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ONLINE EDUCATION AT A MODERN UNIVERSITY: TOOLS FOR INTERACTIVE LEARNING

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Abstract: *The article substantiates the utility of digital tools and services in interactive learning in the context of distance education. It analyses the capabilities of technical equipment enabling interactive learning (interactive response and assessment systems, interactive panels, testing and voting systems, touch tables, interactive sandbox and interactive floor) and discusses the didactic side of digital tools and services application in learning (online demonstration, simulation, experiment; webinars; visualization tools; testing tools; mind maps and knowledge maps; timelines, word clouds; virtual digital boards, etc.). Finally, the article presents the findings from faculty and student surveys exploring advantages and downsides of the use of digital tools and services for interactive learning.*

Keywords: digital tools, informatization of education, interactive learning, distance education, modern university, specialist training.

INTRODUCTION

The present day global situation of the pandemic and its aftermath has transformed the ways various aspects and dimensions of human life operate. The most noticeable changes have taken place in education, including higher education. Within a very short time we have witnessed the transition from the phase of getting accustomed to distance learning to the phase when distance mode is a major form of students' learning. Faculty teaching online classes using various video conferencing services (Google Meet, Zoom, Jitsi, Duo and others) has become the new normal. So, it appears to bear out the claim made by American scholars that "the future and education in the future will be digital…" (Bonn, 2021). It should be noted that online learning belongs to the synchronous mode of interaction between various actors when participants are simultaneously present in the electronic educational environment. The synchronous mode is complemented by the asynchronous mode when the interaction between actors in distance learning takes place with a time lag, utilizing interactive education platforms, e-mails, forums, social networks, etc.

The synchronous mode of online classes can last from 1.5 to 3 hours but in such settings the students' focus in terms of active listening and processing of material often drops since the typical ability to concentrate lasts for 45–60 minutes, thus diminishing the effectiveness of cognitive performance. In this context, an important question is how to maintain students' focus and engage them in active learning while taking into consideration their needs and demands? The answer can be found through analysis of application possibilities and didactic value of interactive methods and technologies of distance learning with related multimedia resources.

The purpose of this article is to discuss a rationale for the application of digital tools and digital services for implementation of interactive learning within the context of distance education and to analyse their didactic specificity in learning.

1. ANALYSIS OF CURRENT RESEARCH

The problem of interactivity and interactive learning methods is not new in pedagogy. The areas of relevant scientific research touch upon general pedagogical aspects of exploration and implementation of interactive learning methods (Moreno & Mayer, 2007; Cairncross & Mannion, 2001; Sysoieva, 2011), discovery of possibilities to mainstream digital tools and resources in the educational process (Kumawat, 2020; Hurlbut, 2018), conceptualization of the phenomenon of a new pedagogy – digital humanistic pedagogy (Bykov, 2016), a didactic model of sustainability commitment (Öhman, 2021), and other. The research by Yürüm, & Yıldırım (2022) on the influence of interactive video on learning outcome and learner satisfaction in e-learning environments, deserves attention. Development of digital pedagogical tools in learning is widely featured in the works of scholars, such as Pacheco (2022), Insorio (2021), Tsai (2020) and other. Thus, theoretical and methodological principles of using interactive whiteboards have been revealed in the works Dudaitė & Prakapas (2019), Samsonova (2021), Bajtoš & Kašaiová (2016), Bodnenko, Kuchakovska, Proshkin, & Lytvyn (2020). The study of the higher school is in the research of Khoruzha, Bratko, Kotenko, Melnychenko, & Proshkin (2019) and organisation of the educational process in Ukrainian schools under the lockdown conditions Hrynevych, Ilyich, Morze, Proshkin, Shemelynets, Lyniov, & Riy (2020). In addition, the theoretical and practical principles of using digital technologies for the organization of interactive learning are given in some studies (Subhash & Cudney, 2018; Estriegana, Medina-Merodio, & Barchino, 2019; Valverde-Berrocoso, del Carmen Garrido-Arroyo, Burgos-Videla, & Morales-Cevallos, 2020; Makransky & Petersen, 2019; Liao, Chen, & Shih, 2019).

Consolidation of scholarship on this subject matter allows us to maintain that interactivity in learning is a way of organising students' cognitive activity based on active communication, information exchange, performance of assignments in an electronic educational setting that helps boost learning motivation and create an emotionally conductive climate.

The aim of this study is to find out the peculiarities of the implementation of the templates method in the process of e-learning of higher mathematics for automated generation and visualization of tasks using cloud services. The **research and problem questions** are the following: to analyse the methodological aspects of using the templates method as a real and affordable method of creating and using packages of practical mathematical tasks for students; to reveal the possibilities of cloud-based learning technologies for the implementation of the method of templates in the process of learning higher mathematics.

The research hypothesis is that the use of digital tools and services for interactive learning could improve its quality. We do not intend to reveal the effectiveness of digital tools and services. It more important for us to diagnose the real state of their use in the educational process now.

2. MATERIALS AND METHODS

The research employed a set of methods that included both theoretical methods, such as analysis, synthesis, comparison, generalization to study scientific literature and identify various tools of interactive online learning; and empirical methods, in particular testing of teachers and students to determine their awareness and degree of utilization of interactive tools of online learning. We also used statistical methods, in particular, the ranking, to interpret the results of the research. We did not use special statistical criteria because our task was to establish the real state of implementation of interactive learning in the conditions of distance education. At the same time, the given recommendations require statistical proof of their significance in the future.

3. MAIN RESULTS

Exploring the concept of interactivity for a distance-learning system, scholars identify four main types of interactivity. The classification is based on the definition of message sender and message recipient in the process of learning interaction:

- learner – learner;
- learner – teacher;
- learner – learning material;
- learner – multimedia presentation management tools (Sysoieva, 2011).

Utilization of interactive tools in online learning stipulates a clear definition of didactic goals and objectives; actualization of underlying knowledge and skills; grasping of the essence of concepts and performance methods; assimilation of received knowledge; problem solving; control and assessment of knowledge, overall satisfaction level, etc. Using interactive tools of online learning in achieving identified didactic objectives helps foster creativity in learning and cognition; introduce the elements of competition and play; organise student interaction within and across groups; carry out continuous monitoring of satisfaction, emotional comfort level, etc.

Thus, interactivity promotes collaboration, mutual understanding, tolerance and friendliness, and enables person-oriented learning. Given that interactivity predominately takes place in cooperative learning when each student contributes to a common success, attention should be paid to the availability of necessary technical equipment, digital tools and services.

3.1. Technical equipment for interactive learning

According to the expert survey involving faculty of Borys Grinchenko Kyiv University (35 respondents), equipment that is most frequently used in university education includes interactive sets (board and projector), tablet, designer sets for robotics and programming, etc.

Equipment that is still uncommon in the educational process because of its high cost but that has a significant potential for the realization of interactivity can include:

- *digital measurement computer sets* (Vernier, NEULOG, Einstein) enabling to conduct laboratory experiments, practical assignment and demonstration of phenomena in mathematics, physics, chemistry, biology, geography and other subjects. The device has a built-in memory, can run on various operating systems. This allows the collection of information, its prompt processing with playback on the built-in display or projector screen;
- *interactive panels* (Promethean, EdPro Touch, Intboard) enabling to create digital interactive classrooms with the possibility to connect more than 30 users. It enables to check knowledge by polling, create and edit office documents (tables, documents, presentations), etc., operates as a multimedia presenter, and offers toolkits for mathematics, physics, chemistry, biology, etc. It also enables the use of interactive stylus. As practice shows, the most common in-teractive panels have a 65", 75" or 86" diagonal. Typically, all modern inter-active panels have a resolution of 4K Ultra HD, which ensures a clear picture with rich, bright colours, which attracts students' attention. It is important that modern models do not have a visible pixilation of the image;
- *interactive response and assessment systems* (SunVote, XPRESS, SMART RESPONSE) enabling surveys and polls, collecting generalized and individual responses, as well as conducting seminars, conferences, etc. It enables teachers to receive quick responses from audiences and allows students to participate in joint activities and group work. In the process of interactive interaction, it is possible to distribute consoles into teams among students, receive information about the current and final voting, etc. Most often, for interactive voting, participants are given consoles, but an option is possible with the help of other means, such as mobile applications;
- *interactive touch tables* (Elpix, Intboard Dotyk) with screen and in-built computer that utilize multi-touch technology (simultaneous work of several users) to enable teamwork and enhance interaction between participants of the learning process;
- *interactive sandbox* (iSandBox, Briolight, SandBox) is a piece of equipment based on the concept of augmented reality which creates a movement sensitive projection on real sand. By moving and building sand, user can create

mountains, volcanoes, rivers and other virtual landscapes, working with their own imaginary world that can be changed. It is used for teaching geography, natural sciences as well as therapeutic counselling and psycho-correction. For students of pedagogical specialties it is necessary to master the method of working with interactive sandbox, because it promotes the development of pupils' speech, communication skills, stimulates the visual, tactile system, as well as develops general motility and coordination of movements. In addition, the device is used in sand, sensory and game therapy, is an effective tool for training with a speech therapist, psychologist, teacher and other professionals who work with children. It is used in schools, kindergartens, rehabilitation and play centres, treatment rooms;

- *interactive floor* (Briolight, OMG Interactive, FunFloor) is a system containing displays with projected images and sensors that enable interaction with projected images on the floor. It is used in inclusive and rehabilitation facilities, schools, pre-schools, sports schools and facilities. Future teachers should understand that interactive floor can be used for school development or recovery of motor, intellectual, emotional and volitional students. Content in the form of a game makes the execution of tasks a relaxed and exciting process. The interactive floor can be used both individually and for a small group, with a corrective or entertaining purpose, as a stand-alone tool or as part of a general program depending on individual needs.

The analysis of actual practice suggests that the above-mentioned technical means enabling interactivity allow students to better adapt in a group, build personal contacts, share information, take responsibility for group activity, put forward ideas, create projects, take calculated risk and out-of-the-box solutions, avoid repeating mistakes, convincingly present ideas, anticipate work outcomes, effectively manage their performance and time, etc.

3.2. Digital tools and services

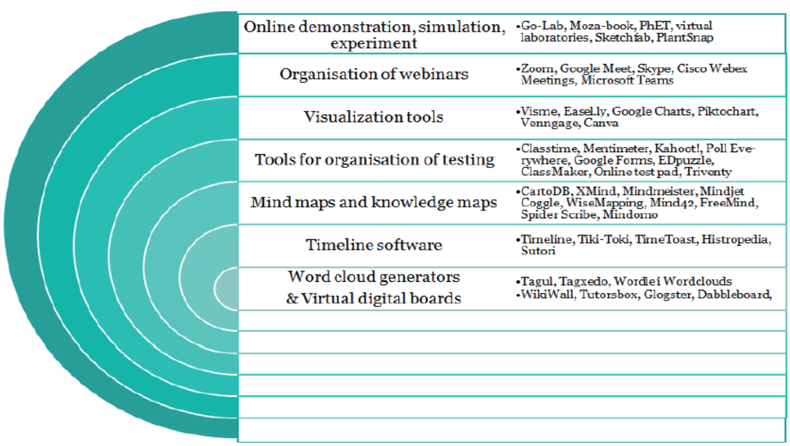


Figure 1. Classification of digital tools and services

Source: Own work.

The selection of digital tools and services has been guided by the following requirements for students' interactive engagement (see Figure 1):

1. understanding that the collective organisation of learning and joint learning is an effective form of education process;
2. creating conditions for group interaction;
3. activation of autonomous learning in an actor-actor dialogue;
4. processing of learning information in different forms and at different levels of complexity;
5. mandatory reflection in the process of group work.

Therefore, we identify the following digital tools and services for interactive engagement between students and teachers in distance learning settings:

- *Online demonstration, simulation, experiment* (for example, Go-Lab, Mozabook, PhET, virtual laboratories, Sketchfab, PlantSnap, etc.). The software solutions imitate performance of laboratory assignments, simulate experiments, and visually demonstrate the principles of device operation. They allow observation of processes that are difficult to see in real life without auxiliary technical means, for example, due to small size of observed objects or short interval of time. It enables to implement interactive case study that envisages decision-making and utilization of existing advantages to resolve problems. It is advisable to use imitation learning, enabling students to acquire knowledge, skills and abilities through imitation of certain ways of performance and precise reproduction. One of the most common is the PhET project of the University of Colorado (https://phet.colorado.edu), which has developed more than 100 interactive models for teaching and studying science. These simulations provide animated interactive and game environments that allow students and pupils to explore. The experience of the authors of the article on the use of digital tools and services allows us to identify problematic issues that will be promising for further research: whether simulations can completely replace experiments with real laboratory equipment; how not to turn educational simulations into entertainment; how best to use simulations during distance learning.
- *Organisation of webinars* (Zoom, Google Meet, Skype, Cisco Webex Meetings, Microsoft Teams, etc.). Apart from conventional functions, some software solutions enable to pose questions and conduct polls, use interactive boards, vote, form mini-groups, etc. They enable different types of interactive communication such as conversation, dialogue, debate as well as role play. The possibility of maintaining several rooms simultaneously enables such an interaction method as interview.
- *Visualization tools* (Visme, Easel.ly, Google Charts, Piktochart, Venngage, Canva, etc.) enable generation of graphs, diagrams, presentations and other visual educational content and offer templates for organisation of remote classes. These tools include the possibility of organising work in mini-groups. The use of images enables brainstorming that stimulates search for new ways to look at a problem to be addressed. Building associations between solutions and images is a useful tool to solicit new ideas and develop creative thinking.

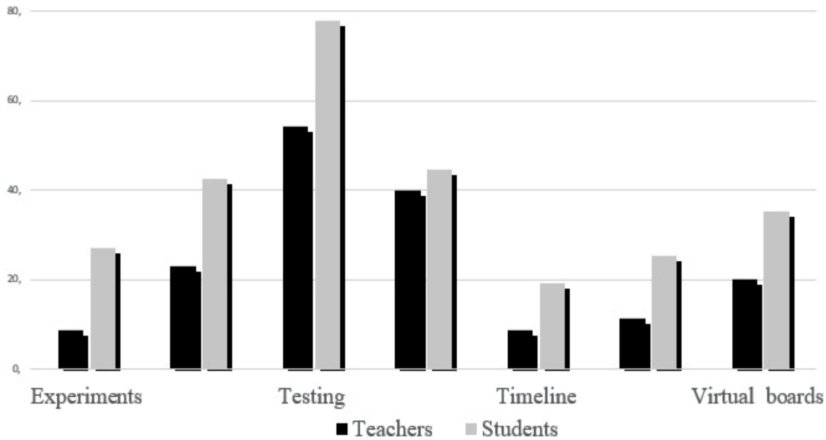
- *Tools for organisation of testing* (Classtime, Mentimeter, Kahoot!, Poll Everywhere, Google Forms, EDpuzzle, ClassMaker, Online test pad, Triventy, etc.) enable the generation of various multiple-choice surveys, quizzes and learning games. As a rule, modern resources allow you to create tests with single and multiple choice questions, entering a number or text, giving an answer in free form, setting the sequence, filling in the blanks (number, text, list), sequential removal of redundant information and more.
- *Mind maps and knowledge maps* (CartoDB, XMind, Mindmeister, Mindjet Coggle, WiseMapping, Mind42, FreeMind, Spider Scribe, Mindomo, etc.) enable information visualization and structuring through diagrams reflecting words, ideas, tasks, etc. with other elements around a core word or idea. They enable brainstorming as type of interactive discussion. The advantages of digital tools include the following: intuitive controls (many graphic design options, elements can be added to any part of the workspace, draw lines of any shape and size and sign them, view the map in different planes, attach files, folders and links, create a catalogue of images: when you hover over the attached icon, the image increases to its true size, etc.); ability to save the map in different formats (jpeg, pdf, html, etc.).
- *Timeline software* (Timeline, Tiki-Toki, TimeToast, Histropedia, Sutori, etc.), apart from traditional functions, enable diagnostic and forecasting of task performance by revealing inter-connectedness between events, their analysis at micro-, macro- and mega-levels, separation of details, etc. They enable the use of 'solution trees' when each student provides input about a certain problem in a chronological order and teacher summarizes students' thoughts. They also enable to use a 'microphone' method, giving each student a possibility of providing answers or comments in a particular order or sporadically.
- *Word cloud generators* (Tagul, Tagxedo, Wordle i Wordclouds, etc.) enable visualized cataloguing and are used in teamwork to describe key concepts. The importance of words is reflected in font size or colour. These generators help implement the 'snowball' method as collective search for joint solution or view. Each participating student has the possibility of presenting their vision of problems. Highlighting the main characteristics of Word cloud generators the following should be mentioned: the ability to change fonts; the ability to choose different colours in which the text and background will be displayed; the ability to display certain words exclusively in the selected colour; the presence of the function of selecting the page orientation and aspect ratio of the image; the presence of a button of random settings, thanks to which you can generate different options for displaying text; free access to download your own cloud or distribute it via a link.
- *Virtual digital boards* (WikiWall, Tutorsbox, Glogster, Dabbleboard, Twiddla, Scribblar, Padlet, Educreations, Popplet, Realtimeboard, Twiddla, etc.) enable collaboration among students and teachers through chat function and demonstration of texts, illustrations, videos, etc. The experience of the authors of the article on the use of virtual digital boards shows that they are an

> effective means of implementing various forms of educational process: web contests, interactive games, quizzes, also allow students to organize and reflect, expand opportunities for research, counselling. It should be noted that the use of virtual digital boards in the educational process contributes to the formation of students' ability to work independently with different sources of information, allow them to immediately see the results and evaluation of their work through the ability to respond quickly to one board or provide access to their own board. Virtual digital boards provide a great opportunity to visualize information, working in groups, even at a distance from each other, but under the control of a teacher who acts as an administrator, coordinator. He/She remotely regulates, adjusts the flow of information. The administrator receives notifications of changes on the board. After the required information is collected, students, together with the teacher begin to systematize the information and compile a single project (Bodnenko, 2020).

The variability of application of digital tools and services for implementation of interactive learning in the context of distance education, and their didactic specificity in application for learning purposes solicited exploration of the actual situation with their practical application in university education. A survey of 35 faculty members and 238 students of Borys Grinchenko Kyiv University, conducted in March 2022, has revealed mixed perceptions and awareness among students and faculty as regards digital tools and services for implementation of interactive learning in the context of distance education. In the process of developing the questionnaire, experts were involved, namely, 6 university teachers who take care of the problems of organizing and implementing distance learning. Their comments and wishes were taken into account in the process of developing the questionnaire.

The vast majority of faculty members (94.3%) believe that the use of digital tools and services for implementation of interactive learning is important in the context of distance education; however, a considerably lower percentage of students (66.4%) share this opinion. Such high percentage of faculty members is likely to suggest that they may to a certain degree equalize distance education with interactive learning or insufficiently understand the concept of interactive learning itself.

Students are more pragmatic in this regard, predominantly focusing on distance education outcomes rather than the process. 71.4% have stated that they have experience of using digital tools and services for implementation of interactive learning in the context of distance education; and 62.2% of students confirm that teachers use these digital tools and services. At the same time, Graph 1 suggests that this experience is not far-reaching: only 8.6% of faculty members use digital tools and services for demonstration, simulation, experiment and timeline activities; 11.4% use word cloud generators; and about 20% use visualization tools and virtual boards (see Figure 2). Interestingly, students appear to be more confident users of digital tools versus teachers. In some categories, students outperform teachers in 1.5 – 2 times, for example, in the use of software for demonstration, simulation and experiment (students – 26.9%, teachers – 8.6%), word cloud generators (students – 25.2%, teachers – 11.4%), timeline generators – (students – 19.3%, teachers – 8.6%), etc.



F i g u r e 2. The use of digital tools and services in distance learning

S o u r c e: Own work.

In light of these findings, it was important to find out teachers' opinions about factors that hamper effective use of digital tools and services. The rank-ordered factors are presented below (Table 1).

T a b l e 1. Ranking of factors hampering the use of digital tools and services (from smallest to largest contributors)

Rank order	Factor	Responses, %
1	Students' insufficient knowledge of computer software (or Moodle) enabling interactive learning	31.4
	Overloaded thematic plan in the curricula	
2	Lack of willingness, passivity of students	42.9
3	Lack of willingness, passivity of teachers	48.6
4	Inadequate technical capabilities (weak internet connection, limited availability computers or mobile devices)	54.3
5	Teachers' insufficient knowledge of computer software (or Moodle) enabling interactive learning	65.7
	Teachers' lacking time to prepare for classes involving interactive learning	

S o u r c e: Own work.

3.3. Use of interactive services in teaching of the natural sciences

Here are fragments of the use of interactive services in the educational process. At the stage of submission of new material, through the use of deductive method, we carry out the disclosure of material from general to partial. The use of frames or Mind maps helps to implement this method (for example Mind Map). MIt is possible to use an inductive method (from partial to general) when creating a roadmap for studying the discipline. In particular, through the use of reflection from school material and through brainstorming, the general mental structure of the thematic plan of the academic discipline is formed. During the compilation of the Mind Map, students in small groups in an online resource must form thematic components of the discipline by content modules (each team is engaged in one of the five content modules of the discipline "Physics"). Having created the components (by modules), students together with the teacher build a roadmap for studying the discipline "Physics" in a shared cloud service. Figure 3 shows the result of the road map formation for studying the discipline "Physics" in the introductory lecture.

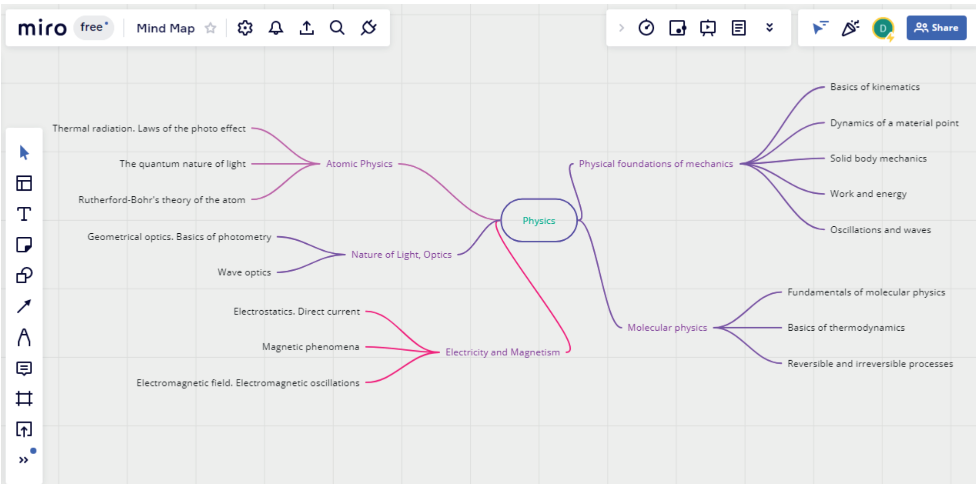


Figure 3. Using Mind Map mental maps to create a roadmap for studying the discipline "Physics"

Source: Own work.

At the stage of reflection (it can be both the beginning of a class (practical, seminar or lecture) and the end of a class, that is summing up what has been learned) it has already become a tradition to use online testing with the help of Testing Tools. The authors of the study propose to conduct a "team briefing" – blitz of control works, which contain questions of both theoretical and practical nature. Interactive team briefing is carried out, for example, when studying the discipline "Physics" for students of the educational program "Security of information and communication systems", using virtual digital jamboard (miro, Padlet, Realtimeboard, Twiddla, etc.). To implement the blitz of interactive control, the lecturer develops the template of the team briefing in advance. The template is positioned according to the environment. The briefing template is located on the virtual digital board, the necessary number of templates is replicated in the same board (according to the contingent of students of the group/subgroup) (Figure 4).

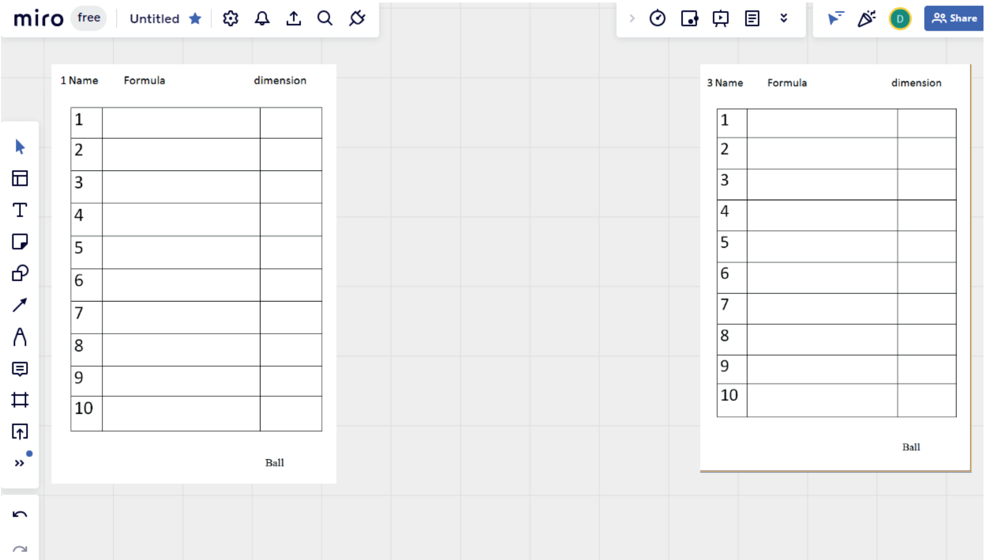


Figure 4. Use of virtual digital boards (Jamboard, Miro) for conducting team briefing (blitz control works)

Source: Own work.

The recommendation to arrange the templates in pairs (horizontally or vertically, conventionally it is possible to name the first and the second, or the first-fourth option), which is freely formed in a digital resource (using the zoom tool, both the teacher (can see by reducing the scale as much as possible) the activity of whole group, and the student (can work with maximum zoom) in his template, respectively). Students are given access to an online whiteboard where they sign each of their templates (selected randomly by the students, or by the sequence number in the group list). Next, the questions are announced in the established order: part of the questions are the same for everyone (for example, write a formula for the average path speed); the second part is different for each versions (for example, version I – write a formula for the law of energy conservation, and version II should write a formula for maintaining the momentum); the third part is arbitrary formula(s) by subject, with a mandatory indication of the formula's name; a separate task can be to indicate the dimensions in the formulas given in the briefing. The number of questions varies depending on the value of the score assigned to this type of work in the current lesson. Upon completion of the briefing writing, students of odd variants check the work and give points to students of even variants (and vice versa). The entire process can be freely coordinated by the discipline lecturer by observing the activities of students both through webinar organisation tools (Zoom, Google Meet) and by observing their activities in a virtual digital whiteboard (Jamboard, Miro). Note that, according to a survey of expert teachers, it is advisable and convenient (when organising distance learning) to use two means of outputting video data (for example, one gadget (monitor) demonstrates a window (for example, Google Meet) with a digital audience of students, the second – allows for visual control over the activities of students in a virtual digital board (for example, Miro)).

To check the work, students are recommended to use the "first" part of rainbow colours (red, orange, yellow), and to write the work, conventionally can be used black (or the "second" part of rainbow colours (green, azure, blue, purple). The distribution into the variant zones, the icons of each student's movement and the different colours of the work (writing/checking) does not give students the opportunity to correct their own ("someone else's") work or write it off.

Tools for online demonstration and simulation of experiments are of particular importance to ensure interactive interaction. Here is an example of using phet.colorado.edu (Interactive Simulations for Science and Maths – https://phet.colorado.edu/), which gives students the opportunity to understand the nature and essence of physical (as well as chemical, biological) phenomena and the laws of mathematics. In particular, solving the problem of Coulomb law with the help of a virtual digital board, students, together with the teacher, can get acquainted with the virtual model of this law demonstration, the dependence of the strength of the interaction of point charges on the module of their magnitude and distance between them and form an appropriate explanatory drawing-demonstration in PHET to solve typical problems (Figure 5).

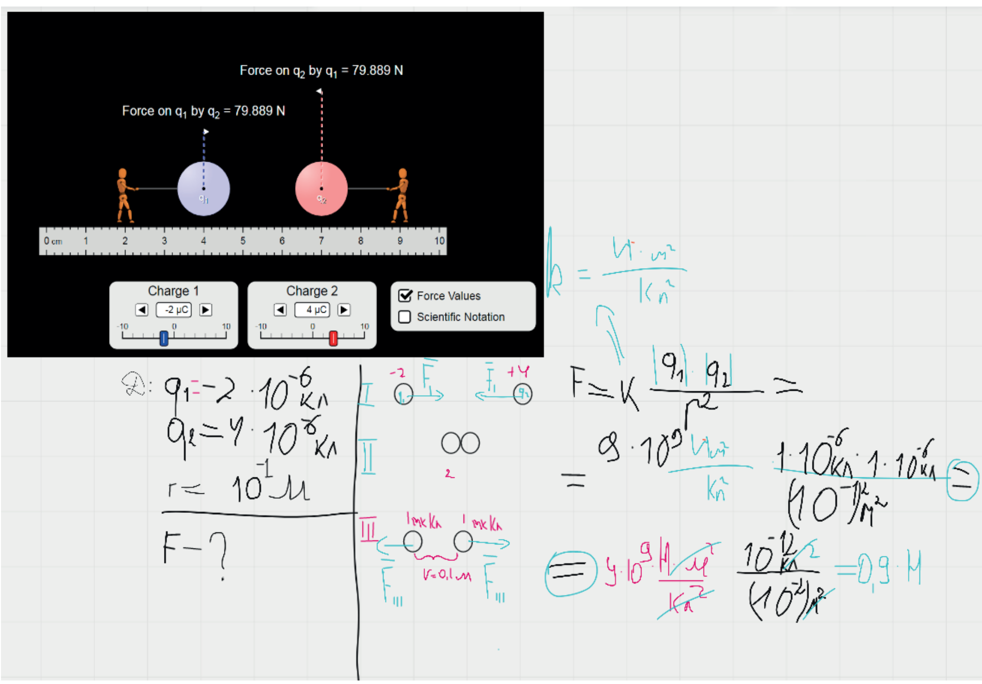


Figure 5. Using Interactive Simulations for Science and Maths phet.colorado.edu to build a physical model for solving a typical Coulomb Law problem

Source: Own work.

CONCLUSION

The problem of the use of digital tools and services for implementation of inter-active learning in the context of distance education is of relevance for the improvement of higher education quality and cognitive activity of students.

The variability of digital tools and services allows for their extensive use in the education process, in line with respective didactic goals and objectives. Their didactic specificity in application for learning purposes have been analysed.

The diagnostic of awareness and perceptions among teachers regarding the use of digital tools and services for implementation of interactive learning in the con-text of distance education has shown that teachers make only limited use of such digital tools and services in class. However, students appeared to be more knowledgeable. This highlights the issue of raising teachers' information and communication competence to master relevant tools and services and understand their didactic value in education process. To this end, the content of diverse programs and courses in post-diploma education requires updating and relevant training should be offered to teachers.

Thus, the use of mental maps and knowledge maps (brainstorming, deductive and inductive method), virtual digital boards (writing briefings, checking them and solving physical problems), online demonstrations, simulations, experiments (solving problems using the construction of a physical model), etc.: contributes to the practical introduction of interactive teamwork between participants in the educational process; enhances the level of consolidation of material by topic (content module, discipline); contributes to the formation of critical thinking and analytical competencies in students.

Therefore, the organisation of interactive learning in the context of distance education should ensure two aspects: utilization of digital tools and services, and interpersonal interaction between teachers and students and between students.

REFERENCES

Bajtoš, J. & Kašaiová, M. (2016). Use of interactive whiteboards in the work of teachers of vocational subjects with an emphasis on the effectiveness of teaching. *The New Educational Review*, *46*(4), 119–129. https://doi.org/10.15804/tner.2016.46.4.10.

Bodnenko, D.M., Kuchakovska, H.A., Proshkin, V.V., & Lytvyn, O.S. (2020). Using a Virtual Digital Board to organize student's cooperative learning. https://doi.org/10.31812/123456789/4419.

Bonn, M., Green, H., Courtney, A., & Senseney, M. (2021). Innovation Through Colaboration in Humanities Research. *Digital Humanities Quarterly*, *15*(4).

Bykov, V. & Leshchenko, M. (2016). Digital humanistic pedagogy: Relevant problems of scientific research in the field of using ICT in Education. Information Technologies and Learning Tools, *53*(3), 1. https://doi.org/10.33407/itlt.v53i3.1417.

Cairncross, S. & Mannion, M. (2001). Interactive Multimedia and Learning: Realizing the benefits. Innovations in Education and Teaching International, *38*(2), 156–164. https://doi.org/10.1080/14703290110035428.

Dudaitė, J. & Prakapas, R. (2019). Influence of use of Activinspire interactive whiteboards in classroom on students' learning. *Digital Education Review*, 299–308. https://doi.org/10.1344/der.2019.35.299-308.

Estriegana, R., Medina-Merodio, J.-A., Barchino, R. (2019). Student acceptance of Virtual Laboratory and practical work: An extension of the Technology Acceptance Model. *Computers & Education*, *135*, 1–14. https://doi.org/10.1016/j.compedu.2019.02.010.

Hrynevych, L., Ilyich, N., Morze, N., Proshkin, V., Shemelynets, I., Lyniov, K., & Riy, H. (2020). Organizatsiya osvitnogo protsesu v shkolah Ukrayini v umovah karantinu: analitichna zapiska [Organization of the educational process in Ukrainian schools under quarantine: an analytical note]. *Kyiv: Kyiv University im. Borysa Hrinchenka, 76.*

Hurlbut, A. (2018). Online vs. traditional learning in teacher education: a comparison of student progress. *American Journal of Distance Education*, *32*(4), 248–266. https://doi.org/10.1080/08923647.2018.1509265.

Insorio, A. (2021). Technological and Operational Mobile Learning Readiness of Secondary Teachers. *International Journal of Pedagogical Development and Lifelong Learning*, *2*(1). https://doi.org/10.30935/ijpdll/9362.

Khoruzha, L., Bratko, M., Kotenko, O., Melnychenko, O., & Proshkin, V. (2019). The study of the Higher School Lecturer's competence in Ukraine: Diagnostics and analytics. *The New Educational Review*, *55*(1), 233–246. https://doi.org/10.15804/tner.2019.55.1.19.

Kumawat, D. (2020). E-Learning in times of COVID-19 Crisis. *Delhi Journal of Ophthalmology*, *31*(2). http://dx.doi.org/10.7869/djo.583.

Liao, C.-W., Chen, C.-H., & Shih, S.-J. (2019). The interactivity of video and collaboration for learning achievement, intrinsic motivation, cognitive load, and behavior patterns in a digital game-based learning environment. *Computers & Education*, *133*, 43–55. https://doi.org/10.1016/j.compedu.2019.01.013.

Makransky, G. & Petersen, G.B. (2019). Investigating the process of learning with Desktop Virtual Reality: A structural equation modeling approach. *Computers & Education*, *134*, 15–30. https://doi.org/10.1016/j.compedu.2019.02.002.

Moreno, R. & Mayer, R. (2007). Interactive multimodal learning environments. Educational Psychology Review, *19*(3), 309–326. https://doi.org/10.1007/s10648-007-9047-2.

Öhman, J. & Sund, L. (2021). A didactic model of sustainability commitment. *Sustainability*, *13*(6), 3083. https://doi.org/10.3390/su13063083.

Pacheco, A. (2022). Digital Humanities or Humanities in Digital: Revisiting Scholarly primitives. *Digital Scholarship in the* Humanities, *37*(4), 1128–1140. https://doi.org/10.1093/llc/fqac012.

Samsonova, O. (2021). Educational Technology in Abu Dhabi Public Schools: Teaching with Interactive Whiteboards (iwbs). *International Journal of Technology Enhanced Learning*, *13*(1), 60. https://doi.org/10.1504/ijtel.2021.10032781.

Subhash, S. & Cudney, E.A. (2018). Gamified learning in Higher Education: A systematic review of the literature. *Computers in Human Behavior*, *87*, 192–206. https://doi.org/10.1016/j.chb.2018.05.028.

Sysoieva, S. (2011). Interaktyvni tekhnolohii navchannia doroslykh: navch.-metod. posib. [Interactive adult learning technologies: tutorial manual]. *National Akademy of Educa-*

tional Sciences of Ukraine, Institute of Pedagogical Education and Adult Education. Kyiv: VD "EKMO".

Tsai, Y. (2020). Collaborative translation in the Digital age. *Research in Language*, *18*(2), 119–135. https://doi.org/10.18778/1731-7533.18.2.01.

Valverde-Berrocoso, J., del Carmen Garrido-Arroyo, M., Burgos-Videla, C., & Morales-Cevallos, M.B. (2020). Trends in educational research about e-learning: A systematic literature review (2009–2018). *Sustainability*, *12*(12), 5153. https://doi.org/10.3390/su12125153.

Yürüm, O., Yıldırım, S., & Taşkaya-Temizel, T. (2022). An intervention framework for developing interactive video lectures based on video clickstream behavior: A quasi-experimental evaluation. *Interactive Learning Environments,* 1–16. https://doi.org/10.1080/10494820.2022.2042312.