

Oleksandr Yu. Burov
Arnold E. Kiv
(Eds.)

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Using a virtual digital board to organize student's cooperative learning

Dmytro M. Bodnenko^[0000-0001-9303-6587], Halyna A. Kuchakovska^[0000-0002-4555-896X],
Volodymyr V. Proshkin^[0000-0002-9785-0612] and Oksana S. Lytvyn^[0000-0002-5118-1003]

Borys Grinchenko Kyiv University, 18/2, Bulvarno-Kudriavska Str., Kyiv, 04053, Ukraine
d.bodnenko@kubg.edu.ua, h.kuchakovska@kubg.edu.ua,
v.proshkin@kubg.edu.ua, o.lytvyn@kubg.edu.ua

Abstract. The article substantiates the importance of using a virtual digital board to organize student's cooperative learning in the conditions of distance education, incl. social distance (for the quarantine period 2020). The main advantages of using a virtual digital board are outlined and their functions for the organization of cooperative education are compared. An analysis of the benefits of using virtual digital boards and a survey of experts made it possible to identify the most popular virtual digital boards: Wiki-Wall, Glogster, PadLet, Linoit, Twidla, Trello, Realtimeboard (Miro), Rizzoma. The comparison of the functions of virtual digital boards outlines their ability to organize students' cooperative learning. The structure of the module E-Learning "Creating education content with tools of virtual digital board Padlet" is presented in the system LMS Moodle. The results of the experiment are presented, which show the effectiveness of the use of instruments of the virtual digital board to organize student's cooperative learning. Perspectives of researches in developing methods of using a virtual digital board by students of natural-mathematical specialties are determined.

Keywords: visualization, virtual digital board, digital technologies, LMS Moodle, cooperative learning.

1 Introduction

The rapid spread of the COVID-2019 pandemic in the early 2020s [12] has become a kind of global challenge for the entire educational environment, in particular for higher education [2]. The forced transition to distance learning during quarantine has outlined a number of pressing issues at all levels: macro-levels (Ministry of Education and Science of Ukraine – development of national strategy and tactics of realization educational process in conditions of forced quarantine), mezo-level (higher education institution – the choice of structure and forms of education, focusing on the educational-professional (scientific) program, curriculum, level of preparation of students, their emotional state, available technical capabilities, etc.), micro-levels (teacher – ensuring implementation of the educational process, the realization of its quality control). It is clear that in such a situation, it is the teacher of the higher institutions is the one who

has a heavy responsibility for the process and results of the professional training of students.

In the context of social distance (during quarantine) teachers, even e-learning opponents, have made massive use of digital technologies. However, the practice has shown that for most of them the ability to use digital technologies is extremely limited. Typically, during quarantine time teachers used the free open system Moodle learning management system [10], and various programs for video-conferencing (Google Meet, Skype, Webex, MS Teams, Zoom). An insufficient level of development of the digital competence [11] of several teachers showed their weak ability to bring distance learning to the usual classroom lesson as much as possible. We attribute the current situation to a limited ability of teachers to use such digital technologies that can effectively simulate full-time education. As an example, the need to use a regular board as a classic technical tool in the educational process. This digital interpretation is represented by virtual digital (interactive) boards (Whiteboard), which as virtualization tools allow users to conveniently make different markings in much the same way as on a regular board or flipchart.

2 Analysis of previous results

There have been a number of studies recently outlining various aspects of using whiteboard in the educational process. So, Christine E. King described the directions for using whiteboard within computer-aided design courses [5]. Wisam Zaqoot and Lih-Bin Oh discovered the possibilities of Whiteboard in the process of Teaching design thinking [14]. Adherence to the principle of accessibility of education for all people with disabilities has encouraged Caron Y. Inouye, Christine L. Bae and Kathryn N. Hayes to highlight the methodological principles of using whiteboard in the organization of inclusive education [3]. Besides, Karina J. Wilkie explored the process of organizing math teaching using whiteboard in inclusive educational space [13]. General theoretical-methodological principles of using whiteboard in the process of teaching physics are presented by Colleen Megowan-Romanowicz [9]. Noteworthy principles prepared by Marek Kowalkiewicz for working with Whiteboard “IdeaWall” in a process of realization “brainstorm” [6]. Dmytro L. Desyatov [1], Svitlana H. Lytvynova and Oleksandr Yu. Burov [8] revealed the essence and advantages of using a virtual digital board as a means of organizing students’ cooperative activities. Nataliia A. Khmil and Iryna V. Morkvian reviewed virtual digital boards and highlighted their considerable didactical potential [4]. Taking into account the results of the conducted research, the problem of organizing students’ cooperative education with the use of a virtual digital board requires further investigation.

3 Research methodology

The purpose of the article – is to substantiate and experimentally test the possibilities of using the virtual digital board tools to organize student’s cooperative education.

In the process of research the following methods were used: analysis of scientific-pedagogical literature on highlighting the theoretical foundations of the use of digital technologies in the educational process; analysis of online resources, methodological literature on a generalization of opportunities of virtual digital boards; studying and generalization of pedagogical experience on the use of virtual digital boards in the educational process; a pedagogical experiment to prove the effectiveness of using virtual digital board tools to organize student's cooperative education.

Work on the material of the article was conducted within the framework of the scientific topic of the Department of Computer Science and Mathematics of Borys Grinchenko Kyiv University "Theoretical and practical aspects of the use of mathematical methods and information technologies in education and science", state registration number 0116U004625.

4 Results and discussion

Analysis of scientific sources allows us to say that modern scientists use similar terms: virtual digital board, virtual electronic whiteboard, interactive whiteboard, virtual interactive whiteboard, and others. In our opinion, these definitions are essentially more common than different. In our work, we do not aim to define the differences between these terms, therefore, we propose to use a common definition – a virtual digital board.

Virtual digital boards have been successfully used in the educational process for over 20 years. The experience of the authors of the article suggests that a virtual digital board – is a convenient instrument for cooperative student's learning, that allows people, even at a distance from one another, to combine text, images, videos, audios, etc. in one interactive format.

According to Mariya P. Leshchenko and Inga I. Kapustyan, the strategy of such education is a popular model of partnership. In co-operation during training, tasks should be shared between the members of the working group, who are united to achieve the goal, and each is responsible for part of the problem identified. The focus is not on the individual performance of a task, but on the development of cooperation within the group [7]. In other words, cooperative education appears not as a form of education, but a special method of organizing educational activities in a group, the basis of which is the positive interdependence between individuals in the course of an educational task and the result of such educational activities become a joint effort created by the end product [1].

Today, there are dozens of resources available on the Internet to create virtual digital boards, including: WikiWall, Tutorsbox, Glogster, Dabbleboard, Twiddla, Scribblar, Padlet, Educreations, Popplet, Realtimeboard (Miro), Twiddla, etc.

They are quite similar in the instrumental set, but each has its specific properties, that can be applied at different stages of the lesson and for different purposes. Using a digital virtual online board can be a very convenient tool in organizing cooperative learning, in creating different types of projects, because classroom projects are a popular and important component of the modern educational process.

In terms of efficiency of use in the educational process, we highlight some advantages of virtual digital boards. First, the virtual board can be posted on social networks (Facebook, Twitter, etc.) that students actively use daily, saved as an electronic document in PDF, CSV, JPG, etc., and sent via email, embed in your page or blog, and use its mobile version and create a QR code. Second, various objects can be added to the virtual digital board. This allows students to work with their projects at any time of the day; to collaborate in a familiar environment for today's youth; ensure simultaneous processing (filling, editing) of the project irrespective of geographical location and social distance (introduction of quarantine/state of emergency in the region, etc.).

Besides, the experience of the authors of the article on the organization of the educational process with the help of virtual digital boards shows that virtual boards act as an effective means of realization of various forms of conducting classes (web competitions, interactive games, quizzes), allow to organize student surveys and carry out reflection, expand opportunities research work of students, consulting.

It should be noted that the use of virtual digital boards in the educational process promotes the formation of students' ability to work independently with different sources of information, allow to immediately see the result and evaluation of their work through the ability to respond quickly to the participants of one board or giving access to their board.

Virtual digital boards provide a great opportunity to visualize information while working in groups, even when away from each other, but under the control of a teacher who acts as an administrator, coordinator. It regulates remotely, adjusts the flow of information. The administrator is notified of changes to the board. After the necessary information is collected, students, together with the teacher, begin to systematize the information and draw up a single project. Figure 1 demonstrates several variants of boards in services Wikiwall, Realtimeboard (Miro) and Linoit.

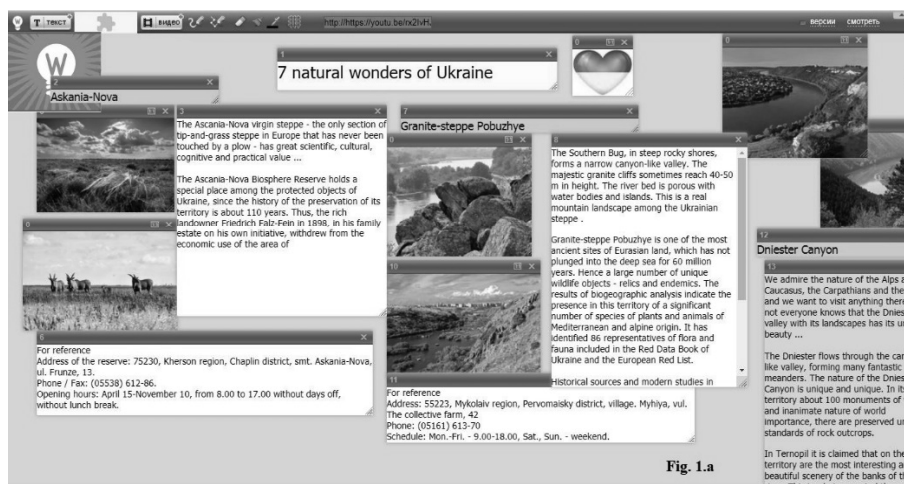


Fig. 1.a

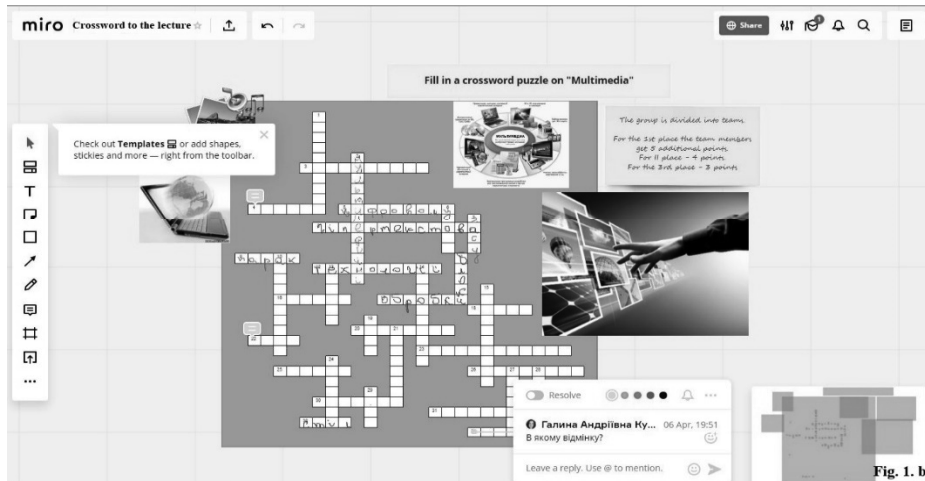


Fig. 1. b



Fig.1.c

Fig. 1. Board options in services Wikiwall (a), Realtimeboard (Miro) (b), Linoit (c).

Let's focus on another important advantage of using virtual digital boards. It is sometimes quite difficult for a teacher to identify and evaluate each student's contribution to the final product as a result of collaborative learning. It is the digital technologies that allow recording the individual contribution of each student, which permits to realize the principle of cooperative learning – individual responsibility of each person for their activity.

In order to find out the real state of the use of virtual digital boards in the educational process, we surveyed teaching staff during September, October 2018. In total, 14 experts from the Department of Computer Science and Mathematics, and the Department of Information and Cyber Security at the Borys Grinchenko Kyiv University, who are involved in teaching computer science and experience in application virtual digital boards, participated in the study. The survey found that the

most popular tools used by teachers in the educational process are the following: WikiWall, Glogster, PadLet, Linoit, Twidla, Trello, Realtimeboard, Rizzoma. Summarizing the answers of the respondents, it can be argued that these tools are the most adapted for the organization of educational activities with various content for better visualization of the material. This allowed us to systematically summarize the main features of digital virtual boards, so we provide a comparative table of their advantages and disadvantages to provide visualization of the training material (table 1).

Table 1. Comparative table of functions of digital virtual boards.

Opportunities	WikiWall	Glogster	PadLet	Linoit	Twidla	Trello	Miro	Rizzoma
Collaboration on one board	+	+	+	+	+	+	+	+
Communication on the board via chat	-	-	-	+	+	-	-	+
Placing text, illustrations, videos on the desktop	+	+	+	+	+	+	+	+
To build in documents, widgets and html-code	+	+	+	+	+	+	+	+
Saving a board/wall on computer as a picture	-	-	+	-	-	-	-	-
Common browsing websites in online	-	-	-	-	+	+	-	-
Organize a discussion for each marked object	+	-	-	+	-	-	+	+
Consistency with other web-services	+	+	+	+	+	+	+	+
Collaboration (registered & unregistered participants)	+	-	-	+	+	+	+	+
Free registration and use	-	-	+	-	+	+	+	+
Support for Cyrillic in posts	+	-	+	-	-	+	+	+

Next, we give a detailed description of the virtual digital board's capabilities.

- Collaboration on one board. Denies communication among students and facilitates discussion when organizing cooperative, in particular, project activities in terms of distance education.
- Communication on the board via chat. A separate chat gives a chance to discuss problem issues with a concrete user or organize a separate chat for a project group.
- Placing text, illustrations, videos on the desktop; To build in documents, widgets, and html-code. Facilitates exchange of information among participants/users for better visualization of training information when organizing a lecture/practical classes.
- Saving work on a computer as a picture.
- Consistency with other web-services (posting board on your blog, site, social network page; creating a QR-code for the board). Improves the communicative component of education and the ability to disseminate your work to other Internet users. When organizing cooperative education or project activities assists the approbation of produced materials.
- Collaboration with the board for both registered and unregistered participants. It simplifies the step of registering on the resource, but comments or entries on the board will be added as an anonymous note.

- Support for Cyrillic in posts. An important feature of the service for those who do not speak a good foreign language. Working with the non-Ukrainian language interface helps to develop users' linguistic competence.

Note also that these services have many features that are interesting for students of particular specialties, such as formula editor, patterns of geometric shapes, etc.

Therefore, the opportunities defined are a compelling argument for purposeful student learning in the context of using virtual digital boards for cooperative training, especially in the case of failure to complete a full-time study (for example, during the quarantine period of 2020).

To accomplish the outlined task, we developed an e-learning module in the LMS Moodle system on "Creating educational content with tools of virtual digital board Padlet", which contained small group method-related tasks (that is, it contained a task aimed at developing cooperative learning). The module has been added to courses in LMS Moodle within the framework of information science for students of the following specialties: "International Law" (discipline "Information-analytical Studies: Modern Information Systems and Technologies"), "International Information" (discipline "International Information: ICT in International information"), "English Philology" (discipline "Information Technologies in Foreign Languages: Modern Information Technologies in Foreign Languages"), "Eastern Philology" (discipline "Information Technologies in Eastern Languages"). "Creating educational content with tools of virtual digital board Padlet" module is designed as universal for computer science courses taught to enhance students' digital competence.

Padlet virtual board service is chosen by us as an easy-to-use, popular among our experts – teachers at KUBG. Besides, as shown in table 1, this tool contains a significant amount of functionality.

The module "Creating educational content with tools of virtual digital board Padlet" contains the following components:

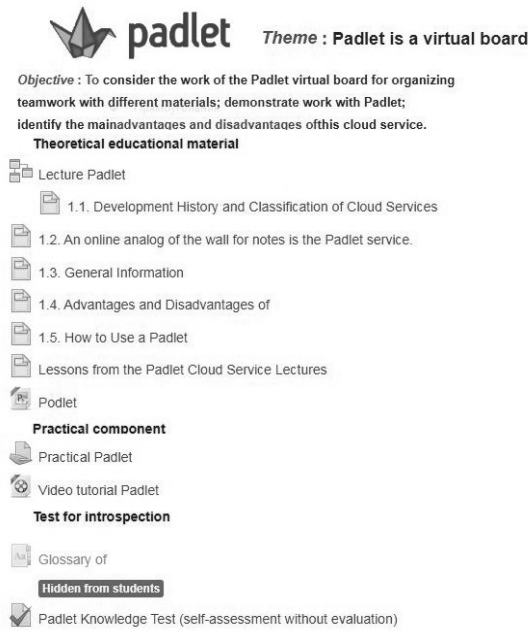
- lectures (1. The history of development and general characteristics of cloud service; 2. An online analog of the wall for notes – is the Padlet service; 3. Advantages and disadvantages; 4. Using the Padlet in professional activity and presentation of a given topic);
- practical work (20 detailed tasks for mastering the skills of work in the service);
- video manual (step-by-step instructions for completing the most practical tasks);
- glossary (dictionary of terms);
- knowledge tests.

In fig. 2 shows a copy of the screen element of the training course "Creating educational content with tools of virtual digital board Padlet" in LMS Moodle.

Here are examples of using a virtual digital board Padlet at different stages of training within the ELC in the LMS Moodle system.

Fig. 3 presents a fragment of the results of students' work during the discussion of the material as part of the lecture on "Social network services". The purpose of the task was to organize students into groups and discuss the types of social networking services, their opportunities, and directions of use in future professional activity. All

members of groups had the opportunity to add, comment on relevant entries, put likes/dislikes. We believe that when organizing such a reflexive approach, students are highlighted in collaborative and communication skills.



Theme : Padlet is a virtual board

Objective : To consider the work of the Padlet virtual board for organizing teamwork with different materials; demonstrate work with Padlet; identify the mainadvantaes and disadvantages ofthis cloud service.

Theoretical educational material

- Lecture Padlet
- 1.1. Development History and Classification of Cloud Services
- 1.2. An online analog of the wall for notes is the Padlet service.
- 1.3. General Information
- 1.4. Advantages and Disadvantages of
- 1.5. How to Use a Padlet
- Lessons from the Padlet Cloud Service Lectures
- Podlet

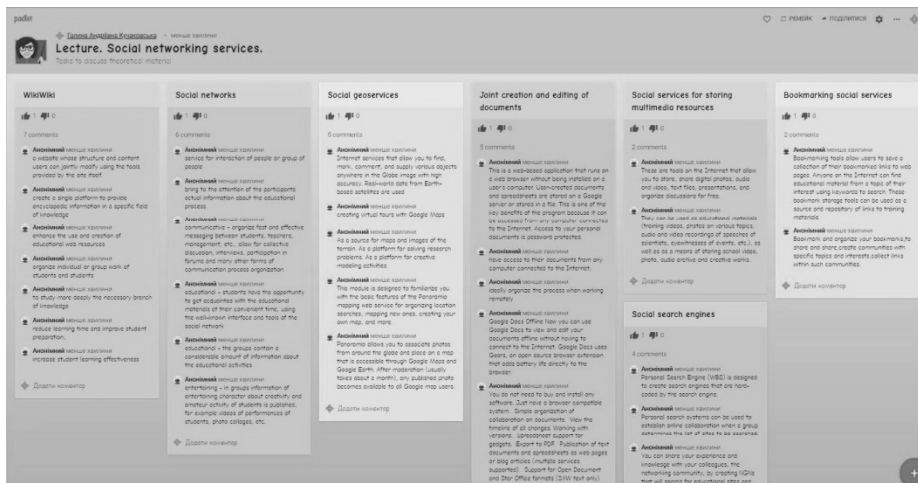
Practical component

- Practical Padlet
- Video tutorial Padlet

Test for introspection

- Glossary of
- Hidden from students
- Padlet Knowledge Test (self-assessment without evaluation)

Fig. 2. The element of the training course “Creating educational content with tools of virtual digital board Padlet” in LMS Moodle.



padlet

Lecture. Social networking services.

Take to discuss theoretical material

- WikWiki** (7 comments)
 - Academician virtual education: a website whose structure and content users can edit freely, using the tools provided by the site host.
 - Academician virtual education: create a single platform to provide encyclopedic information in a specific field of knowledge.
 - Academician virtual education: enhances the use and creation of educational web resources.
 - Academician virtual education: organizes individual or group work of students and students.
 - Academician virtual education: to study more deeply the necessary branch of knowledge.
 - Academician virtual education: reduce learning time and improve student preparation.
 - Academician virtual education: improve student learning effectiveness.
- Social networks** (6 comments)
 - Academician virtual education: source for interaction of people or group of people.
 - Academician virtual education: bring to the attention of the participants actual information about the educational process.
 - Academician virtual education: communicative - organized fast and effective messaging between students, teachers, management, etc., allow for collective discussion, opinions, participation in forums and many other forms of communication process organization.
 - Academician virtual education: educational - students have the opportunity to get acquainted with the educational methods of their counterpart firms, using the evaluation interface and tools of the social network.
 - Academician virtual education: a considerable amount of information about the educational activities.
 - Academician virtual education: participating - in groups information of interesting information about reality and structure activity of students is published, for example, ideas of participation of students, photo catalogs, etc.
- Social geoservices** (5 comments)
 - Academician virtual education: Internet services that allow you to find, view, comment, and easily virtual objects anywhere in the Globe using high-resolution, Real-time data from Earth-based satellites are used.
 - Academician virtual education: creating virtual tours with Google Maps.
 - Academician virtual education: As a source for maps and images of the terrain. It is a platform for solving research problems. As a platform for creative mapping activities.
 - Academician virtual education: The module is designed to form large 3D with the basic features of the 3D modeling web service for organizing location scenarios, mapping new areas, creating your own map, and more.
 - Academician virtual education: Displays where you the satellite photos from around the globe and place on a map, and a screenshot through Google Maps and Google Earth. After moderation (usually fields about a month), any published photo becomes available to all Google map users.
- Joint creation and editing of documents** (5 comments)
 - Academician virtual education: This is a web-based application that runs on a web browser without being installed on a user's computer. User-created documents and comments are stored on a Google server or stored in the. This is one of the key benefits of the program because it can be accessed from any computer connected to the Internet. Access to your personal documents is password protected.
 - Academician virtual education: have access to their documents from any computer connected to the Internet.
 - Academician virtual education: locally organize the process when working remotely.
 - Academician virtual education: Google Docs Offline how you can use Google Docs to view and edit your documents offline, without having to connect to the Internet. Google Docs uses Gears, an open source browser extension that uses history file directly to the browser.
 - Academician virtual education: You do not need to buy any special proprietary software. Just have a browser compatible system. Great organization of collaboration on documents. View the history of all changes. Working with versions. (approximate support for projects. Based on PDF. Distribution of text documents and attachments as web pages or long articles. Multiple services. Subscribed. Support for Open Document and Other Office formats (DOC, DOCX, etc.).
- Social services for storing multimedia resources** (2 comments)
 - Academician virtual education: These are tools on the Internet that allow you to share, store digital photos, audio and video, text files, presentations, and organize discussions for free.
 - Academician virtual education: They can be used as educational materials (training videos, photos on various topics, audio and video recordings of lectures of seminars, conferences of events, etc.), as well as as a means of storing social tasks, photo, audio archive and creative works.
- Bookmarking social services** (2 comments)
 - Academician virtual education: Bookmarking tools allow users to store a collection of their favorites links to web pages. Anyone on the Internet can find the educational material from a list of their interests using keywords to search. These bookmark storage tools can be used as a source and repository of links to training materials.
 - Academician virtual education: Bookmark and organize your bookmarks to store and analyze content, create user-specific tabs and interests collect links within user communities.
- Social search engines** (4 comments)
 - Academician virtual education: Personal Search Engine (PSE) is designed to create custom engines that are personalized to the search engine.
 - Academician virtual education: Personal search systems can be used to enhance online collaboration when a group determines the list of links to be searched.
 - Academician virtual education: You can share your experience and knowledge with your colleagues, the networking community, by creating tags that will search for educational sites and

Fig. 3. An example of using a virtual board in the course of a lecture on “Social network services”.

In fig. 4 a teacher's board is submitted, which presents the tasks for the practical work, evaluation criteria, etc. Besides, there are student's comments, links to other boards created. With such a visual observation organization, users can view, discuss, and comment on other students' boards, which helps communicate to users both in separately organized groups in project work and in general when organizing cooperative learning.

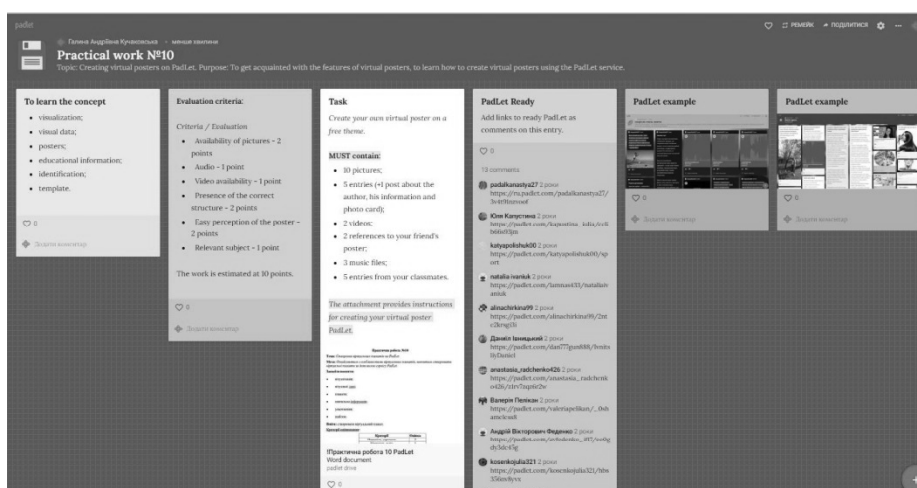


Fig. 4. An example of using a virtual board in the process of organizing a practical lesson.

Students of the above specialties of KUBG were involved in the implementation of the forming experiment (conducted during February – December 2019). The experiment aimed to determine the effectiveness of using a virtual digital board for the organization of student's cooperative learning. The experiment was conducted over two academic semesters, depending on the curricula governing the study of computer science in different specialties at the university. The total number of students was 164 persons, of which – the control group (80 persons), the experimental group (84 persons). All students studied the element of the training course “Creating educational content with tools of virtual digital board Padlet”.

For the students in the control group, we used the standard tasks to develop skills to work with virtual digital boards, for example:

1. Register and create your digital board (wall), give access to the digital board to your small group of researchers (hereinafter SGR).
2. Add your files from your desktop or computer folders, drag photos to your wall.
3. Add a portrait and change the wallpaper.
4. Change file location to Grid.
5. Click on the plus icon in the right column to start a new wall.
6. Click on any item to zoom in and make it easier to view.
7. Post your wall on any social network.
8. Set up privacy and more.

For the students of the experimental group, in addition to the standard tasks, we have developed our tasks aimed at implementing cooperative learning (in small groups). To accomplish each task effectively, it was necessary to share responsibilities among the group members. Each student was responsible for solving part of a common problem. In addition, it was important to establish effective collaboration between team members to achieve the desired result.

Here is an example of a problem. Add a file or advertisement to a virtual digital board containing a specific problem (for example organizing of student distant learning: motivation and incentives). Discuss (for example, using SWOT analysis, identifying strengths, weaknesses, opportunities, and threats). As a result of the discussion, make the appropriate decisions as a result of the small group discussion.

To evaluate the effectiveness of using a virtual digital board for the organization of student cooperative learning, a test was developed and conducted that contained 10 tasks that required the presence of cooperative activities skills. So, students had to solve problems regarding the effective organization of work in small groups, systematization of knowledge, reflection, etc.

Test results for students in the control and experimental groups, we obtained data. The statistical hypothesis was tested using the Student's *t*-test. Obtained that $t_{emp} = 4.78 > t_{cr} = 2.6380$ at the level of statistical significance $\alpha=0.01$, therefore, we can argue that the use of virtual digital board tools is effective for organizing cooperative student learning.

5 Conclusions

The importance of realization of cooperative student's education in the process of professional training is proved in the article, including in the conditions of social distance (for example, during quarantine time). To maximize the approximation of distance learning to full-time form, the importance of using a virtual digital board, which simulates the work of a regular board as a classic technical medium is outlined.

An analysis of the benefits of using virtual digital boards and a survey of experts made it possible to identify the most popular virtual digital boards: WikiWall, Glogster, PadLet, Linoit, Twidla, Trello, Realltimeboard, Rizzoma. The comparison of the functions of virtual digital boards outlines their ability to organize students' cooperative learning.

The ELC module "Creating educational content with tools of virtual digital board Padlet" has been developed, containing the following components: lectures, practical work, video-manual, glossary, knowledge test. A pedagogical experiment was conducted to test the possibilities of using a virtual digital board for organizing cooperative student learning. For students of the experimental group, tasks aimed at implementing cooperative learning (in small groups) were introduced. Statistical processing of the study results (Student's *t*-test) allowed us to establish that the use of virtual digital board tools is an effective means of organizing cooperative student learning.

The perspectives for further research are seen in the development of methods of using virtual digital boards by students of natural-mathematical specialties.

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