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Daryna V. Vasylieva
PhD (Pedagogy), Senior Researcher of Mathematics and Informatics Education Department,
Institute of Pedagogy of the NAES of Ukraine, Kyiv, Ukraine
ORCID ID 0000-0002-4083-681X
vasylievadaryna@gmail.com

Tetiana L. Hodovaniuk
D. Sc. (Pedagogy), Professor,
Vice-Rector for Research, Professor of Higher Mathematics and Methods of Teaching Mathematics Department
Pavlo Tychyna Uman State Pedagogical University, Uman, Ukraine
ORCID ID 0000-0002-7087-7102
tgodovanyuk@ukr.net

GIOS ONLINE PLATFORM AS A TOOL FOR OVERCOMING LEARNING LOSSES IN MATHEMATICS

Abstract. The COVID-19 pandemic worldwide has led to a shift from face-to-face to distance learning. The sudden change in the learning format and the unpreparedness of the education system led to learning losses of students. The most researched and documented learning losses are the ones in mathematics, reading, and science. In Ukraine, face-to-face learning has not fully resumed yet, as a full-scale war broke out after 2 years into the pandemic. Consequently, the problem of overcoming learning losses in mathematics is particularly acute, as the country's economy depends on it in the future. According to the research reviewed in this article, the use of information and communication technologies in the educational process helps to overcome learning losses. These technologies can be used to organize synchronous or asynchronous learning. The article examines the effectiveness of students' independent use of GIOS platform materials to overcome learning losses in mathematics. The results of the entrance and exit tests of students, along with a survey of students and their parents after 1.5 months of independent learning on the platform are described. It is concluded that the independent learning format without a teacher or tutor is not suitable for everyone. Nevertheless, one of the components of overcoming learning losses can be students' independent study of multimedia materials. It has been found that the older students are, the more effective this kind of learning is. Based on a survey of students, the characteristics of the GIOS platform that motivated students to learn and helped them to understand the material were identified. Among the characteristics are: the integrity of the course, elements of gamification, the availability of theoretical material in several forms (videos, schemes, examples of solved tasks), the ability to view it several times and return at any time, the availability of training tasks, tasks of different levels and formats (including non-standard ones), the ability to review the covered materials to analyze errors, the ability to improve results by solving similar tasks. It is noted that in order to help their students overcome learning losses, teachers should either develop mathematics materials independently or use ready-made materials.

Keywords: learning losses; overcoming learning losses; teaching mathematics; mathematics methods; distance learning; GIOS platform.

1. INTRODUCTION

Problem statement. The emergence of the COVID-19 pandemic contributed to the transition of full-time schooling in Ukraine, first to a distance format (second semester of the 2019/2020 academic year), and then to a blended format (2020/2021 academic year, first semester of the 2021/2022 academic year). The distance and blended learning format, illness and stress of the participants in the educational process, their low level of computer literacy, lack of gadgets in the family, problems with the Internet and communication have led to learning losses for students.

Learning losses is the failure of students to achieve educational outcomes due to the absence or limited learning opportunities.

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On February 24, 2022, Russia began a large-scale invasion of Ukraine, accompanied by constant bombardment of the entire territory of Ukraine. Therefore, Ukrainian students spent the second semester of the 2021/2022 academic year in a distance format again, and the 2022/2023 academic year in a blended or distance format (depending on the conditions of the educational institution and the security situation).

The war in Ukraine has had a profound impact on all areas of Ukrainian life, including the organization of education in Ukrainian schools. At the time of russia's large-scale invasion of Ukraine, all participants in the educational process had some experience in organizing distance or blended learning. But the constant shelling posed new challenges for the participants in the educational process:

- students and teachers could be thousands of kilometers away from each other (located in different countries, including different time zones; in different regions of Ukraine, which caused asynchrony during the announcement of alarms);
- different security situation and constant change of learning formats (education in educational institutions could be organized in face-to-face, blended or distance format, depending on the conditions in the region and the availability of bomb shelters in the educational institution);
- classes are no longer permanent groups (some students attend classes only remotely, some attend only sporadically, etc);
- inability to organize synchronous online learning during blackouts, lack of electricity, the internet or communication;
- failure to meet basic needs and constant stress contributed to the deterioration of cognitive processes of all participants of the educational process, etc.

All of the above factors contribute to the fact that the learning losses incurred by students during COVID have only worsened as the hostilities continue. Learning losses increase in proportion to the duration of the cessation of functioning of educational institutions [1].

Analysis of recent studies and publications. Analysis of recent studies and publications. The existence of learning losses caused by COVID has been actively covered in native and foreign scientific articles [2] - [16].

S. Harmey and G. Moss point out that the extent of learning losses should first be identified for different groups of students and studied in detail, and only then governments and educational institutions should develop appropriate strategies to overcome them [2].

Lokshyna, O., & Topuzov, O. in their study analyze the challenges and opportunities that have emerged for the education system during COVID-19, paying special attention to improving the digital literacy of teachers and the need to develop distance teaching methods [3].

A review [4] draws attention to possible further disruptions to learning and recommends that education systems around the world prepare teachers for online learning to maximize learning and minimize inequality.

The absence of face-to-face education during the pandemic, which caused uneven learning losses among different segments of the population, thereby exacerbating learning gaps, is noted in [5]-[7].

Most often, scientific articles cover studies of learning losses in mathematics, reading, and science [6]-[8].

M. Gyöngyvér and H. Zoltán experimentally substantiated the existence of learning losses in mathematics, reading, and science in grades 2-8 due to distance learning during the COVID pandemic. They also described the groups of students who were most affected by the lack of face-to-face learning [6].

J. Schult, N. Mahler, B. Fauth, M. Lindner studied the learning losses in reading and mathematics of German 5th grade students. They found that the lower the socio-cultural level of students is, the greater the learning losses in mathematics are [7].

I. Khalil found that mathematics teachers understand learning losses differently, and they use different models to overcome them. In his opinion, it is important to conduct educational activities among teachers to identify learning losses and effective strategies to overcome them [8].

According to scientists, it is important to develop plans to overcome learning losses [9], [10] and a significant place in this should be given to information and communication technologies [11]-[16].

During the COVID pandemic, the introduction of online learning allowed students to learn, albeit remotely. However, the results of online learning depended heavily on the availability of connectivity/the internet and the quality of the videos recorded by teachers. As noted in [11], students who participated in online learning using a computer got better results than those who used a smartphone. The use of adaptive practice software during the pandemic reduces gaps in students' mathematics knowledge [16].

It is worth noting that the learning losses of Ukrainian students are much greater because they are caused not only by the pandemic but also by the war on the territory of Ukraine. A number of works by domestic [1], [17]-[18] and foreign scholars [19] are devoted to the study and overcoming of learning losses of Ukrainian students.

According to rough estimates by a group of researchers, the losses of Ukrainian students due to school closures and interrupted education during the pandemic and the war, amount to at least one academic year. They estimate that in the future this will have a long-term impact on income loss of 10% for each person annually. And with each additional year of hostilities on the territory of Ukraine, the situation will worsen. [19].

Today, the issue of overcoming learning losses in mathematics is extremely relevant for Ukraine. According to scientists [13], it is the current number of students who will have to rebuild Ukraine's economy in the future, which is very difficult to do without a mathematical base.

Since synchronous learning is not always possible in the context of war, it is advisable to consider various opportunities to overcome the learning losses of students in mathematics in an asynchronous format using ICT. Under such conditions, students can acquire mathematical competencies when they have the necessary conditions for this.

Modern students have clip thinking [20], [21] and low reading literacy [22]. Therefore, it is advisable to look for successful tools and forms of presenting educational material and its consolidation [23], [24]. A modern and interesting form of presenting theoretical material for students is educational videos, which should be short and preferably interrupted by questions to the audience [25].

At the same time, it is worth noting that watching a training video is not effective without students applying the newly acquired knowledge in practice. Therefore, it is advisable to offer students not only educational videos for self-study, but also a series of questions to them and a number of tasks that allow students to try to apply the knowledge gained while watching the video in practice. In other words, teachers should create a set of relevant materials or use ready-made products that meet the above conditions.

One of the effective learning tools that helps to overcome learning losses is online platform GIOS (gioschool.com). The authors of this article also participated in the development of the content of this platform. The platform offers online courses for studying the program material for grades 5-9. Each course is divided into topics, which in turn is divided into a number of lessons. The lessons on the platform consist of two blocks: theoretical and practical. The theoretical block includes 3 steps (an educational video, a diagram, and examples of solved problems on the topic). The practical block is made up of 16-22 tasks of different levels, different forms, and different purposes (10 test tasks for learning purposes, 1 matching task, 1 task for establishing the order of actions when solving a problem, 1 task for finding an error, 3 tasks for entering an answer; for all but the test tasks, a student can receive a bonus task if he or she answers incorrectly). Students earn points for completing the lesson, collect

achievements, and receive special avatars. This adds gamification elements to learning. In their personal account, students can see their daily progress. To track learning outcomes, students can also take an entrance test before learning a topic and an exit test after completing it.

The GIOS platform acts as an electronic textbook for students and enables them, if they have the desire and resources, to master the school's mathematics curriculum on their own and overcome the existing learning losses.

The GIOS can be used as a learning tool in different ways. Students can:

- master the learning materials on their own;
- choose a course with the support of a tutor who conducts online meetings, monitors the passage of materials and provides feedback;
- use the materials at school, provided that the teacher has activated the package Class for all students in the class.

The GIOS platform is already being actively used in Ukraine by mathematics teachers as a modern educational tool for organizing blended or distance learning [26], [27].

However, the question of how effective the platform is for students' independent learning of educational material and overcoming existing learning losses has not been studied by scientists yet.

The research goal is to investigate the effectiveness of using the GIOS as the instrument for overcoming mathematics learning losses of students in grades 5-9.

3. RESEARCH METHODS

In February 2023, with the support of the Ukrainian Startup Fund, the Ministry of Education and Science of Ukraine, the Ministry of Digital Transformation, and Diia. Digital Education, 21,440 students from all over Ukraine were granted access to the GIOS online platform for 1.5 months as a part of the Play Math project. The aim of the project was to overcome the existing learning losses in mathematics among students of grades 5-9 by engaging students into independent and conscious learning of mathematics on the GIOS platform. The project created an atmosphere of healthy competition and awarded prizes to the most diligent students.

Despite the fact that 21,440 applications were submitted, only 7,530 students actually took advantage of the opportunity to learn independently on the GIOS platform. That is, about 35% of the students who applied. Out of 7,530 students, 380 were selected for the study. They were asked to take an entrance test of their knowledge of the first semester of their current mathematics class before starting the platform. For 1.5 months, students took lessons on the platform independently, and upon completion, they did the exit math test (similar to the entrance test). In addition, at the end of the access to the platform, students and parents were interviewed about their attitude to the platform, the format and learning outcomes during this time.

4. THE RESULTS

After closely examining the results of the Play Math project, we have arrived at the following conclusion.

The Play Math project involved 7,530 students of 5-9 grades. Among them, about 36% were 5^{th} grade students, 22% were 6^{th} grade students, 15% were 7^{th} grade students, 15% were 8^{th} grade students, and 12% were 9^{th} grade students. To find out the effectiveness of using the GIOS as the instrument for overcoming mathematics learning losses we formed a sample of 380 students (from different regions of Ukraine, living in different conditions: abroad, in the de-occupied and non-occupied territories of Ukraine, and internally displaced persons).

Students of 5th and 6th grades were about 58% of 7,530 participants. The sample of 380 students for the research was formed with an approximate preservation of this ratio. Among them were 137 students of 5th grade, 83 students of 6th grade, 58 students of 7th grade, 58 students of 8th grade, and 44 students of 9th grade.

4.1. Analysis of entrance and exit test results

In order to see the changes in students' knowledge and skills in math over 1.5 months, we conducted an entrance and exit test. The 380 students took the mathematics entrance test (before they started using the GIOS platform) and the mathematics exit test (after 1.5 months of studying on the platform).

Access to the GIOS platform was opened at the beginning of the second semester of the school year. Accordingly, students at the school should have already completed the mathematics topics of the first semester of the current grade. The entrance and exit tests consisted of 10 tasks of different levels in mathematics based on the topics of the first semester of the current grade. The tasks of the exit test were similar to those offered at the entrance test. Each test was scored on a 12-point system. The results of the average scores of both tests by grade are shown in Table 1.

Table 1.

Average test score by grade

Grade	Average score of the entrance test	Average score of the exit test
5	8.33	9.48
6	9.1	10.33
7	8.66	10.68
8	7.89	9.79
9	6.32	8.43

The average score of the exit test for each grade is higher than the average score of the entrance test. This indicates that in the process of self-study on the GIOS platform, students did manage to improve their mathematics knowledge to some extent. Students of different grades managed to improve their performance in different ways. Grade 9 students improved by about 33%, grade 8 students by 24%, grade 7 students by 23%, and grade 5 and 6 students by about 14%. In other words, students in grades 7 to 9 scored better than students in grades 5 to 6. In our opinion, this is primarily due to the age of the students. Independent learning of mathematics on the platform requires students to be self-motivated, self-disciplined, and have a certain level of will. Students in grades 7 to 9 are more independent and self-organized, and they are no longer studying a propaedeutic course in mathematics, but systematic courses in algebra and geometry.

4.2. Analysis of the student survey

Students had been studying on the GIOS platform for 1.5 months. To find out how students organized their independent learning using the platform, we conducted a survey for students. 380 students were asked by a Google form.

The entrance test revealed that most students had learning losses in their mathematical knowledge for the first semester of this year. Having gained access to the GIOS platform, students worked on the topics of the first semester of the current grade. Seventy-five percent of

students reported having initiated their studies on the topics of the second semester via the platform. Among these students, 90% indicated that the new material was presented clearly and that they were able to comprehend it independently.

On the GIOS platform, the theoretical part of the lesson consists of three parts: educational videos, schemes, and examples of solved problems. The results of the survey show that when mastering the topics of the first semester, about 56% of students familiarized themselves with all 3 stages of the theoretical part of the lesson, and about 13% watched only videos and examples of solved problems. When students were studying new topics (topics of the second semester), the percentage of those who watched all three parts increased to 68%. About 11% of 380 students watched only videos and examples of solved problems.

About 98% of students say that the training videos were clear. About 90% of students characterize the length of the educational videos on the platform (4-7 minutes) as normal, but there are also 9% of students who consider the videos too short and 1% of students who consider the videos too long. About 95% of students say that interrupting the video with questions helped them understand the material. About 68% of students like the presentation of theoretical material through animated videos. But different students process educational videos differently. The number of times students viewed an educational video is shown in Figure 1.

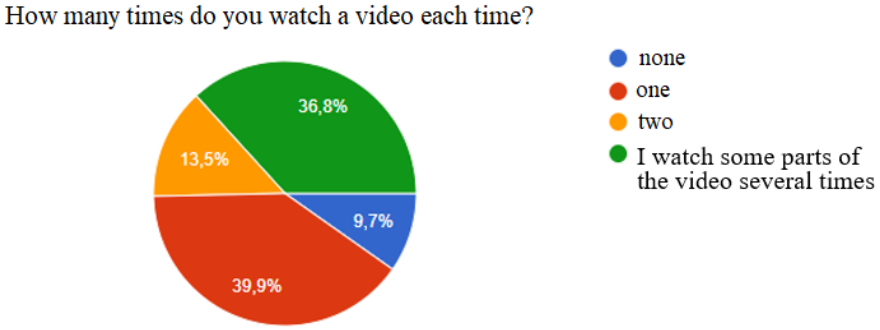

Figure 1. Results of students' responses to re-watching the video

We were also interested in whether students returned to the theoretical material when solving the tasks offered on the platform. The results can be seen in Figure 2.

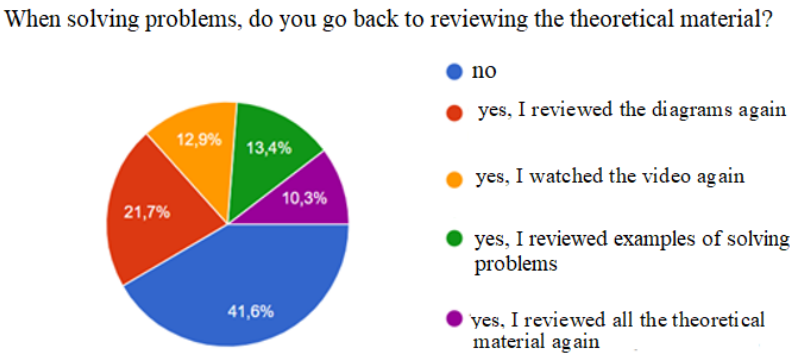

Figure 2. The results of students' responses to revising theoretical material while solving problems

We also asked students which components of the lessons on the platform they liked the most.

About 68% of students say that they liked the presentation of theoretical material on the platform (3 stages: video, diagrams, examples of problem solving). 62% of respondents say

they like the types of tasks and the fact that they can improve their results (try to pass a lesson with similar tasks), 56% of students like the fact that they can review the lesson they have passed and analyze their mistakes, 53% of students say they like that the platform presents the entire mathematics course for a particular grade.

About 66% of students like the platform's tests, which allow them to independently check their understanding of theoretical material. Students also like the non-standard forms of tasks presented on the platform. For about 46% of students, the most favorite are tasks to identify the order of actions in solving a problem, for about 43% of students - tasks to identify errors and matching tasks.

About 64% of students took the lesson twice (the second time they were offered tasks similar to those in the first lesson) to improve their results.

About 99% of students enjoyed learning mathematics on the GIOS platform.

About 95% of students believe that they managed to improve their mathematics knowledge in the first semester using the GIOS platform.

4.3. Analysis of the parent survey

Students themselves or their parents registered for the Play Math project. At the end of the project, we conducted a survey not only of students but also of their parents. It was interesting to find out what parents thought about this learning format and the GIOS platform. We managed to interview 175 parents.

Most parents appreciated the benefits of learning mathematics on the platform (Fig. 3).

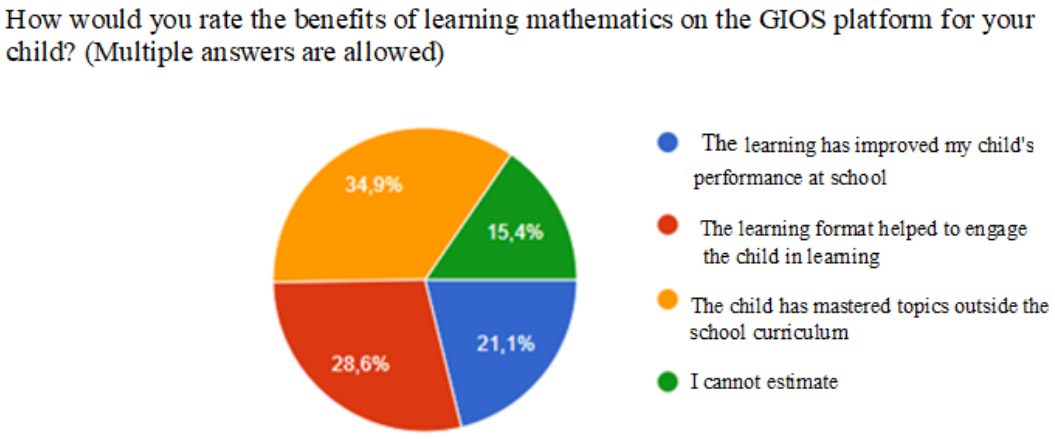

Figure 3. Results of parents' responses about their perception of the benefits of their children's learning on the platform

48% of parents were surprised by their child's independence.

About 58% of parents believe that one of the advantages of the platform is the availability of both theoretical material and different levels of tasks to consolidate it. About 54% of parents say they think their child liked the accessibility of the material and its format.

At the same time, parents noted a number of things that, in their opinion, prevented their children from learning:

- the platform works only if there is the Internet access (12% of parents);
- lack of an app (about 11% of parents);
- small font of the task conditions (about 10% of parents);
- lack of a tutor from the platform (about 9% of parents).

Also, about 45% of parents say that the spirit of competition is important. The possibility of receiving prizes for the best results created additional external motivation for students.

5. DISCUSSION

When developing courses on the GIOS platform, we were guided by the following considerations:

- it is convenient when one service contains all the program material studied in the current grade;
- students like it when they have the opportunity to review theoretical material in different formats (for example, students can watch a video if it is a new or unlearned topic, or quickly review a diagram to refresh the basic connections between the concepts of a topic they know);
- most students of students in grades 5 to 9 have a positive perception of animated videos lasting 4-7 minutes (students should have the opportunity to stop the video, watch it or parts of it several times, return to watching it later, etc.);
- interrupting the video with questions to the student contributes to a better understanding of the theoretical material;
- to overcome learning losses, students need to immediately consolidate the newly acquired theoretical knowledge in practice (it is desirable that some of the tasks are educational or that students have the right to make a mistake and solve an alternative task);
- students are interested in tasks of a non-typical form (for example, to find an error in the given solution, to find the correct order of actions to be performed when solving a problem etc.);
- the presence of gamification elements increases students' motivation to learn;
- the possibility to review what has been learned, analyze mistakes, and perform similar tasks contributes to better student learning.

These considerations were supported by the results of the student survey discussed in this article was confirmed by the results of the student survey described in this article.

When teachers create such materials on their own, it is important to pay attention to the points described above, as well as to choose fonts, color combinations, and control the absence of unnecessary distractions.

In the context of war, it is important that materials created to overcome learning losses are available to students even in the absence of the Internet or electricity. For example, downloading an app would solve this problem if the gadget has sufficient memory.

6. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

Due to the COVID-19 pandemic and russia's large-scale invasion of Ukraine, traditional education for Ukrainian students has been disrupted. Some students couldn't attend classes, and teachers faced challenges in organizing effective training. Consequently, since 2020, educational stability has been compromised, leading to significant learning losses among Ukrainian students. Learning losses in math, in particular, hinder students' progression. Developing students' foundational mathematical skills contributes significantly to Ukraine's future economic growth and stability. Therefore, it is important to develop tools to overcome students' learning losses in mathematics. Learning losses cannot be solely addressed through traditional classroom methods, as each student's learning losses vary. And it is beneficial to have tools that allow students to overcome these challenges independently. Information and

communication technologies can play an essential role in addressing this need. One of the tools that can help organize students' independent overcoming learning losses in mathematics is the GIOS platform. The platform contains online courses for grades 5-9. Each lesson in the course contains theoretical material (presented in various formats), practical tasks of various forms and gamification. Students like to be able to view materials several times and return to them at any time, to review the materials passed to analyze errors, to improve results by solving similar problems. All of this engages and motivates students to learn mathematics. The results of our research show that some students in grades 5-9 can significantly improve their math knowledge and skills using this platform on their own.

It is also important to note that not all students can overcome the existing learning losses by learning the material on their own, even with external motivation and an interesting and convenient presentation of the material. After all, this requires willpower, constant self-discipline, self-organization, and self-motivation on the part of students. Our research shows that not every student has this level of independence. According to our research, only 35% of students who had access to the platform used it. The success of overcoming learning losses during self-study is also influenced by the age of students. Students in grades 7 to 9 are not sufficiently independent, and it is more difficult for them to maintain attention and engage in one activity for a long period of time. They are not used to working independently and regulating their learning activities. That is why, in our opinion, their result of independent study of the materials of the first semester increased by only 14%. This learning format is more suitable for students in grades 7 to 9 (they are usually more independent and have a higher level of digital competence).

Teaching students through online courses requires a certain level of independence, while also nurturing and developing this independence. It is worth noting that 48% of parents were impressed with their children's independence. Therefore, in order to overcome learning losses in mathematics, it is advisable to introduce an independent component of students' learning of educational materials into the educational process (at least for students in the upper 7th grade). To overcome learning losses, teachers can develop such materials on their own or use ready-made materials (for example, on the GIOS platform).

We assume that students' results will be higher if there is a tutor to help them with planning, monitoring, and providing feedback. Future research will be aimed at measuring the success of overcoming learning losses in mathematics using the GIOS platform with a tutor or at analyzing other platforms as a means of overcoming learning losses.

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ОНЛАЙН-ПЛАТФОРМА GIOS ЯК ІНСТРУМЕНТ ПОДОЛАННЯ ОСВІТНІХ ВТРАТ З МАТЕМАТИКИ

Васильєва Дарина Володимирівна
кандидат педагогічних наук, старша наукова співробітниця,
відділ математичної та інформатичної освіти
Інститут педагогіки НАПН України, м. Київ, Україна
ORCID ID 0000-0002-4083-681X
vasylievadaryna@gmail.com

Годованюк Тетяна Леонідівна
доктор педагогічних наук, професорка, проректор з наукової роботи,
професорка кафедри вищої математики та методики навчання математики
Уманський державний педагогічний університет імені Павла Тичини, м. Умань, Україна
ORCID ID 0000-0002-7087-7102
tgodovanyuk@ukr.net

Анотація. Пандемія, зумовлена COVID-19, у всьому світі спричинила перехід від очного формату навчання до дистанційного. Раптова зміна формату навчання і неготовність до цього системи освіти зумовила появу освітніх втрат в учнів. Найбільш дослідженими і зафіксованими є освітні втрати з математики, читання та природничих наук. В Україні процес очного навчання повноцінно не відновився й досі, оскільки через 2 роки пандемії розпочалась повномасштабна війна. Відповідно проблема подолання освітніх втрат з математики стоїть особливо гостро, бо від цього залежить і економіка країни в подальшому. Як свідчать розглянуті в статті дослідження, подоланню освітніх втрат допомагає використання в освітньому процесі інформаційно-комунікаційних технологій. Їх можна використовувати для організації синхронного чи асинхронного навчання. У статті розглядається результативність самостійного використання учнями матеріалів платформи GIOS для подолання наявних

освітніх втрат з математики. Описані результати вхідного і вихідного тестування учнів, опитування учнів та їх батьків після 1,5 місяців самостійного навчання на платформі. Зроблено висновки, що самостійний формат навчання без учителя чи куратора підходить не всім. Але все ж однією із складових подолання освітніх втрат може бути самостійне опрацювання учнями мультимедійних матеріалів. Встановлено, що чим старші учні, тим ефективнішим є такого роду навчання. На основі опитування учнів виокремлено характеристики платформи GIOS, що мотивували учнів до навчання, а також допомагали усвідомити та засвоїти матеріал. Серед характеристик доцільно виділити: цілісність курсу, елементи гейміфікації, наявність теоретичного матеріалу в декількох видах (відео, схема, приклади розв'язаних завдань), можливість перегляду його декілька разів і повертатися в будь-який момент часу, наявність завдань навчального характеру, завдань різного рівня та в різних формах (зокрема й нестандартних), можливість перегляду вивченого матеріалу для аналізу помилок, можливість поліпшити результати за рахунок розв'язування аналогічних завдань. Зазначено, що для подолання освітніх втрат такого роду матеріали з математики потрібно розробляти вчителям самостійно або використовувати вже готові.

Ключові слова: освітні втрати; подолання освітніх втрат; навчання математики; методика математики; дистанційне навчання; платформа GIOS.

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