UDC 373.5.013.74.018.43.018:[373.5.016:004](045)

Oleh Topuzov
Dr Sc. in Education, Professor, Full Member (Academician) of the NAES of Ukraine,
Director of the Institute of Pedagogy of the NAES of Ukraine, Vice President of the National Academy of Educational Sciences of Ukraine
Institute of Pedagogy of the National Academy of Pedagogical Sciences of Ukraine, Kyiv, Ukraine
ORCID ID 0000-0001-7690-1663
proftop@ukr.net

Oleksandr Malykhin
Dr Sc. in Education, Professor, Corresponding Member of the NAES of Ukraine, Head of the Didactics Department
Institute of Pedagogy of the National Academy of Educational Sciences of Ukraine, Kyiv, Ukraine
ORCID ID 0000-0001-6042-6298
malykhinalex1972@gmail.com

Oksana Onopriienko
Dr Sc. in Education, Senior Researcher, Corresponding Member of the NAES of Ukraine, Head of the Department of Primary Education named after Oleksandra Savchenko
Institute of Pedagogy of the National Academy of Educational Sciences of Ukraine, Kyiv, Ukraine
ORCID ID 0000-0002-0301-1392
oks_on@ukr.net

Inna Lipchevska
PhD in Pedagogy, Senior Researcher at the Didactics Department
Institute of Pedagogy of the National Academy of Educational Sciences of Ukraine, Kyiv, Ukraine
ORCID ID 0000-0002-6901-5863
linla@ukr.net

COMPARATIVE ANALYSIS OF THE EFFECTIVENESS OF DISTANCE AND IN-PERSON LEARNING OF COMPUTER SCIENCE WITHIN THE ADAPTATION CYCLE OF BASIC SECONDARY EDUCATION

Abstract. The article is devoted to a comparative analysis of the effectiveness of distance and in-person learning of Computer Science in basic secondary education (adaptation cycle). The relevance of the study is determined by: (1) the necessity of ensuring the continuity of the educational process under prolonged instability caused by the pandemic, war, and other global challenges; (2) the appropriateness of utilizing the digital learning tools pedagogical potential for the implementation of modern methodological approaches and learning principles; and (3) the demand of the educational system for identifying optimal instruments for the rapid adaptation of students to the conditions of basic secondary school education.

Within the framework of a quasi-experimental study, the academic performance of fifth-grade students engaged in the educational process in two different formats – traditional in-person and asynchronous distance learning – was analyzed. The aim of the study was: (1) to investigate the feasibility of implementing short-term (lasting up to one academic semester) asynchronous distance learning of Computer Science for students of basic secondary school while maintaining its effectiveness; and (2) to determine the advantages and disadvantages of this learning format in basic secondary education (adaptation cycle).

A total of 125 fifth-grade students participated in the study. The control group received in-person instruction, while the quasi-experimental group studied in an asynchronous distance format. The analysis of results was based on students' academic progress and their participation in extracurricular activities in the field of Computer Science.

The findings support the feasibility of using the asynchronous distance format as a tool to support learning in conditions of instability (particularly under the martial law). This format fosters the development of digital literacy, independence, responsibility, and lifelong learning skills. The authors emphasize the importance of maintaining pedagogical support, providing high-quality feedback, and implementing adaptive digital content.

© Oleh Topuzov, Oleksandr Malykhin, Oksana Onopriienko, Inna Lipchevska, 2025.

A promising direction for further research is the study of the impact of distance learning on other educational fields and age groups.

Keywords: distance learning; Computer Science; basic secondary education; pedagogical support; student independence; educational effectiveness.

1. INTRODUCTION

Problem Statement

Over the past decade, digital didactics has been actively developing as a branch of modern pedagogy. The focus of academic inquiry concerns the organization, designing, and implementation of the educational process within a digital environment. Education is evolving in dynamic conditions driven by the rapid transformation of society. Challenges arising from global, unpredictable factors, such as pandemics, wars, natural disasters, and economic crises, not only contribute to decreased academic performance among students but also serve as a foundation for rethinking established teaching approaches and principles, fostering innovation in education, and stimulating the modernization and advancement of pedagogical thought.

The COVID-19 pandemic intensified research into the pedagogical potential of implementing digital technologies in education. The initial attempts to implement distance and blended learning in general secondary education institutions revealed a number of systemic difficulties and stimulated collaborative efforts between researchers and practicing teachers to find ways to optimize the educational process under complex and unstable conditions. There emerged an urgent need for the rapid development of digital competence among teachers, students, and parents, as well as for ensuring their access to digital learning and communication tools. Issues related to students' motivation and academic independence across all levels of secondary education became more relevant, as did the need to maintain the psychological well-being of all participants in the educational process under adverse circumstances.

Under martial law in Ukraine, distance and blended learning have been used (either continuously or periodically) in many general secondary education institutions. The initial phase of adaptation to the digital educational environment has largely been completed, providing a basis for identifying the advantages of these formats. Gradually, evidence-based approaches and principles of distance and blended school education are being developed, along with corresponding forms, methods, techniques, and teaching tools.

The use of these educational formats is potentially effective not only for ensuring the flexibility and resilience of educational systems, but also for achieving learning outcomes related to the development of students' digital literacy and competence, their academic independence and responsibility, lifelong learning skills, motivation for self-improvement, and initiative in shaping their individual learning trajectories. A foundational prerequisite for empirical studies in this area is the availability of modern digital learning and communication tools for all participants in the educational process, as well as the methodologically and didactically sound guidance of the learning process by the teacher.

At the same time, the dominant prolonged use of distance learning may hinder the development of students' social competence, emotional intelligence, and in-person communication skills. Blended learning may create difficulties due to the need to dynamically alternate between face-to-face and distance learning formats. Purposeful pedagogical intervention is required to develop students' ability to learn both with and without the use of digital tools within individual, pair, group, and collective activities; while working through learning content with a teacher; and while completing independent tasks. Issues of maintaining students' physical and psychological health during the use of digital learning and communication tools also remain highly relevant.

The importance of developing substantiated and practically validated insights regarding the potential benefits and risks of distance and blended learning formats in general secondary education institutions necessitates further empirical research. It is especially important to study this issue in the context of students' adaptation to basic secondary school, as this stage involves the development of academic independence, the formation of motivation to master new subjects, adaptation to a changed structure of the educational process, and the acquisition of new formats of interaction with teachers and peers. The success of this period largely determines a student's further educational trajectory, which makes the choice of learning format at this stage particularly significant.

Analysis of Recent Studies and Publications.

The decline in students' academic performance, particularly at the secondary education level, during the implementation of distance and blended learning formats amid the COVID-19 pandemic is evidenced by educational research conducted in various countries. For instance, findings from a study by Swiss researchers indicate that students engaged in distance learning encountered significant difficulties caused by the lack of established online education practices, an appropriate methodological foundation, and digital infrastructure. Their academic performance was considerably lower compared to that of peers receiving face-to-face instruction [1]. An Italian study similarly reports that during the pandemic, school students faced a number of challenges, including limited access to digital devices, unstable internet connectivity, low levels of motivation, and insufficient pedagogical support from teachers [2].

At the same time, existing studies from this period also highlight certain positive aspects of distance learning, such as the development of students' digital skills and the flexibility of educational process organization, particularly in terms of individual learning pace [3]. Comparative analysis of in-person and distance learning demonstrates that the quality of interaction between participants in the educational process is a critical factor, regardless of the mode of delivery [3]. Flexibility, adaptability of educational content, and pedagogical autonomy are essential for the stable functioning of the education system under new conditions [4]. Subsequent studies show that the effectiveness of distance and blended learning has increased due to the modernization of digital infrastructure in educational institutions, the adaptation of educational content to the operational conditions of schools, and the growth in teachers' competencies [5]. International research in this domain confirms that the structured nature of distance lessons, regular feedback, and formative assessment significantly enhance the learning outcomes of students in general secondary education institutions [6].

In recent years, the Ukrainian educational system has shown an intensified development and refinement of distance and blended learning formats. Monitoring data from the Institute of Digitalization of Education of the National Academy of Educational Sciences of Ukraine indicate that teachers have gradually adapted to the conditions of martial law, mastered digital tools, and successfully integrated them into their daily teaching practices [7]. In 2024, domestic scholars conducted research on the digital transformation of education in the context of sustainable development. The findings confirmed that the "digital turn" contributed to increasing the resilience of educational systems to crisis impacts and supported the adaptation of education to new challenges [8]. The use of messaging apps, shared documents, and video conferencing platforms enables the development of students' communication skills, fosters collaboration, and supports the organization of learning processes in online environments [9]. Thoughtfully designed didactic and methodological application of formats, methods, techniques, and tools of digital didactics in distance and blended learning enhances its effectiveness and helps minimize learning losses among primary [10] and secondary [11] school students.

Nevertheless, despite the available theoretical frameworks and empirical studies, this area of contemporary pedagogy remains insufficiently explored and requires further investigation.

Aim of the Research.

To examine the feasibility of implementing short-term (up to one academic semester) asynchronous distance learning in Computer Science for secondary school students while maintaining its effectiveness in comparison to traditional in-person instruction. The study aims to identify the advantages and disadvantages of this learning format within the adaptive cycle of basic secondary education.

2. RESEARCH METHODOLOGY

A quasi-experiment aimed at assessing the effectiveness of asynchronous distance learning in Computer Science during the first (adaptation) cycle of basic secondary education (in comparison with the traditional face-to-face format) was conducted in the first semester of the 2024/2025 academic year.

The study involved 125 fifth-grade students from a city general secondary education institution (Table 1).

Table 1

Distribution of research participants

Groups	Class	Number of students in class	Number of students in group
Quasi-experimental group	5-B	32 (51 %)	63 (100 %)
	5-C	31 (49 %)	
Control group	5-A	32 (52 %)	62 (100 %)
	5-D	30 (48 %)	

The sample was formed within a single general secondary education institution, which determines the contextual specificity of the obtained data. Nevertheless, the study allows the identification of characteristic trends in the influence of learning format on educational outcomes under real conditions of school operation under martial law. The one-semester observation period enables conclusions to be drawn regarding the short-term effects of asynchronous distance learning, which is a crucial stage for assessing its feasibility in the adaptation cycle of basic secondary education.

The study did not involve intentional pedagogical intervention or modification of the educational process. The learning formats (face-to-face / asynchronous distance learning) were applied in the educational institution according to internal schedules driven by security circumstances under martial law in Ukraine.

In the first semester of the 2024/2025 academic year, Classes 5-A and 5-D studied all subjects (including Computer Science) in a face-to-face format (control group), while in Classes 5-B and 5-C (quasi-experimental group), Computer Science was taught in an asynchronous distance format alongside face-to-face instruction in other subjects. Scientific observation and analysis of results were carried out based on existing educational practices without interference in the organization of the learning process.

All participants in the study had stable access to computer devices and the Internet, which ruled out technological limitations. According to teachers' feedback, most parents of students in all classes involved in the study were interested in their children's academic achievements and provided assistance when necessary; however, Computer Science was not among the subjects they regarded as a priority. Therefore, parental support was situational in nature and did not significantly influence the course of the experiment.

All teachers involved in the study had experience in both face-to-face and distance (synchronous/asynchronous) learning and actively integrated digital technologies into their professional and pedagogical activities. Consequently, it can be stated that the learning conditions were comparable in terms of teachers' professional training and teaching experience

in Computer Science, and, accordingly, the potential pedagogical influence on students' learning outcomes.

The research hypothesis assumed that the level of students' learning outcomes in asynchronous distance learning of Computer Science during the first (adaptation) cycle of basic secondary education would not differ statistically from the level of outcomes achieved through face-to-face learning, provided that the didactic and methodological support was of appropriate quality, effective digital learning tools were available, and the duration of the distance format was limited to one semester.

The study was structured in three stages:

- Science among fifth-grade students in both formats was conducted.
- At Stating stage, aimed at evaluating the similarity or divergence of the quasi-experimental and control groups based on characteristics of primary importance to the research;
- Formative stage, during which the quasi-experimental group studied Computer Science in an asynchronous distance format;

Control stage, during which a comparative analysis of the learning outcomes in Computer the Stating stage, a conclusion regarding the similarity or divergence of students in the control and quasi-experimental groups based on a comparison of their academic performance in the previous academic year was drawn. The study utilized indicators and descriptors of learning outcome levels in accordance with the *Methodological Recommendations for the Assessment of Learning Outcomes of Students in Grades 1–4 of General Secondary Education Institutions* [12]. To determine students' interest in mastering the content of the Computer Science educational domain, the obtained results were supplemented with an analysis of their participation in the "Digital Sketches" competition (May 2024) and the quality of the submitted works. At the beginning of the study, the level of learning motivation in the quasi-experimental and control groups was comparable.

At the beginning of the formative stage of the study, participants in the quasi-experimental group were enrolled in the Google Classroom learning environment, which facilitated asynchronous distance interaction among teachers, students, and parents.

The learning process was coordinated by Computer Science teachers, who uploaded learning materials in accordance with the class schedule. The core content comprised the New Ukrainian School Computer Science textbook for Grade 5 and a digital supplement that integrated interactive lessons, multimedia resources, and an automated system for monitoring learning outcomes. This format provided timely feedback and allowed students to progress at their individual pace.

Additionally, video materials, digital didactic games, resources from educational platforms, and teachers' own instructional materials were used. Practical tasks were selected with regard to students' individual characteristics and included elements of creativity and choice.

Assessment was carried out in Google Classroom and duplicated in the school's digital gradebook. Students were given the opportunity to revise their assignments and improve their results throughout the study of each topic.

During the formative stage of the quasi-experiment, the curriculum included two topics: *"Information Processes and Systems"* (covering issues such as information technologies in modern life, the structure and functionality of local networks and the Internet, safe Internet use, and effective online search strategies) and *"Algorithms and Programs"* (covering the creation and implementation of linear, branching and looping algorithms in the visual programming environment Scratch).

At the end of the first semester, students from both the quasi-experimental and control groups were invited to participate in an exhibition-contest of animated programs-cartoons

created in Scratch using linear algorithms. The participation guidelines emphasized the importance of creating a gripping and original storyline, encouraged the selection of unique characters, addition of sound effects, and the use of dynamic animation to make the cartoons captivating and lively. Participation in the "MultScratcher" exhibition-contest was voluntary, with students completing the projects independently during extracurricular time. Once submitted works were collected, all projects were uploaded to a Padlet online board for viewing.

The formative stage of the quasi-experiment aligns with the educational concept "Education 4.0", which positions digital technologies as both a tool for developing students' competencies and a means of transforming the structure of the educational process. Specifically, the use of the aforementioned tools corresponds to the "modification" level of the SAMR model (Puentedura, 2010), which involves significant redesign of educational process realization.

Moreover, the general methodological framework of digital learning in Computer Science used in this study corresponds with the principle of effective digital technology integration in the educational process outlined in the TPACK model (Koehler & Mishra, 2009). This model emphasizes the need to combine technological, pedagogical, and content knowledge for effective learning experience design.

During the control stage of the study, a comparative analysis was conducted on the learning achievements of students in the quasi-experimental and control groups during the first semester of the 2024/2025 academic year. To evaluate student success in mastering Computer Science, performance indicators and assessment criteria were applied in accordance with the *Methodological Recommendations for Assessing the Learning Outcomes of Students According to the State Standard of Basic Secondary Education* [13]. Additionally, student participation in the "MultScratcher" exhibition-contest and the quality of their submitted projects were analyzed.

Furthermore, a survey of Computer Science teachers involved in the quasi-experimental group regarding the process and outcomes of asynchronous distance learning was conducted. Teachers provided detailed responses to open-ended questions such as: *"How would you assess the effectiveness of asynchronous distance learning compared to face-to-face instruction under the unstable conditions of martial law?"*, *"What specific features of asynchronous distance learning during the adaptation cycle of basic secondary education can you identify?"*, and *"What recommendations would you give to colleagues regarding the organization of asynchronous distance learning during the adaptation cycle of basic secondary education?"*

The study was conducted in accordance with the principles of academic integrity and the ethical responsibilities accepted by the scholarly and pedagogical community. Personal data of students and teachers were not recorded; the results are presented in anonymized form. The research procedures did not interfere with the educational process and did not impose additional workload on the participants.

3. RESEARCH RESULTS

3.1. Findings of the Stating Stage of the Study

During their primary education, all students involved in the study received face-to-face instruction (except for periods when quarantine restrictions were in place due to the COVID-19 pandemic, as well as at the beginning of the full-scale invasion of Ukraine by the russian federation). The academic performance of students in Computer Science at the end of primary school indicates that the quasi-experimental and control groups were equivalent in terms of characteristics relevant to the research. The majority of students in both groups demonstrated high or sufficient levels of academic achievement upon completing primary education (Table 2).

Table 2

Academic performance in Computer Science of students in the quasi-experimental and control groups (Grade 4)

Level of academic achievement	Computer Science performance indicator			
	Uses digital devices to complete learning tasks (I1)	Creates informational products (text, images, presentations) in software environments (I2)	Composes linear, branching, and looping algorithms based on descriptions and obtains the expected outcome (I3)	Collects information using digital devices according to the learning objective, uses online environments for collaboration and idea exchange (I4)
Control group				
High	79 % (49 students)	69 % (43 students)	66 % (41 students)	74 % (46 students)
Sufficient	19 % (12 students)	29 % (18 students)	29 % (18 students)	23 % (14 students)
Average	2 % (1 student)	2 % (1 student)	5 % (3 students)	3 % (2 students)
Low	0 % (0 students)	0 % (0 students)	0 % (0 students)	0 % (0 students)
Quasi-experimental group				
High	81 % (51 students)	67 % (42 students)	63 % (40 students)	76 % (48 students)
Sufficient	19 % (12 students)	30 % (19 students)	32 % (20 students)	24 % (15 students)
Average	0 % (0 students)	3 % (2 students)	5 % (3 students)	0 % (0 students)
Low	0 % (0 students)	0 % (0 students)	0 % (0 students)	0 % (0 students)

Since the results of students' academic performance in Computer Science are measured on an ordinal scale with four levels (low, average, sufficient, and high) and each group includes ≥ 30 students, it is appropriate to use Pearson's chi-square test of homogeneity (χ^2) to determine whether the quasi-experimental and control groups are statistically equivalent/divergent at the stating stage (and later at the control stage) of the experiment. The empirical value of the chi-square statistic χ^2 for samples of unequal sizes is calculated using the following formula:

$$\chi^2_{emp} = N \cdot M \cdot \sum_{i=1}^{L} \frac{(\frac{n_i}{N} - \frac{m_i}{M})^2}{n_i + m_i} \quad (1),$$

where

N – total number of students in the quasi-experimental group;

M – total number of students in the control group;

L – number of assessment levels (degrees of freedom = L – 1);

n_i – number of students in the quasi-experimental group who demonstrated high (n_1), sufficient (n_2), average (n_3), or low (n_4) levels (frequency of observations in the experimental group);

m_i – number of students in the control group with high (m_1), sufficient (m_2), average (m_3), or low (m_4) levels (frequency of observations in the control group).

The empirical values of the χ^2 test statistic at the stating stage are presented in Table 3.

Table 3

Empirical χ^2 Values for the Stating Stage of the Quasi-Experiment

	Computer Science Performance Indicator			
	I1	I2	I3	I4
χ^2_{emp}	1,03	0,36	0,11	2,07

To evaluate the obtained data, the critical value of χ is determined for a significance level of P = 0.95. Since all students achieved levels above the lowest category, the number of degrees of freedom for all Computer Science performance indicators is $v = L - 1 \rightarrow v = 3 - 1 = 2$, and the critical value is $\chi^2_{0.05} = 5.99$ [14].

At the stating stage of the experiment, the empirical values of χ^2_{emp} for all indicators of academic performance are significantly lower than $\chi^2_{0.05} = 5{,}99$, which confirms the equivalence of the quasi-experimental and control groups with a confidence level of 0.05 in terms of the characteristics that are essential to this study.

In addition to Pearson's χ^2 criterion, Cramer's V coefficient was applied to quantitatively assess the strength of the association between the learning format (face-to-face and asynchronous distance) and the level of students' academic achievements (Table 4):

$$V = \sqrt{\frac{\chi^2_{\text{ем}}}{n \cdot min(r-1, c-1)}} \quad (2),$$

where

n – total number of students participating in the study;

r – number of groups (2);

c – number of levels of academic achievement (3, since there were no students with low achievement level).

Table 4

Cramer's V Value for the Stating Stage of the Quasi-Experiment

	Computer Science Performance Indicator			
	I1	I2	I3	I4
V	0,09	0,05	0,03	0,13

Since the Cramer's V value obtained for all Computer Science performance indicators at the stating stage of the experiment was below 0,2, it can be concluded that students' academic performance had only a minimal association with the group to which they belonged (quasi-experimental or control).

The level of interest in Computer Science among students in the quasi-experimental and control groups was evaluated through their participation in the creative competition "Digital Sketches", organized by Computer Science teachers at the end of the 2023/2024 academic year (Table 5), as well as through the quality of the submitted student works.

Table 5

Statistical Data on the Participation of Students from the Quasi-Experimental and Control Groups in the "Digital Sketches" Creative Competition

Groups	Students who submitted one work	Students who submitted two works	Total participants	Students who did not participate
Quasi-experimental group	65 % (41 students)	11 % (7 students)	76 % (48 students)	24 % (15 students)
Control group	71 % (44 students)	0 % (0 students)	71 % (44 students)	29 % (18 students)

Participation in the competition was voluntary. The slightly higher engagement of students in the quasi-experimental group (specifically class 4-B) can be explained by the individual interest of some children in visual arts, particularly in digital drawing. Several students from this class who submitted two creative works are involved in non-formal education in this area.

The analysis of the quality of student submissions is presented in Table 6. The proportion of students who independently created their works using digital graphic editors was 77 % for the quasi-experimental group and 72 % for the control group. The proportion of students who completed their work with teacher assistance was 23 % and 28 %, respectively.

Table 6

Analysis of the Quality of Student Submissions for the "Digital Sketches" Competition

Groups		Students who submitted creative works		Students who submitted reproductive works	
		Done independently	Done with teacher assistance	Done independently	Done with teacher assistance
Quasi-experimental group	Total number of students	22 students	4 students	15 students	7 students
	% of group participants	46 %	8 %	31 %	15 %
	% of total group	34 %	6 %	24 %	11 %
Control group	Total number of students	20 students	3 students	12 students	9 students
	% of group participants	45 %	7 %	27 %	21 %
	% of total group	32 %	5 %	19 %	15 %

Overall, based on the analysis of the submissions to the "Digital Sketches" competition, it can be concluded that the level of interest in the Computer Science subject area is comparable between the students in both groups.

Thus, the quasi-experimental and control groups are considered equivalent in terms of the key characteristics essential to the research.

3.2. Results of the Control Stage of the Study

The homogeneity of research conditions in terms of technical support, the relatively equal level of students' learning motivation in the quasi-experimental and control groups, and the comparable professional competence of teachers in both groups ensured the reliability of the obtained results. Parental assistance was situational, lacked a systematic character, and did not cause any significant differences between the groups.

The academic achievements in Computer Science of the students involved in the study are presented in Table 7. Overall, the data indicate that the performance of the quasi-experimental group is slightly lower compared to that of the control group.

Table 7

Computer Science Performance of the Quasi-Experimental and Control Groups

Level of academic achievement	Computer Science Performance Indicators			
	Processes information, data, and models	Creates informational products	Operates in a digital environment	Uses information technologies safely and responsibly
Control group				
High	68 % (42 students)	65 % (40 students)	69 % (43 students)	72 % (45 students)
Sufficient	27 %	32 %	27 %	26 %

	(17 students)	(20 students)	(17 students)	(16 students)
Average	5 % (3 students)	3 % (2 students)	3 % (2 students)	2 % (1 student)
Low	0 % (0 students)	0 % (0 students)	0 % (0 students)	0 % (0 students)
Quasi-experimental group				
High	65 % (41 students)	57 % (36 students)	64 % (40 students)	68 % (43 students)
Sufficient	27 % (17 students)	35 % (22 students)	30 % (19 students)	26 % (16 students)
Average	8 % (5 students)	8 % (5 students)	6 % (4 students)	6 % (4 students)
Low	0 % (0 students)	0 % (0 students)	0 % (0 students)	0 % (0 students)

Specifically, the number of students in the quasi-experimental group who achieved a high level of performance is 3–8 % lower, depending on the performance indicator. Conversely, the proportion of students who achieved a sufficient level is 0–3 % higher, and the proportion with an average level is 3–5 % higher (Fig. 1).

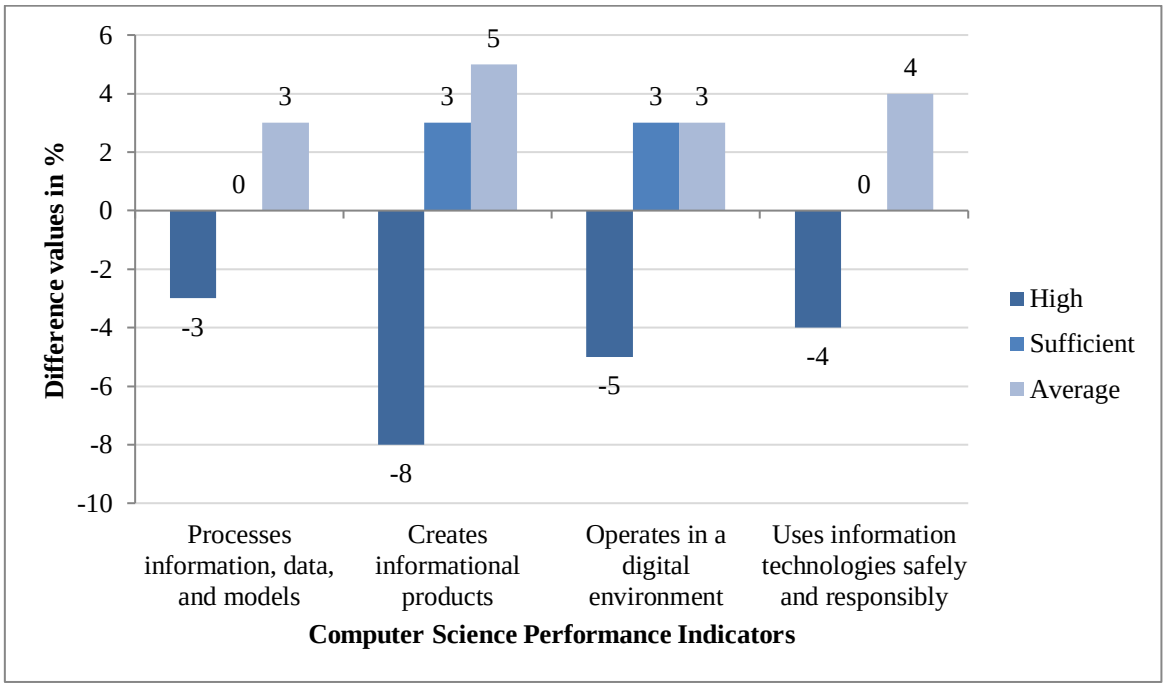

Fig. 1. Differences in Computer Science learning outcomes of students between the quasi-experimental and control groups at the control stage of the study

The empirical values of Pearson's chi-square test (χ^2_{emp}) at the control stage of the study are presented in Table 8.

Table 8

Empirical χ² Values (χ^2_{emp})
Control Stage of the Quasi-Experiment

	Computer science performance indicator			
	I1	I2	I3	I4
χ^2_{emp}	0,50	1,58	0,88	1,84

To interpret these results, we determine the critical value of χ at the confidence level $P = 0{,}95$. With three levels of achievement considered (excluding the lowest level, which was not present), the degree of freedom for all Computer Science performance indicators is $v = L - 1 \rightarrow v = 3 - 1 = 2$, and the critical value is $\chi^2_{0.05} = 5{,}99$ [16].

At the control stage of the quasi-experiment, as at the stating stage, the empirical values of χ^2_{emp} for all performance indicators are significantly lower than the critical value $\chi^2_{0.05}$= 5.99, which confirms the statistical equivalence of the quasi-experimental and control groups at a 0.05 significance level.

The values of Cramer's V coefficient used to quantitatively assess the strength of the association between the learning format (face-to-face and asynchronous distance) and the level of students' academic achievements at the control stage of the experiment are presented in Table 9.

Table 9

Cramer's V Value for the Control Stage of the Quasi-Experiment

	Computer Science Performance Indicator			
	I1	I1	I1	I1
V	0,06	0,11	0,08	0,12

According to the data presented in the table, the Cramer's V values for all Computer Science performance indicators at the control stage of the experiment were also below 0,2. Therefore, students' academic performance had only a minimal association with the group to which they belonged (quasi-experimental or control).

Thus, we conclude that the use of a short-term asynchronous distance learning format over the course of one semester led to a slight decrease in learning outcomes for fifth-grade students.

It is also worth noting that student performance in the first semester of Grade 5 (in both the quasi-experimental and control groups) was lower compared to their achievements at the end of Grade 4. This decline is primarily attributed to the adaptation period associated with the transition to basic secondary education and the onset of adolescence for many students. In addition, the assessment indicators in basic secondary school differ from those used in primary school. For example, the indicator "Uses digital devices to complete learning tasks," where students had demonstrated the best results in primary school, is no longer included in the Grade 5 curriculum. This change contributes to somewhat different assessment outcomes of fifth graders' academic achievements.

It should also be noted that certain external factors – such as the psycho-emotional state of students may have influenced learning outcomes, although these were not specifically controlled for within the scope of this study.

Regarding student engagement in the "MultScratcher" animation exhibition-contest, fifth-grade students demonstrated lower levels of interest in such activities compared to students in primary school. This tendency can be interpreted in light of the transitional nature of the adaptation period that accompanies the shift to a new stage of schooling, as well as the psychological and personal changes typical of early adolescence. These factors may significantly affect students' motivation and engagement in extracurricular learning-oriented activities.

In the quasi-experimental group, the number of students who participated in the event was 1.7 times higher than in the control group (Table 10). This allows us to conclude that the quasi-experimental group demonstrated *greater motivation toward learning programming in the Scratch environment and toward studying Computer Science in general.*

Table 10

Statistical Data on Participation of Students from Quasi-Experimental and Control Groups in the "MultScratcher" Exhibition-Contest

Group	Number of Students Who Participated in the Contest	Number of Students Who Did Not Participate in the Contest
Quasi-Experimental Group	41 % (26 students)	59 % (37 students)
Control Group	24 % (15 students)	76 % (47 students)

All students who participated submitted one work each. Content analysis of the works created by students (Table 11) indicates that participants from both quasi-experimental and control groups have a similar percentage distribution in terms of the duration of their animations – up to 30 seconds and over 30 seconds – with a difference of only 3 % between the groups. However, differences were observed in characteristics such as the use of a wide range of Scratch commands from the "Motion," "Looks," "Sound," "Events," and "Control" categories (difference of 9 %), as well as the use of unique objects (sprites, backgrounds taken not from the Scratch library) (difference of 14 %).

Table 11

Content Analysis of Students' Works Presented in the "MultScratcher" Contest

Groups		Number of Students Who Created Animations with Duration			Number of Students Who Used a Wide Range of Scratch Commands	Number of Students Who Used Characters and/or Backgrounds Not from Scratch Library
		≤ 30 s.	30 s. – 1 min.	≥ 1 min.		
Quasi-Experimental Group	Number of students	13 students	8 students	5 students	15 students	5 students
	% of Students Who Participated	50 %	31 %	19 %	58 %	19 %
	% of Total Group	21 %	13 %	8 %	24 %	8 %
Control Group	Number of students	8 students	6 students	1 student	10 students	3 students
	% of Students Who Participated	53 %	40 %	7 %	67 %	33 %
	% of Total Group	13 %	10 %	2 %	16 %	5 %

The data presented in Table 11 allow an assessment of students' creative activity. When considered relative to the total number of students in each group, the quasi-experimental group demonstrated a higher level of creativity – 8 % of students created original characters or scenes, whereas in the control group only 5 % did so. This suggests that the experimental conditions fostered broader student engagement in the creative process and encouraged them to extend beyond the standard capabilities of the Scratch library.

At the same time, the control group demonstrated a greater number of creative entries in the competition: 33 % of the competition participants created projects featuring original characters or scenes, compared to 19 % in the quasi-experimental group. This may indicate that competition entrants from the control group manifested stronger individual motivation and independent initiative, even without specific pedagogical intervention.

Since the students' projects had a linear structure without interactive elements, the level

of algorithmic complexity was reasonably assessed by the duration of the animation and the variety of commands used. In the quasi-experimental group, 19 % of the animations lasted more than one minute, whereas in the control group only 7 % did so. Moreover, 24 % of the students in the quasi-experimental group (58 % of that group's competition participants) used a wider set of Scratch commands, while in the control group the corresponding values were lower – only 16 % of all students (67 % among competition participants). These findings point to better mastery of the Scratch programming language among students in the quasi-experimental group.

Conversely, analysis of the control group's project structures revealed another strength – a more deliberate composition and logical coherence in the short animations. Even with fewer commands used, such projects were characterized by precise timing, coordinated movements and sound effects, demonstrating attention to detail and a high quality of implementation.

Overall, it can be concluded that the quality of works from the control group is slightly better, although the differences in the indicators are minor.

During a survey, teachers who taught in the quasi-experimental classes noted the following:

"Under martial law conditions, there are certain difficulties both during in-person and distance learning. During on-site school attendance, lessons are periodically canceled due to air raids warnings, and students must independently catch up on some of the learning material at home. At the same time, many students in grades 5 and 6 do not complete assignments aimed at compensating for missed Computer Science material, hoping to quickly catch up during breaks before the lesson or during the lesson itself. There are also justified absences due to family circumstances or illness. In such cases, the material covered by classmates in Computer Science classes is rarely reviewed at home. [The principle of systematic learning is disrupted]. During distance learning, the necessary conditions for successful Computer Science study include a high level of student motivation, the ability to organize their own learning independently, and self-monitoring to ensure lessons are beneficial. This is challenging for many adolescents. Teacher support (which is difficult to provide in a distance format) or parental assistance is often needed."

"It is very helpful to occasionally hold face-to-face consultations at school during asynchronous distance learning. Such short meetings allow completing difficult tasks together with students and stimulate their interest in studying Computer Science."

"Asynchronous distance learning during the adaptation cycle of basic secondary education requires close cooperation between teachers, students, and, necessarily, parents. It also implies a greater workload for teachers in preparing lesson materials and home assignments."

"Under asynchronous distance learning, teaching methods need to be changed, and a wider range of digital tools should be used to organize classroom interaction and communication."

"Both formats can be effective under current conditions; however, asynchronous distance learning is more challenging to implement and monitor."

"In-person Computer Science teaching involves close teacher-student interaction and teacher supervision. Asynchronous distance learning primarily involves students' independent learning at home. [The latter] has advantages – children indeed adapt, learn responsibility, and develop self-control faster. But not all students in grades 5-6 are ready for this format. Motivation, support, and formative assessment are especially critical."

Teachers' responses demonstrate an impartial attitude towards different teaching formats during the first (adaptation) cycle of basic secondary education. Educators consider that, if necessary, asynchronous distance learning of Computer Science can be implemented with this age group and ensure educational progress in accordance with the requirements of the State Standard of Basic Secondary Education (2020) and the Computer Science curriculum followed by their lyceum.

4. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

The results of the quasi-experiment demonstrated that short-term (one-semester) asynchronous distance learning in Computer Science for fifth-grade students provides learning outcomes comparable to those of face-to-face instruction. The absence of statistically significant differences between the control and quasi-experimental groups (Pearson's chi-square test: χ^2, $p < 0.05$, $df = 2$, $\chi^2 < 5.99$) and the minimal association between indicators of Computer Science learning outcomes and the group to which students belonged during the study (Cramer's $V < 0.2$) confirm the potential of the asynchronous format as an effective tool for maintaining the continuity of the educational process under unstable conditions. Positive trends were also recorded in the development of digital literacy, self-organization, and student initiative, indicating the formation of key competencies for lifelong learning.

Interpretation of the results suggests that short-term distance interaction can serve as an effective supplement to traditional instruction, fostering greater student autonomy and responsibility. At the same time, prolonged use of asynchronous formats may lead to decreased learning motivation, weakened self-regulation, and lower academic performance, as evidenced by the slight decline in Computer Science performance indicators observed in the quasi-experimental group in this study.

To ensure stable learning outcomes in Computer Science (and minimize learning losses) for students in the adaptation cycle of basic secondary education under unstable conditions, it is advisable to:

- maintain a balance between distance and face-to-face instruction, taking into account the psychological and didactic characteristics of the adaptation cycle of basic secondary education;
- develop teachers' capacity and readiness to engage in professional and pedagogical activities in a digital educational environment and to sustain students' learning motivation remotely;
- apply adaptive learning content with tasks of varying difficulty levels;
- implement automated formative-assessment tools to ensure prompt feedback;
- maintain consistent communication among teachers, students, and parents, creating conditions that motivate adolescents to refine their assignments and improve learning outcomes.

Limitations of the study.

The study was conducted within a single general secondary education institution and covered a relatively short observation period (one academic semester). This limits the generalizability of the findings to a broader sample of schools or longer instructional periods.

Directions for further research.

Future studies should explore the effectiveness of digital formats in different subject domains, expand the age range of the sample, and investigate how the duration of asynchronous learning affects the dynamics of learning motivation, self-regulation, and students' cognitive achievements.

REFERENCES (TRANSLATED AND TRANSLITERATED)

[1] M. J. Tomasik, L. A. Helbling, and U. Moser, "Educational gains of in-person vs. distance learning in primary and secondary schools: A natural experiment during the Covid-19 pandemic school closures in Switzerland", *Int. J. Psychol.*, vol. 56, no. 4, pp. 566–576, Aug. 2021, doi: 10.1002/ijop.12728. (in English)

[2] F. Scarpellini *et al.*, "Distance learning in Italian primary and middle school children during the Covid-19 pandemic: A national survey", *BMC Public Health*, vol. 21, no. 1, Dec. 2021, doi: 10.1186/s12889-021-11026-x. (in English)

[3] J. Petchamé, I. Iriondo, E. Villegas, D. Riu, and D. Fonseca, “Comparing face-to-face, emergency remote teaching and smart classroom: A qualitative exploratory research based on students’ experience during the Covid-19 pandemic”, *Sustainability*, vol. 13, no. 12, p. 6625, Jun. 2021, doi: 10.3390/su13126625. (in English)
[4] M. Brown, C. Skerritt, P. Shevlin, G. McNamara, and J. O’Hara, “Deconstructing the challenges and opportunities for blended learning in the post emergency learning era”, *Ir. Educ. Stud.*, vol. 41, no. 1, pp. 71–84, Jan. 2022, doi: 10.1080/03323315.2021.2022526. (in English)
[5] K. H. D. Tang, “Impacts of Covid-19 on primary, secondary and tertiary education: A comprehensive review and recommendations for educational practices”, *Educ. Res. Policy Pract.*, vol. 22, no. 1, pp. 23–61, Feb. 2023, doi: 10.1007/s10671-022-09319-y. (in English)
[6] S. Taggart, B. Skinner, S. Roulston, and R. Austin, “Blended and online learning: What works and why in primary and secondary schools. Evidence from Northern Ireland”, *Technol. Pedagogy Educ.*, vol. 33, no. 3, pp. 313–330, May 2024, doi: 10.1080/1475939x.2024.2305706. (in English)
[7] O. V. Ovcharuk, Monitoring the readiness of teachers to use digital tools during the war in Ukraine, *Information Technologies and Learning Tools*, vol. 98, no. 6, pp. 52–65, Dec. 2023, doi: 10.33407/itlt.v98i6.5478. (in Ukrainian)
[8] A. Hrebeniuk and I. Okseniuk, “Digital turn” in education in the context of society’s sustainable development, *Information Technologies and Learning Tools*, vol. 100, no. 2, pp. 1–15, Apr. 2024, doi: 10.33407/itlt.v100i2.5514. (in Ukrainian)
[9] N. Olefirenko and O. Dobrunov, Digital pedagogical toolkit for supporting collaborative student activities in Computer Science education, *Information Technologies and Learning Tools*, vol. 106, no. 2, pp. 1–14, May 2025, doi: 10.33407/itlt.v106i2.5974. (in Ukrainian)
[10] O. Topuzov, O. Onopriienko, O. Petruk, I. Lipchevska, and T. Pavlova, “Effectiveness of learning formats under unstable conditions: Educational process in primary school”, *Inf. Technol. Learn. Tools*, vol. 107, no. 3, pp. 1–19, Jun. 2025, doi: 10.33407/itlt.v107i3.6112. (in English)
[11] T. Alieksieienko, O. Petruk, O. Baranovska, I. Lipchevska, and T. Pavlova, Didactic and methodological support for overcoming educational losses in basic secondary education. *Pedahohichna dumka*, 2024. doi: 10.32405/978-966-644-763-3-2024-54. (in Ukrainian)
[12] MES of Ukraine, On approval of methodological recommendations for assessing the learning outcomes of sudents in grades 1-4 of general secondary education institutions. [Online]. Available: https://mon.gov.ua/npa/pro-zatverdzhennya-metodichnih-rekomendacij-shodo-ocinyuvannya-rezultativ-navchannya-uchniv-1-4-klasiv-zakladiv-zagalnoyi-serednoyi-osviti. (in Ukrainian)
[13] MES of Ukraine, On approval of recommendations for assessing learning outcomes. [Online]. Available: https://mon.gov.ua/npa/pro-zatverdzhennia-rekomendatsii-shchodo-otsiniuvannia-rezultativ-navchannia. (in Ukrainian)
[14] V. Yeremenko, Yu. Kuts, V. Mokiichuk, and O. Samoilichenko, *Statistical analysis of measurement data.* Kyiv: NAU, 2013. [Online]. Available: https://ela.kpi.ua/server/api/core/bitstreams/1e99dc7d-33a1-48a3-8cbf-9f5747564b2b/content. (in Ukrainian)

Text of the article was accepted by Editorial Team 23.07.2025

ПОРІВНЯЛЬНИЙ АНАЛІЗ РЕЗУЛЬТАТИВНОСТІ ДИСТАНЦІЙНОГО Й ОЧНОГО НАВЧАННЯ ІНФОРМАТИКИ В АДАПТАЦІЙНОМУ ЦИКЛІ БАЗОВОЇ СЕРЕДНЬОЇ ОСВІТИ

Олег Топузов
доктор педагогічних наук, професор, дійсний член (академік) НАПН України,
Директор Інституту педагогіки НАПН України, віцепрезидент НАПН України
Інститут педагогіки НАПН України, м.Київ, Україна
ORCID ID 0000-0001-7690-1663
proftop@ukr.net

Олександр Малихін
доктор педагогічних наук, професор, член-кореспондент НАПН України, завідувач відділу дидактики
Інститут педагогіки НАПН України, м.Київ, Україна
ORCID ID 0000-0001-6042-6298
malykhinalex1972@gmail.com

Оксана Онопрієнко

доктор педагогічних наук, старший науковий співробітник, член-кореспондент НАПН України, завідувачка відділу початкової освіти імені О. Я. Савченко
Інститут педагогіки НАПН України, м.Київ, Україна
ORCID ID 0000-0002-0301-1392
oks_on@ukr.net

Інна Ліпчевська
доктор філософії в галузі знань «Освіта / Педагогіка», старший науковий співробітник відділу дидактики
Інститут педагогіки НАПН України, м.Київ, Україна
ORCID ID 0000-0002-6901-5863
linla@ukr.net

Анотація: Стаття присвячена порівняльному аналізу результативності дистанційного й очного навчання інформатики в базовій середній освіті (адаптаційний цикл). Актуальність дослідження зумовлена (1) необхідністю забезпечення безперервності освітнього процесу в умовах тривалої нестабільності, спричиненої пандемією, війною та іншими глобальними викликами; (2) доцільністю використання педагогічного потенціалу цифрових засобів навчання задля реалізації сучасних методологічних підходів і принципів навчання; (3) запитом освітньої системи щодо пошуку оптимальних інструментів швидкої адаптації учнів до освітніх умов базової середньої школи.

У межах квазіекспериментального дослідження проаналізовано навчальні досягнення п'ятикласників, залучених до освітнього процесу у двох різних форматах: традиційному очному та асинхронному дистанційному. Мета дослідження – (1) дослідити можливість реалізації короткострокового (тривалістю до одного навчального семестру) асинхронного дистанційного навчання інформатики учнів базової школи зі збереженням його результативності; (2) визначити переваги й недоліки такого формату навчання в базовій середній освіті (адаптаційний цикл).

У дослідженні взяли участь 125 учнів п'ятих класів. Контрольна група навчалась очно, тоді як квазіекспериментальна – в асинхронному дистанційному форматі. Аналіз результатів здійснювався на основі освітнього поступу учнів і їхньої участі в позаурочних активностях за інформатичним спрямуванням.

Отримані результати свідчать про доцільність використання асинхронного дистанційного формату як інструменту підтримки навчання в умовах нестабільності (зокрема під час воєнного стану). Він сприяє формуванню цифрової грамотності, самостійності, відповідальності та вміння вчитися протягом життя. Автори підкреслюють важливість збереження педагогічної підтримки, якісного зворотного зв'язку та впровадження адаптивного цифрового контенту.

Перспективним напрямком подальших досліджень є вивчення впливу дистанційного навчання на інші освітні галузі та вікові групи.

Ключові слова: дистанційне навчання; інформатика; базова середня освіта; педагогічна підтримка, самостійність учнів; освітня результативність.

This work is licensed under Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.