Interactive platform Wordwall within the New Ukrainian School's chemistry lessons

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Abstract

Modern educational trends require the integration of digital technologies into the learning process to enhance its effectiveness and meet the needs of the new generation of students. Interactive platforms, such as Wordwall offer broad opportunities to diversify teaching methods, especially in natural sciences. To increase students' interest in learning chemistry, a series of interactive exercises covering key topics in the 8th-grade chemistry curriculum of the New Ukrainian School has been developed, including the quantitative laws of chemistry, atomic structure, chemical bonding, the specifics of locating the elements in the periodic table, and the properties of environmental gases. The advantages of applying the Wordwall platform into the educational process have been identified: universality, adaptability to individual student needs, interactivity, and accessibility. The developed exercises were verified by 8th-grade students in pilot schools across Ukraine. The study demonstrated that Wordwall is an effective tool for modernizing the learning process in chemistry. Its application makes lessons more engaging and effective; boosts learning quality and develops students' key skills. The use of Wordwall boosts the development of students' digital skills, such as information retrieval, data analysis, and online collaboration. It ensures equal access to educational materials regardless of students' location. Tasks can be completed both in the classroom and at home, which is particularly important in the context of quarantine restrictions or remote study. The concept of the New Ukrainian School emphasizes the competency-based approach, the integration of digital technologies, and an individualized approach to each student. The paper demonstrates that Wordwall meets these requirements, enabling the implementation of NUS' key objectives in chemistry education.

Keywords

Wordwall, Interactive platforms, Digital skills, New Ukrainian School, Chemistry

1. Introduction

1.1. The problem statement

Natural sciences, particularly chemistry, have significant potential for developing the related competencies [1, 2]. They help students build systemic thinking, a scientific worldview, and the ability to solve practical problems [3]. However, traditional teaching methods often fail to meet the needs of modern students, leading to decreased motivation and academic performance. Interactive technologies, which enhance students' cognitive engagement and improve the learning process, are gaining more and more popularity.

Currently, one of the most popular, convenient, and effective interactive learning platforms is Wordwall. This online platform allows setting up various educational tasks that can be easily adapted

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to any subject. Wordwall offers tools for creating quizzes, crosswords, interactive games, and other assignments and these make learning exciting and engaging for students of all ages.

Applying Wordwall into the chemistry lessons in the New Ukrainian School aligns with modern educational trends, like personalized learning, the development of key competencies, and fostering a stable motivation for learning. Due to its flexibility and accessibility, Wordwall allows teachers to effectively organize both in-person and remote lessons, creating an interactive environment for knowledge acquisition and revision.

1.2. Research objective

The objective of the research is to verify the efficiency of the interactive Wordwall platform and to develop tasks for modernizing the educational process within the New Ukrainian School (NUS) chemistry classes.

2. Literature review

It's a common knowledge that chemistry, as a science, requires both theoretical understanding and practical application. Traditionally, chemical education has combined theoretical explanations, laboratory experiments, and knowledge assessment. However, within the NUS framework, priority is given to an activity-based approach, where students actively participate in creating educational content, work in teams, and apply acquired knowledge to real-life situations.

The contemporary education system is increasingly connecting its members with the virtual space and its elements. As a result, the role of games and game tech in education is growing and step-by-step they're becoming the key elements of the learning process [4]. Interactive tasks such as crosswords, quizzes, and simulation games effectively motivate students to study. They not only diversify the educational process but also ensure personalized learning, aligning with one of the core NUS principles – "learning for life".

While digitalization offers new opportunities [5, 6], its implementation comes with quite a few challenges. One of the issues is lack of teachers' readiness to use digital tools. Often, teachers fell that they don't have enough technical knowledge and time to apply digital instruments.

Another challenge is the technical infrastructure. Not all the schools in Ukraine have adequate digital resources. Besides, the access to the Internet and devices is not equal for all students, which creates disparities in learning opportunities.

Nevertheless, gamification and interactive platforms enhance accessibility and engagement in education [4, 7, 8, 9, 10, 11, 12]. Students are more eager to participate when presented with interactive quizzes or puzzles instead of traditional textbooks [13] that can be developed in Wordwall. This resource does not require additional software installation and can be applied in classrooms, remotely, or within a blended education approach. Through tests, puzzles, or speed-based games the assignments developed in Worldwall can be adapted with different chemistry topics, such as atomic structure or chemical reactions, Wordwall boosts the development of the activity-based approach, since the students can not only perceive the theoretical knowledge, but also apply this knowledge with the practical tasks.

Interactive assignments improve both specific subject knowledge and key competencies:

- Digital literacy (students learn to work with digital tools);
- Critical thinking (complex tasks promote data analysis, reasoning and expressing conclusions);
- Communication skills (group tasks enhance collaboration and idea-sharing).

Chemistry is often perceived as a difficult subject due to abstract processes. Interactive platforms help teachers create understandable tasks that visualize these processes such as animations and diagrams [14]. This makes the understanding of some topics, like chemical structure, chemical equations, or the periodic table much easier. Wordwall cam also offer a variety of advantages [15]:

- Allows task customization based on individual students' abilities, offering both advanced exercises for stronger students and simplified tasks for those students, who are struggling with education.
- Enables instant knowledge assessment through automated feedback, which saves time, spent on task control and gives the opportunity to react on the spot if knowledge gaps are found.
- Suitable for in-person, remote, or blended approach, making it a versatile tool.

Wordwall is an accessible platform that does not require complex technical equipment or software [16, 17]. It operates online, allowing its utilization both in schools with basic computerization and at home on any device – computer, tablet, or smartphone.

This platform has an intuitive interface that allows teachers create interactive tasks quickly. This is particularly important for educators implementing modern technologies in the learning process but who may lack experience with more complex digital tools. The platform's simplicity also ensures its effective usage for students of various age groups. One of Wordwall's key advantages is the vast number of ready-made templates for creating interactive exercises, making it adaptable to any chemistry-related topic. As a result, Wordwall can be used both for assessing students' knowledge and for reinforcing material in an engaging, game-based format [18, 19, 20]. The platform supports editing and reusing created tasks. That allows teachers to customize content according to students' knowledge levels, topic specifics, or lesson objectives. Wordwall's flexibility makes it a versatile tool suitable for both classroom work and home study. Interactive exercises developed on the Wordwall platform contribute to increasing students' motivation. Thanks to gamification elements, students become actively engaged in the learning process, and instant feedback helps them self-assess their progress. This is particularly important for studying chemistry, the subject that students often treat as a challenging one [15].

3. Results and discussion

The Wordwall platform provides a wide variety of tools for developing interactive assignments adaptable to different chemistry topics. Using the platform's tools, an interactive application was developed to apply with the "Chemistry. 8th Grade" textbook (authors: L. Midak, O. Kuzyshyn, Ju. Pahomov, and Kh. Buzhdyhan).

The developed interactive assignments follow this template:

- Lesson topic.
- Wordwall exercise template (with a link to the exercise).
- Objective of the exercise.
- Exercise content.
- Expected outcomes.

Let us take a closer look at the functionality of this platform, the templates available for creating different types of tasks, and their potential applications in chemistry. Using the "Quiz" or "Game Quiz" templates, teachers can create test-based assignments or open-ended questions to assess students' knowledge. Additionally, there's a possibility to develop tasks for matching, categorization, or sorting with the relevant templates. An interesting variation of these templates is "Air Balloons". The platform can be applied to crate standard crosswords, fill words, and anagrams to enhance the understanding of chemical terminology.

For studying chemical concepts or analyzing texts, the "Fill in the Blanks" template can be used, or teachers can set tasks requiring students to arrange words in a sentence, events in a sequence, or even compounds in a chemical equation. Interesting randomizing templates include "Wheel of Fortune", "Open the Box", and "Random Cards". They can be used to review a topic or activate the existing knowledge at the beginning of a lesson.

The platform also offers innovative ways to present traditional tasks. For example, chose-the-correct-answer questions can be transformed from a standard test format into interactive challenges such as a maze with obstacles, a flying fruit game, or a plane navigation task where students have to choose the

correct answer. Labeling diagrams can be effectively used for studying laboratory equipment, filling tables with relevant data, or exploring the structure of the periodic table. For self-assessment, students can use flashcards or double-sided tiles. To distinguish between myths and facts or classify elements into specific categories, they can use the "True or False" or "Whack-a-Mole" templates. Finally, the pair matching game template not only reinforces chemistry knowledge but also helps improve general memory and concentration skills.

Figures 1, 2, 3, 4, 5, 6, 7, and 8 illustrates the appearance of exercises when edited by the teacher as well as when performed by students.

Task 1

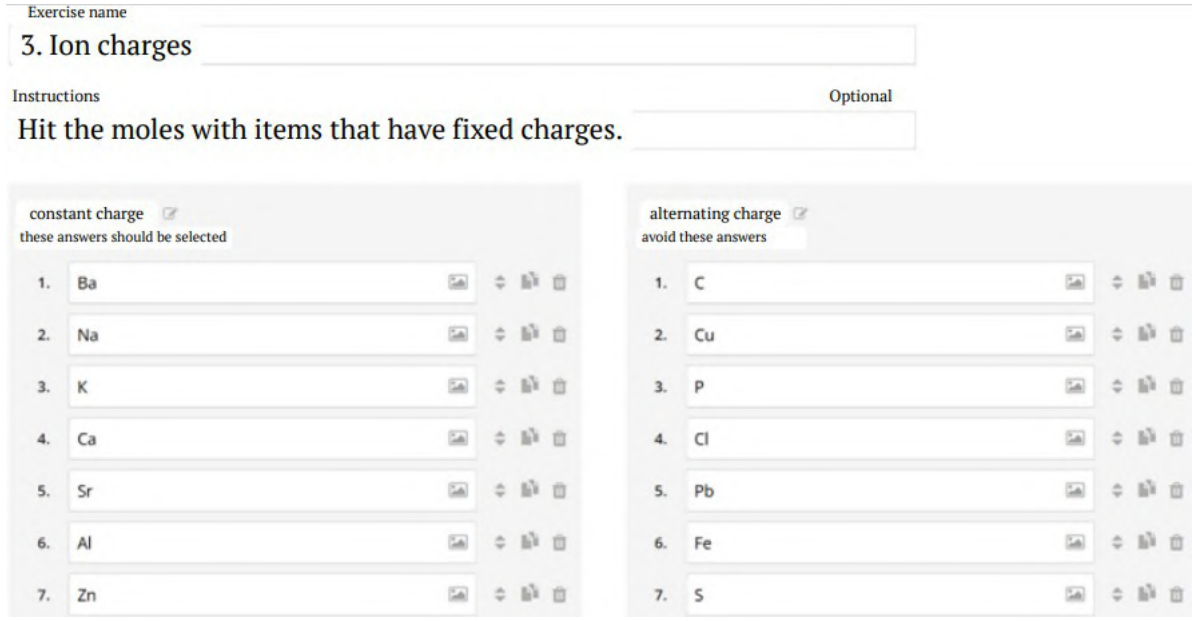
Lesson topic: Binary compounds.

Exercise template: "Whack-a-Mole". https://wordwall.net/uk/resource/81574893

Exercise goal: to quickly distinguish chemical elements, the ions of which have a constant charge.

Exercise content: Students hit moles near a sign with the symbol of a chemical element, the ion of which has a constant charge (figure 1).

Expected outcomes: Students will learn to correctly and quickly identify chemical elements the atoms of which form ions with a stable charge.



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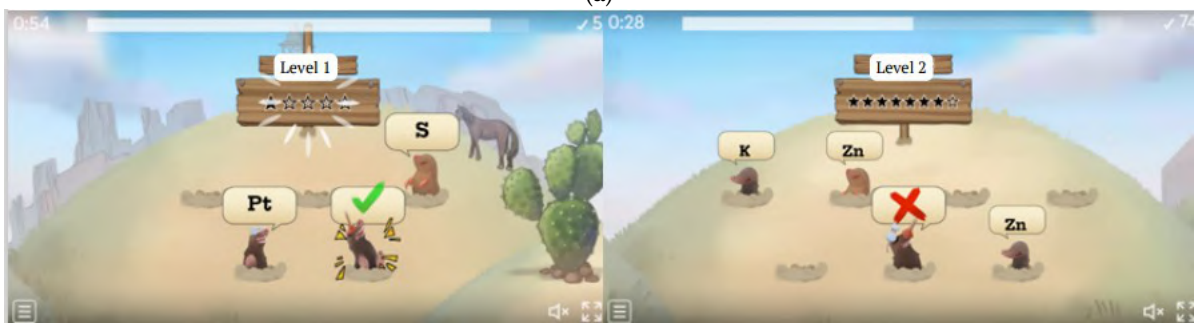

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Figure 1: Interactive exercise "Ion charges": (a) exercise editing; (b) exercise completion.

Task 2

Lesson topic: Principles of writing formulas and names of binary compounds.

Exercise template: "Maze Chase" https://wordwall.net/uk/resource/81574557.

Exercise goal: To learn how to write chemical formulas for binary compounds based on their names.

Exercise content: Students navigate a maze, selecting the correct chemical formula corresponding to the given name of the compound (figure 2).

Expected outcomes: Students will learn to build chemical formulas of binary compounds and improve their concentration skills.

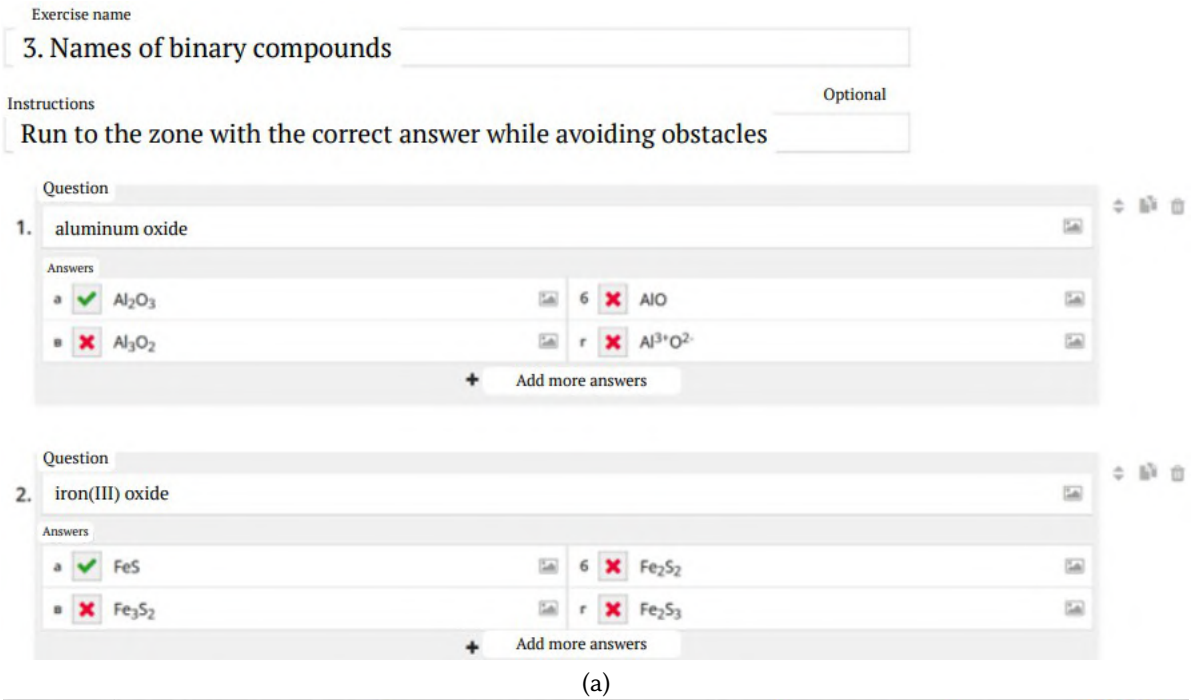

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Figure 2: Interactive exercise "Names of binary compounds": (a) exercise editing; (b) exercise completion.

Task 3

Lesson topic: Relative atomic mass.

Exercise template: "Matching Pairs" https://wordwall.net/uk/resource/81575119.

Exercise goal: To learn the relative atomic masses of the most common chemical elements.

Exercise content: Students take turns flipping tiles with hidden element symbols and their relevant relative atomic masses, aiming to find matching pairs (figure 3).

Expected outcomes: Students will memorize the relative atomic masses of key elements in the Periodic Table and train their general memory skills.

Task 4

Lesson topic: Mass fraction of a chemical element in a substance.

Exercise template: "The Correct Order" https://wordwall.net/uk/resource/81577347.

Exercise goal: To learn how to calculate mass fractions of chemical elements in their compounds.

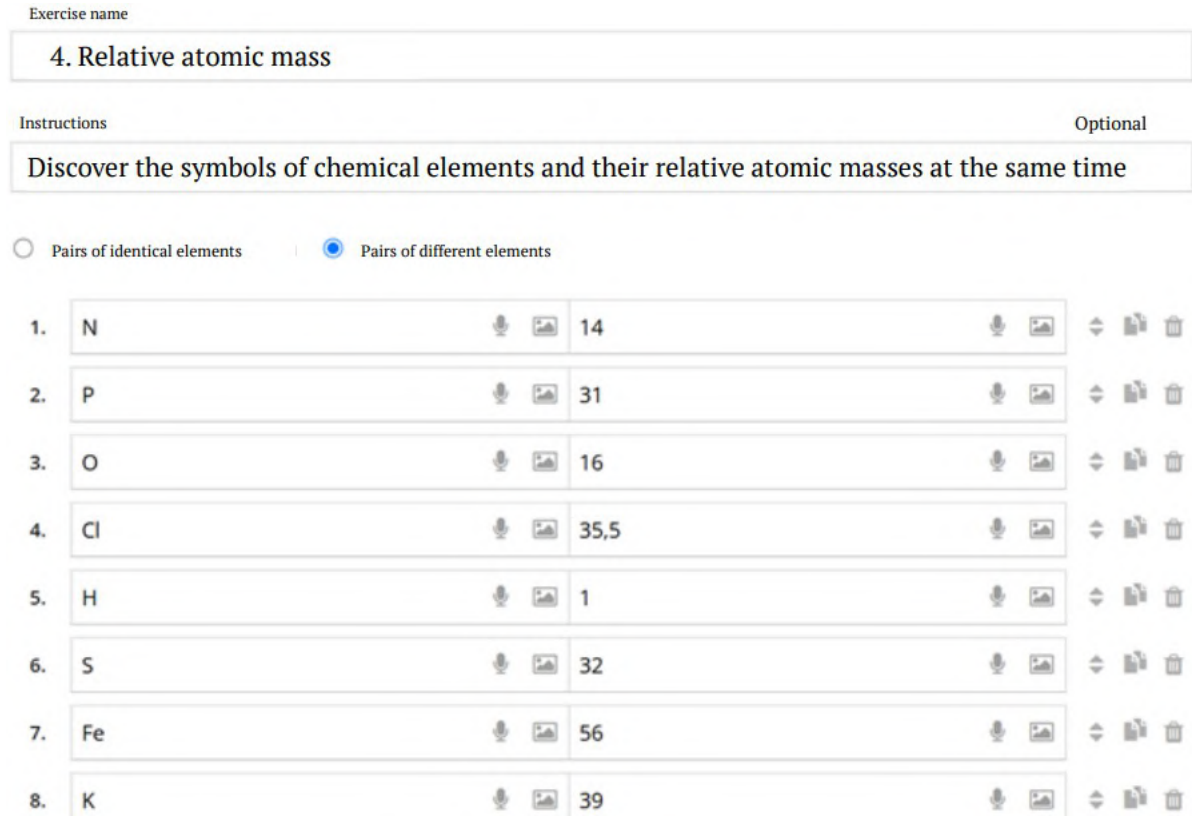

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Figure 3: Interactive exercise "Relative atomic mass": (a) exercise editing; (b) exercise completion.

Exercise content: Students calculate the mass fractions of oxygen in given compounds and arrange them in order (figure 4).

Expected outcomes: Students will practice calculating mass fractions of elements in compounds and improve their ability to order numerical values sequentially.

Task 5 *Lesson topic*: Amount of substance.

Exercise template: "Label Diagram" https://wordwall.net/uk/resource/81585662

Exercise goal: To learn how to solve problems related to the subject.

Exercise content: Students drag labels to complete a table with the calculated data that is necessary (figure 5).

Expected outcomes: Students will learn to calculate the number of structural particles in a given substance portion.

Task 6 *Lesson topic*: Carbon dioxide and carbon monoxide.

Exercise template: "Airplane" https://wordwall.net/uk/resource/82705652

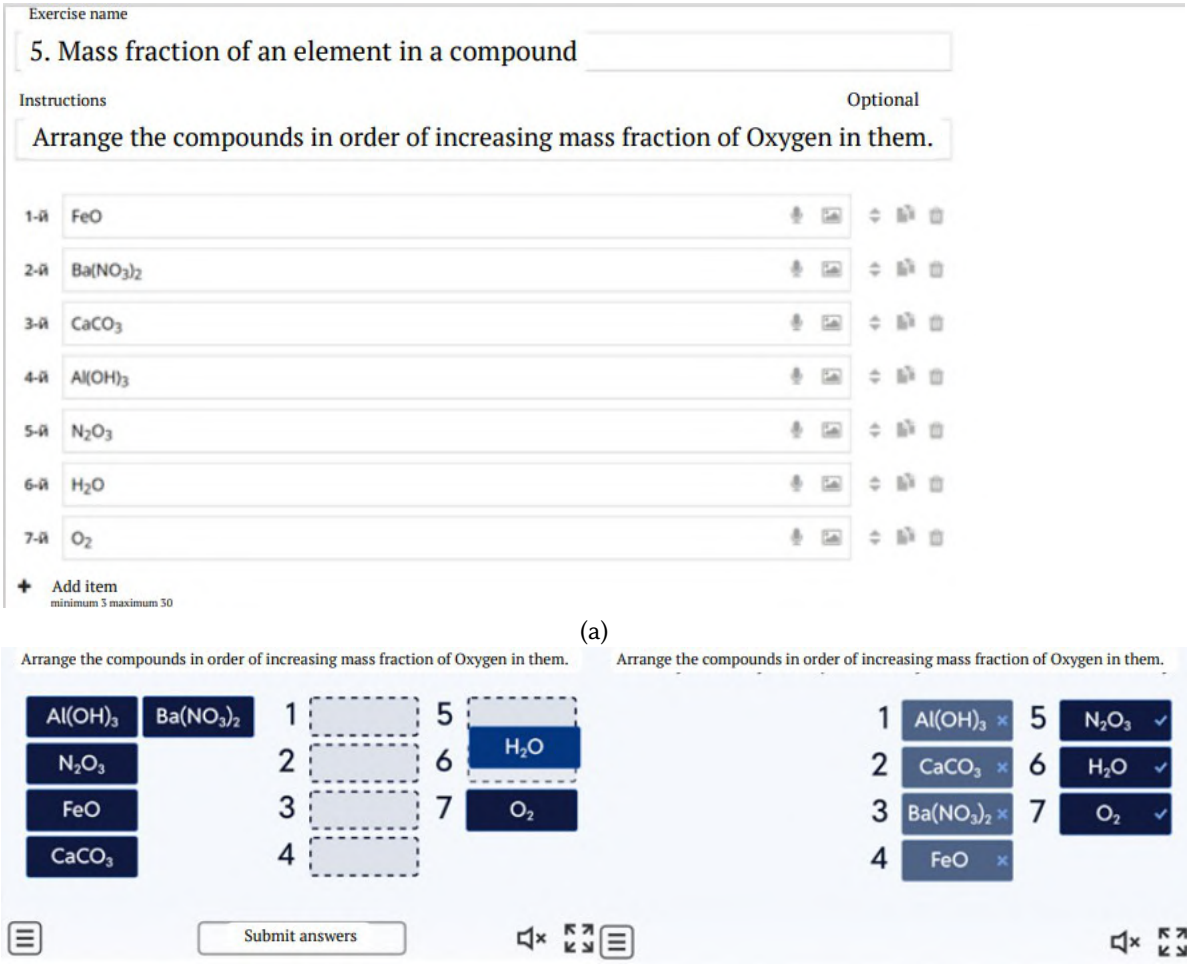

Figure 4: Interactive exercise "Mass fraction of ab element in a compund": (a) exercise editing; (b) exercise completion.

Exercise goal: To explore the properties of carbon dioxide and carbon monoxide.

Exercise content: Students navigate an airplane into a cloud that corresponds to the gas, the property of which is described (figure 6).

Expected outcomes: Students will understand the differences between the properties of carbon dioxide and carbon monoxide.

Task 7 *Lesson topic*: Methane.

Exercise template: "Crossword Puzzle" https://wordwall.net/uk/resource/82795306.

Exercise goal: To memorize key concepts related to the "Methane" topic.

Exercise content: Students uncover cells and answer questions (figure 7).

Expected outcomes: Students will remember fundamental concepts related to the topic and be able to explain them in the future.

Task 8 *Lesson topic*: Atomic structure. The Periodic Table

Exercise template: "Quiz Game" https://wordwall.net/uk/resource/82836836.

Exercise goal: To reinforce knowledge about atomic structure and element placement in the Periodic Table.

Exercise content: Students answer questions related to atomic structure and the Periodic Table (figure 8).

Expected outcomes: Students will recall previously studied material interactively and have opportunities for teamwork if the game is performed as a group activity.

The developed tasks are being trialed by 8th-grade students from pilot schools across Ukraine.

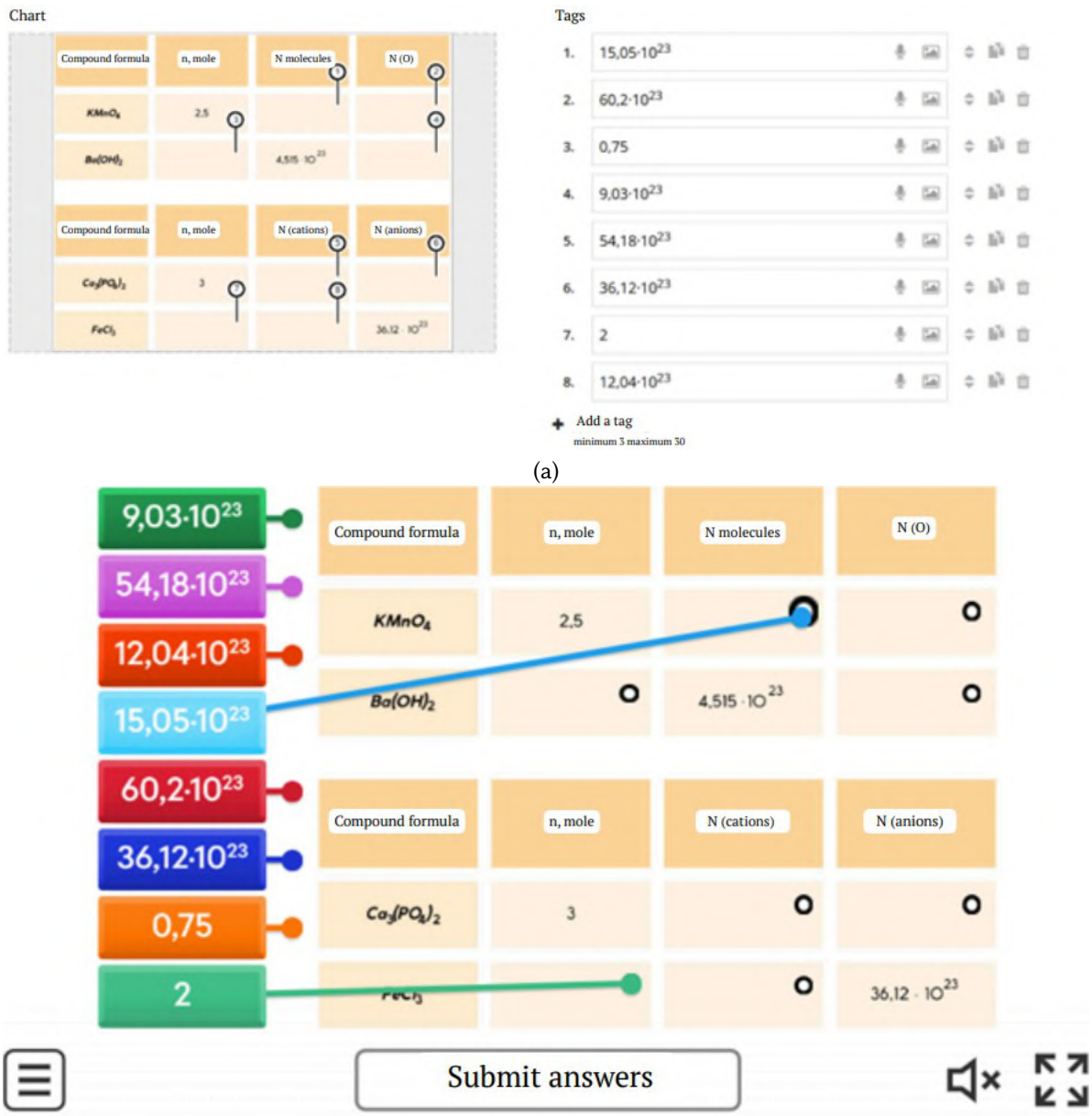

Figure 5: Interactive exercise "Amount of substance (atoms, molecules, ions)": (a) exercise editing; (b) exercise completion.

Seven general secondary education establishments from five regions of Ukraine (Ivano-Frankivsk, Kyiv, Ternopil, Kherson, and Chernivtsi), seven chemistry teachers, and 288 8th-grade students of the New Ukrainian School are participating in the trial.

Since the developed exercises are part of an interactive add-on to the chemistry textbook, the trial was performed along with the pilot testing of the "Chemistry. 8th Grade" textbook (authors: L. Midak, O. Kuzyshyn, Ju. Pahomov, and Kh. Buzhdyhan), in accordance with the Procedure for the Trial of Educational Literature for General Secondary Education Establishments, following the principles of independence, professionalism, objectivity, and impartiality. The trial of this add-on consists of two stages:

1. Familiarization with the types of tasks, assessment of their usability during the lessons, and evaluation of how students perceive the developed exercises;
2. Studying the effectiveness of applying the interactive add-on developed on the Wordwall platform.

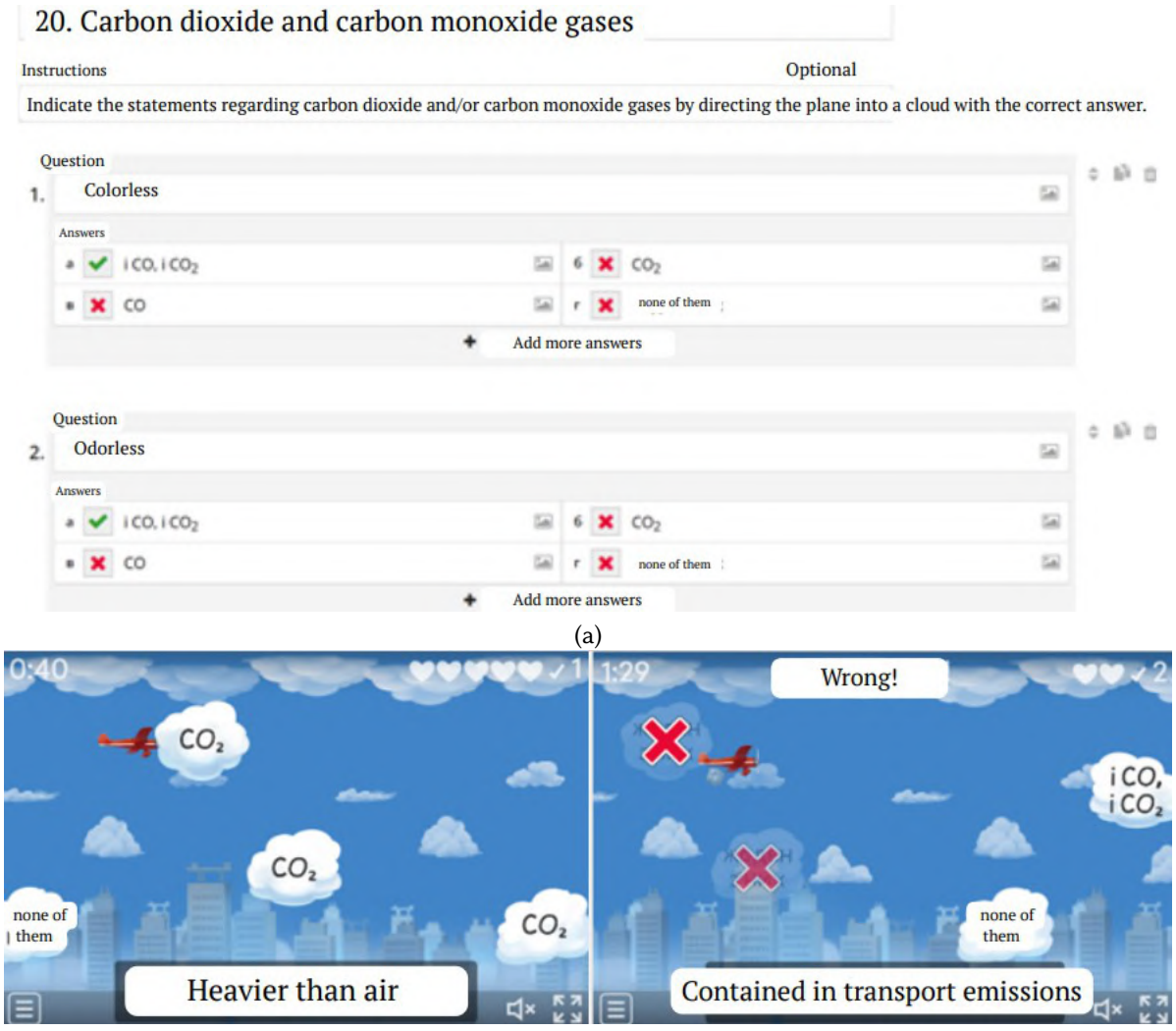

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Figure 6: Interactive exercise "Carbon dioxide and carbon monoxide gases": (a) exercise editing; (b) exercise completion.

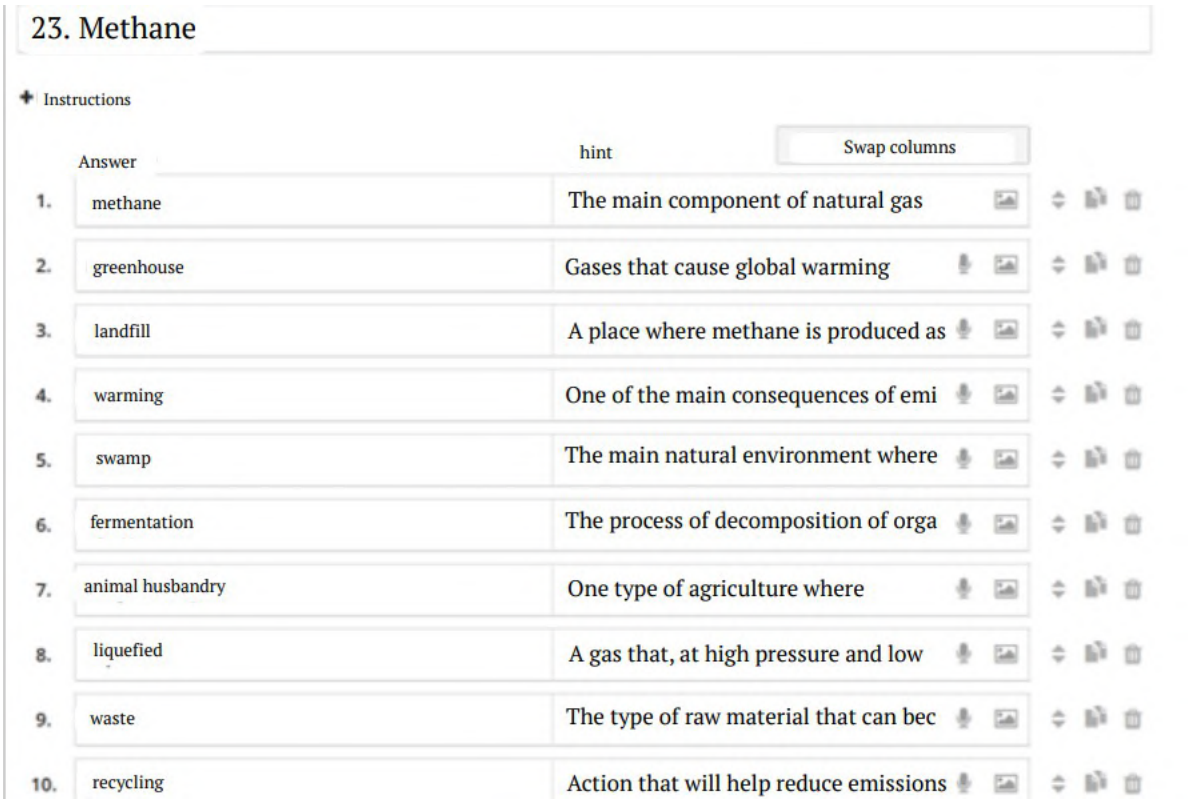
In the first stage of the trial, chemistry lessons were structured using the developed interactive exercises. Students actively engaged in completing the tasks, discussed the results, and received feedback from the teacher.

Teacher feedback was collected via Google Forms created by the Ukrainian Institute of Education Development, in accordance with the Procedure for the Trial of Educational Literature for General Secondary Education Establishments, surveyed the teachers that took part in conducting the trial via Google Forms. The content of the interactive tasks was qualitatively assessed by the participating teachers on the following criteria:

- Didactic tasks are clearly structured (yes / no / other response).
- Tasks/types of educational activities are diverse and understandable (yes / no / other response).
- Didactic methods/techniques are flexible in terms of implementing the interactive study (yes / no / other response).
- Does the content of the exercises correspond to the age characteristics of the students? (yes / no / other response).

Survey results for all criteria: **yes – 7; no – 0**.

Teachers confirmed that the exercises vary in format (quizzes, matching, charts, recognition, sorting, etc.) and are appropriate for the age group of 8th-grade students.



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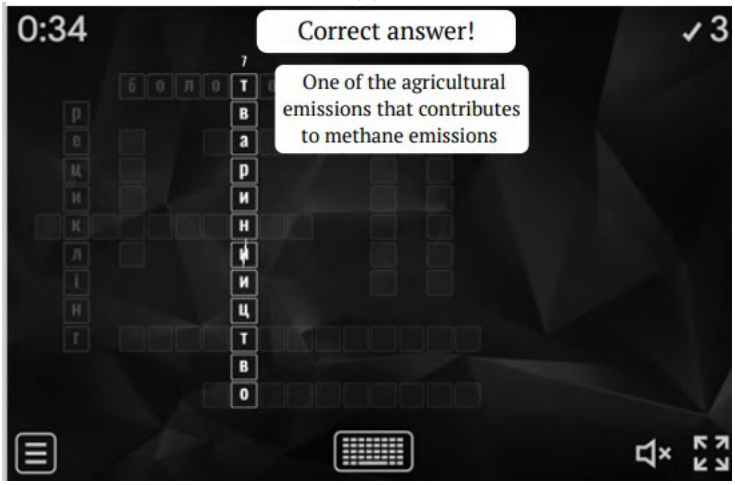

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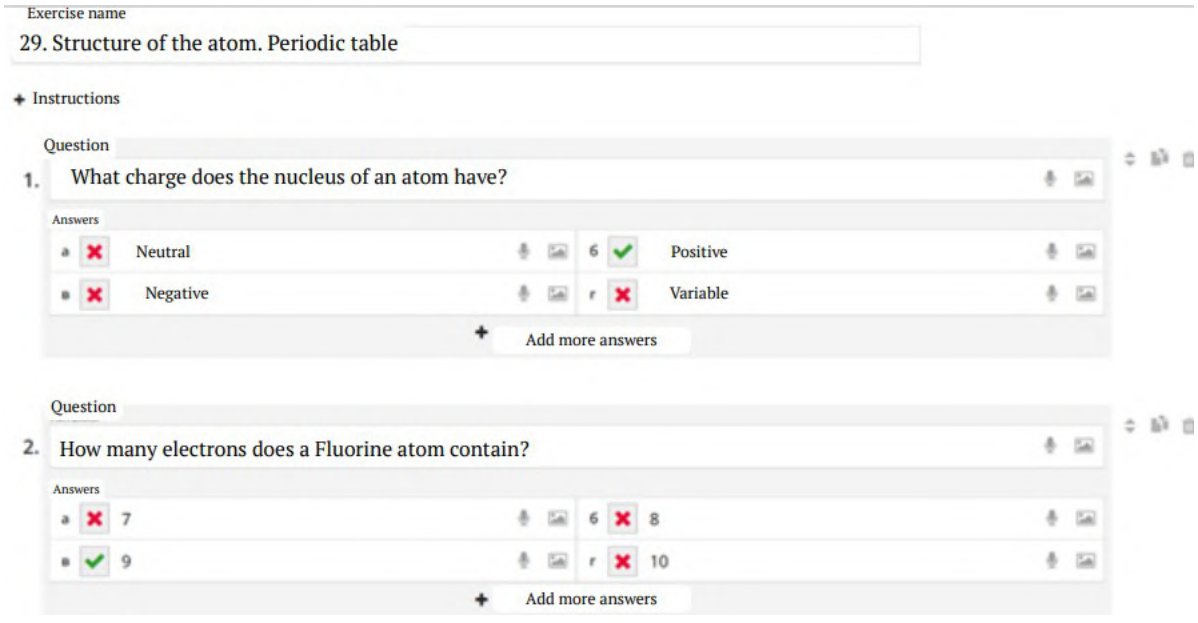
Figure 7: Interactive exercise "Methane": (a) exercise editing; (b) exercise completion.

The results of the diagnostic assessments from the first stage of the trial on the topic "Understanding Quantitative Chemical Laws" showed (figure 9) that 2.2 % of students were at the initial level of academic achievement, 24.6 % at the average level, 54.8 % at the sufficient level, and 18.4 % at the high level. Compared to the entrance assessment results, the number of students at the initial level decreased by 7 %, while those at the sufficient level increased by 10 %.

Quite notable students' progress was particularly evident in topics involving calculations: "Principles of Naming and Building Binary Compounds", "Amount of Substance", and "Relative Atomic Mass". No significant gaps in students'; understanding of the material were identified at this stage.

According to the survey results, 5 out of 7 teachers described the interactive supplement as a "successful pedagogical discovery" for the 8th-grade chemistry textbook, since the interactive exercises promote the development of students' basic capabilities, increase motivation to study, and enhance



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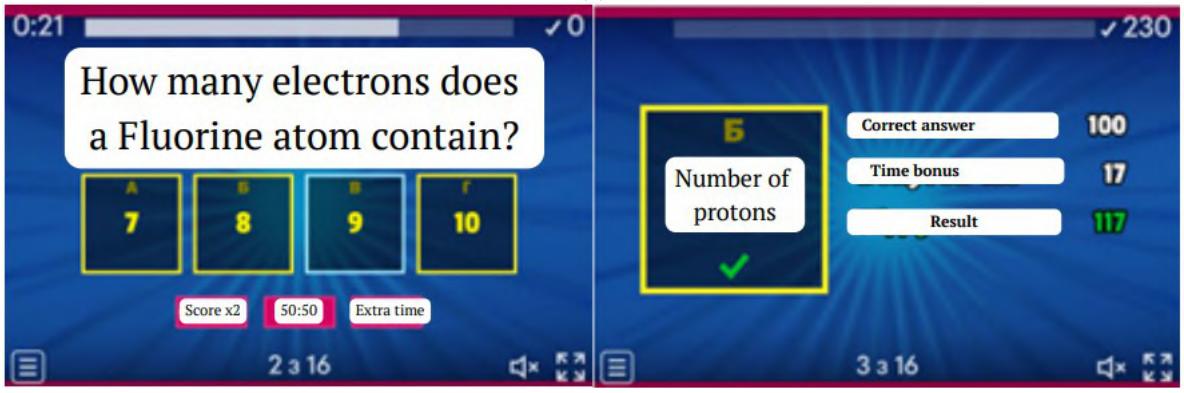

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Figure 8: Interactive exercise "Structure of the atom. Periodic table": (a) exercise editing; (b) exercise completion.

their cognitive skills and creative thinking.

The second stage of the trial is ongoing.

4. Conclusions

The conducted research has demonstrated that the Wordwall platform is an effective tool for modernizing the learning process in chemistry education. Its implementaion makes lessons more engaging and efficient, contributing to improved learning quality and the development of key students' skills.

Using Wordwall fosters the development of students' digital competencies, such as information retrieval, data analysis, and collaboration in an online environment; it also ensures equal access to educational materials regardless of students' locations. Assignments can be completed both in the classroom and at home, which is particularly important in the context of quarantine restrictions or remote education.

The integration of interactive exercises through Wordwall has increased students' interest in the subject, making chemistry lessons more dynamic and interactive.

To assess the effectiveness of the developed interactive tool on the Wordwall platform, it would be advisable to evaluate students' average academic performance after the second stage of testing and compare it with the results of the initial assessment. Expanding the use of Wordwall in chemistry

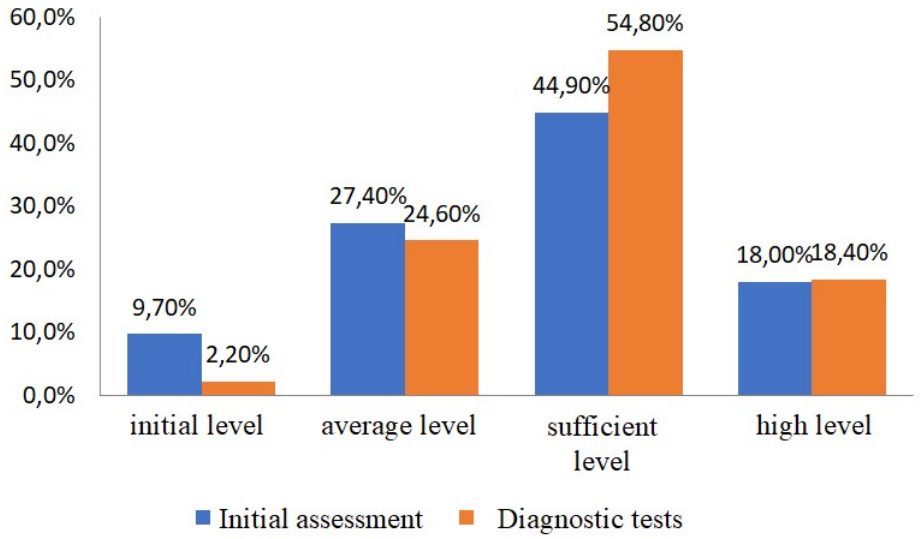

Figure 9: Results of entry assessments and diagnostic tests.

education is recommended. Also, continuing the research on the platform's effectiveness with students of different age groups in the study of other natural science subjects is a must.

The New Ukrainian School concept emphasizes a competency-based approach to education, the integration of digital technologies, and individualized approach to each student. This study has shown that Wordwall meets these requirements, enabling the implementation of key NUS objectives into the chemistry education.

Author contributions

Conceptualization, Liliia Ya. Midak; methodology, Liliia Ya. Midak and Olga V. Kuzyshyn; software, Khrystyna V. Buzhdyhan and Ivan V. Kravets; validation, Khrystyna V. Buzhdyhan and Ivan V. Kravets and Yurii D. Pahomov writing – original draft preparation, Liliia Ya. Midak and Khrystyna V. Buzhdyhan and Olga V. Kuzyshyn; writing—review and editing, Liliia Ya. Midak and Olga V. Kuzyshyn. All authors have read and agreed to the published version of the manuscript.

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Data availability statement

This study used third party data made available under licence that the author does not have permission to share. Requests to access the data should be directed to the Ukrainian Institute of Education Development at https://uied.org.ua/contacts-ua/.

Conflicts of interest

The authors declare no conflict of interest.

Declaration on Generative AI

The authors have not employed any generative AI tools.

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