in STEM education due to Rolling Blackouts of electric energy in Ukraine.

In the conditions of full-time training, educational losses are minimal and are primarily due to the inability to use modern technical teaching tools (digital laboratories, interactive whiteboard, projector, etc.) and the teacher is forced to use traditional teaching tools. It remains possible to conduct problem-solving lessons and a training experiment, both in the form of demonstrations and in the form of laboratory work or experimental research.

Prolonged power outages also caused the lack of broadband internet access in the Educational Institution, which was organized mainly using FTTB technology, and backup power to telecom operators provided autonomy for several hours. In addition, it was necessary to heal the local network of the Educational Institution. This was necessary, since most Educational Institutions worked in a mixed or distance format for organizing the educational process. This problem was successfully solved in educational institutions there was fiber-optic internet using xPON technology, and routers and switches within the educational institution were equipped with a Power Bank with USB power boost line DC 5V to DC 9V/12V Step Up Module or special Mini Portable UPS Backup Power Adapter for Router.

Computer Science lessons were conducted mainly using laptops, which can also be powered by power banks that support PD 20V technology. Personal computers, even equipped with uninterruptible power supplies, were not used in the educational process due to the lack of a power outage schedule and backup power from UPS up to 20 minutes when fully charged.

Most Institutions of General Secondary Education were equipped with points of invincibility where there is a generator and you can charge the equipment that has a battery for both teachers and applicants for education. And teachers in their free time from the educational process did not provide free assistance to residents of the community with charging their gadgets. In addition, heating and hot water were provided at the points of invincibility, and a network of wireless access to the Wi-Fi network was deployed.

In the conditions of distance learning during rolling power outages, educational losses are the greatest. First of all, the synchronous format of teaching the organization of the educational process has suffered the most. Technically, for online learning, teachers and students must have access to high-speed internet at the same time. The practice of rolling blackouts in Kyiv shows that

electricity and the internet are turned off for different students at different times. During power outages, there is also no mobile internet. To compensate for this loss, the teacher is forced to conduct additional group or individual consultations outside the lesson schedule. In an asynchronous learning format, the student can get acquainted with tasks when there is an internet connection, including in points of invincibility, but the student cannot fully use the attached videos or materials of online schools. The main source of educational information remains the textbook and the student's available textbooks [3].

At the same time, STEM education also had significant achievements, which led to the forced overcoming of difficulties caused by power outages and the war in Ukraine. This contributed to the awareness of the value of STEM knowledge for a particular educational applicant, their family, and community.

To help the Defense Forces of Ukraine, many Institutions of General Secondary Education in winter at technology lessons made "trench candles" for which paraffin or wax, corrugated cardboard and a tin of canned food were used. Such candles were transmitted directly to the front and used by soldiers and officers to heat dugouts and warm up food. The process of making a candle consisted in placing corrugated cardboard in various configurations in an empty tin can from under canned food, which was filled with a melt of paraffin or wax.

This product was tested in Natural Science classes, and based on the test results, improvements were made to the design of the product. In particular, the burning time of the candle, the optimal ratio of corrugated cardboard and wax were determined. Such candles were not only transmitted for the needs of the front, but also used in everyday life during long-term power outages. They were especially useful for heating food for residents of apartment buildings equipped with electric stoves, since they had no other option for heating food.

In Computer Science and Science classes, considerable attention was paid to how to provide the house with lighting, communication and power to electrical appliances. This formed the basis of a whole series of STEM projects that students had the opportunity to perform at home with the equipment that their family chose in order to improve living conditions in conditions of lack of electricity.

The projects were diverse. In particular, the process of burning wax and paraffin candles was studied: the dependence of the burning time on the thickness and material, the price-to-cost ratio, the features of different types of waxes, and their own candles were made.

One of the most popular ideas that spread on the internet was the manufacture of an electric candle for home lighting, consisting of a galvanic cell and a light diode. The authors of the idea from the city of Ternopil called such a design "eternal candle" and indeed it shone for a month or more. The duration of the glow and the dependence on the capacity of the battery or battery just had

the opportunity to study during the implementation of such a STEM project.

In Physics classes, students had the opportunity to explore different types of batteries used. Explore modern LED lamps with built-in battery, etc.

In Chemistry classes, study the features of chemical processes that underlie the operation of various batteries. To investigate their effectiveness in discharge-charge processes using the examples of power banks.

In Computer Science classes, you will learn about the energy efficiency of different generations of monitors and processors, which prompted many to upgrade their gadgets for training. For example, a modern IPS monitor 17" 2022 consumes about 7 W, and its analog 2012 release 22 W. Considerable attention was also paid to internet access technologies.

Conclusions. The educational losses and gains of STEM students during power outages have their own specifics. Technical means of training are excluded from the educational process during the absence of electric energy. In such conditions, the main educational and methodological support for the educational process is printed textbooks, manuals, workbooks or their electronic counterparts that can be printed when electrical energy appears. At the same time, students realize the value of STEM knowledge for them and perform individual personally significant STEM projects that family members are also involved in. The educational process requires the creation of individual educational trajectories of students, since it is impossible to organize the educational process frontally for all students. The processes of paying for the additional teaching load of teachers of General Secondary Education Institutions need to be normalized.

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