The Use of ICT in the Flip Teaching of Future Mathematics Teachers

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Abstract. The article highlights possibilities of ICT in the implementation of the "flipped learning" technology in the professional training of future mathematics teachers. Flipped learning technology has been analyzed as a mixed learning model that has a different look at the organization of the educational process. The model of realization of "flipped learning" using ICT while studying the topic "Functions" in the course "Elementary mathematics" is developed. Given examples of the use of interactive learning technologies based on the use of modern information and communication technologies, including cloud and mobile. The lesson scheme of training on the technology "flipped learning" is described in detail using the system of Moodle, a shared virtual board, the use of QR codes during interactive technology "Bingo". The peculiarities of using the Mentimeter online resource to conduct student surveys during reflection are disclosed. The results of student survey are analyzed and presented regarding the expediency of using this technology in future professional activity. It is established that the use of innovative teaching technologies in the process of professional training of future mathematics teachers contributes to the students' awareness of the need to create and use of educational areas, which should become a powerful tool for students to develop critical thinking, self-disclosure of creative abilities, research skills, self-knowledge.

Keywords: ICT, cloud technologies, online resources, flipped learning, future math teachers, professional training.

1 Introduction

1.1 Formulation of the problem.

In modern conditions of reforming the system of national education, the problem of training a new generation by teachers capable of professional activities in the condi-

tions of transition of the world community to the information society becomes especially important.

As noted in the National Doctrine for Education Development in Ukraine in the 21st Century [17], one of the priority directions of educational development is the introduction of educational innovations and information technologies. In particular, the document emphasizes on ensuring the innovative nature of educational activities. Under these conditions, society expects a new teacher today (especially, a teacher of mathematics) who can only be trained in the innovative educational environment of pedagogical institutions of higher education. Only in the conditions of innovative environment it is possible to form a teacher who is a comprehensively developed, independent, self-sufficient personality, able to adapt quickly in the modern education system, to participate in its improvement, to be ready for the introduction of pedagogical innovations, namely a teacher-researcher, a teacher-innovator.

L. Vashchenko believes that the innovative environment of a particular educational institution should be filled with innovative content and forms of organization, provide conditions for the formation of new quality of professional scientific-pedagogical and management activities, thereby creating a powerful potential resource for development of professional activity [9, p. 39].

However, it is worth noting that at this stage a particular importance in the creation and efficient functioning of the innovative educational environment is the introduction of modern ICT in the educational process of higher educational institutions, thereby ensuring the gradual transition of the learning process to a new, quality level.

1.2 Analysis of recent research and publications.

The changes taking place in modern society and the reform of national education require the introduction of new educational technologies into the process of training future mathematics teachers. Among such technologies, the “flipped learning” technology, which is one of the key trends in the educational technologies of the present, is particularly widely used in the educational process.

“Flipped learning” is a model of the educational process in which the typical giving of lectures and the organization of tasks given for self-study swap places.

For the first time, the “flipped learning” technology in the educational process was used in the United States by chemistry teachers Aaron Samson and Jonathan Bergmann, who recorded videos of their lectures and offered them to students for homework.

“Flipped learning” technology is a modern trend in education that is of great interest to scientists. At the same time, it cannot be organized without the use of information and communication technologies.

The use of information and communication technologies in the educational process, in particular in the lessons of mathematics, was considered by such scientists as V. Bykov [8], M. Zhaldak [12, 13], K. Vlasenko [10], O. Spivakovskyi [18], N. Kushnir [18], S. Semerikov [6, 20], S. Shokaliuk [20], R. Ratushnyi [20], O. Markova [6], M. Popel [6].

The problem of introduction of the “flipped learning” technology into the learning process was considered by O. Danysko [11], O. Zymovets [14], V. Kukharenko [15], N. Morze, L. Varchenko-Trotsenko [16], H. Tkachuk [19] etc. Among foreign scientists, the technology of “flipped learning” was studied by J. Bishop and M. Vergeler [2], J. Bergmann, A. Sams [1], M. Critz [3], C. Prober, C. Heath [7] and others.

V. Kukharenko considers flipped learning as the organization of a course or a separate class, when “students study theoretical material remotely instead of traditional homework and then do practical work in the classroom” [15, p. 124].

O. Danysko [11] presented the models of traditional and flipped learning schematically (Fig. 1).

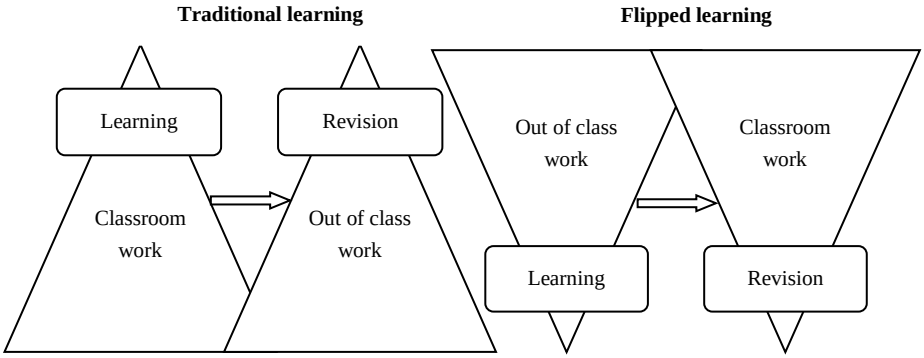

Fig. 1. Comparative models of traditional and flipped learning organization (by O. Danysko)

International organization “Flipped Learning Network” (FLN) interprets “Flipped Learning”; “Flip Teaching” as a pedagogical approach whereby the teaching process is shifted into an individual extracurricular space and the group space of the audience is transformed into a dynamic interactive educational environment for students mastering of educational material and its creative application [4].

“Flipped learning” as an educational technology must meet the following four characteristics [5]:

- Flexible Environment – allows you to use different modes of learning;
- Learning Culture – is student-centered;
- Intentional Content – aimed at supporting the conceptual understanding of the content of the educational course and its assimilation;
- Professional Educator – teacher professionalism is a key factor in ensuring the quality of the educational process.

2 Methods of the study

Methods used in the research process include: analysis of theoretical sources; analysis and generalization of domestic and foreign experience of the best pedagogical practices of using flipped learning in student preparation; monitoring the implementation of educational process and methods of activity of its participants; synthesis, gen-

eralization and conceptualization of development of main provisions of the study; development, substantiation and implementation of the model of "flipped learning" with the use of ICT during studying the topic "Functions"; student survey; analysis of the obtained data and descriptive statistics of the obtained results.

3 Results

One of the priority directions for modernizing the professional training of future mathematics teachers in pedagogical higher educational institutions is to combine traditional learning with the introduction of innovation, information and communication technologies. "Flipped learning" technology is a well-known combined learning model that allows you to take a different look at the organization of the educational process. The use of this technology involves the students' preliminary self-study of the educational material presented in the form of a supporting compendium of the lecture or in the form of slides, video and audio materials. In the classroom, the teacher usually devotes time to explaining the difficult moments that most cause difficulties during the independent learning of the educational material, answers students' questions about the topic of the class, organizes discussion of the studied material, etc.

The use of this technology in the professional training of future mathematics teachers contributes to students' education of independence, responsibility, initiative, development of creativity, mobility, professional, communicative and digital competences.

Here is an example of the use of "flipped learning" technology in a practical class in elementary mathematics on the theme "Interesting world of functions around us". The scheme of the class with all stages is presented in Fig. 2.

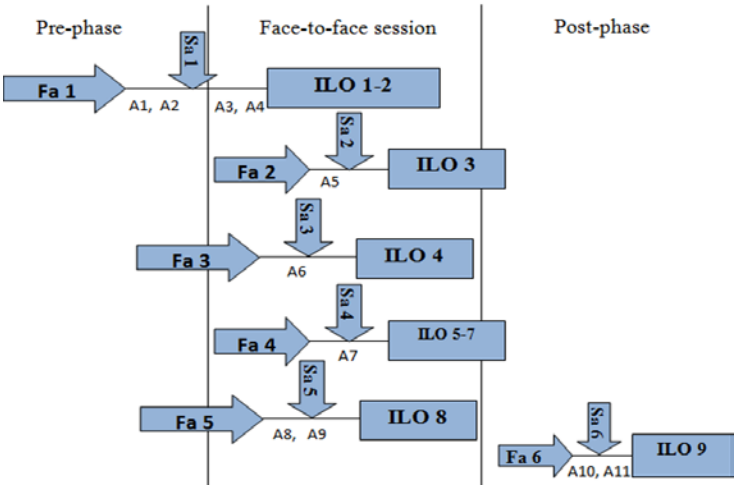

Fig. 2. The scheme of the class on technology "Flipped learning"

We describe the scheme where:

Formative Assessment (Fa) is an in-process evaluation that enables students to understand and track personal progress and plan for next steps with the help of a teacher. During the formative assessment, the teacher should constantly be close to the student and lead him / her to success, and at the Pre-phase and Post-phase stages this is possible due to information and communication technologies. The data that teachers receive during this assessment is used to adjust the learning and provide proper implementation of the tasks done by the students.

Summative Assessment (Sa) – final evaluation. This is the type of assessment that is used at the final stage of a certain period of study and its purpose is to assess the level of learning material. Using information and communication technologies, the teacher can conduct a final assessment not only during the lesson but also outside the classroom.

Pre-phase – work done before the class.

Face-to-face session – work with each other during the class.

Post-phase – work done after the class

ILO – intended learning outcomes.

ICT is often used on each stage of the lesson: it is a work in the MOODLE system and the use of a virtual board, and on-line survey, and the use of a SMART board for the presentation of student projects and watching videos, etc.

FA 1: Using the MOODLE system, students view materials (videos, photos, presentations, etc.), using forum, discuss, share experiences (ILO 1-2).

SA 1: The use of a shared virtual board, teacher assessment (frontal survey, express survey, online tests, etc.).

FA 2: working in groups (ILO 3)

SA 2: mutual student assessment

FA 3: development and presentation of student presentations (project) (ILO 4)

SA 3: student self-assessment, mutual student assessment, teacher assessment.

FA 4: individual and group performing tasks (ILO 5-7)

SA 4: teacher assessment

FA 5: watch video (ILO 8)

SA 5: general discussion, teacher assessment of responses

FA 6: implementation of individual homework and presentation of results to Moodle (ILO 9)

SA 6: general discussion on Moodle

FA 7: presentation of the finished project (ILO 10)

SA 7: mutual assessment and teacher assessment.

Pre-phace

ILO 1-2:

A1: students watching videos about types of functions and their properties;

A2: students discussing questions posted by the teacher on a forum on this topic

Face-to-face session

ILO 1-2:

A3: students' frontal survey of self-study material (3-5 minutes)

A4: liquidation of gaps (presentation of theoretical material) (7-10 minutes)

ILO 3:

A5: work in pairs to perform tasks on ready figures for definition (10-15 minutes):

1) the type of function;

2) types of performed elementary transformations of the function in a general form;

3) analytical record of the function presented in the figure;

4) properties of a given function.

ILO 4:

A6: Teaching division of students into groups to explore the use of functions and their graphs in the environment (mini-project "The World of Functions Around Us") (10-15 minutes):

1) medicine;

2) architecture;

3) nature;

4) science.

ILO 5-7:

A7: individual and group performing tasks (10-15 minutes):

1) graphing the function set analytically in the standard form

2) the simplest transformation of graphs of elementary functions

3) determining the type of function according to a given graph

ILO 8:

A8: students watch a teacher-prepared video showing some examples of function graphs in the environment (2-3 minutes)

A9: presentation of the mini-project results "The World of Functions Around Us" (13-17 minutes)

Post-phace:

ILO 9:

A10: develop a fragment of the lesson in learning types of functions with the obligatory inclusion of material from a mini project:

1) 7th grade

2) 8th grade

3) 9th grade

A11: posting developed fragments of classes on Moodle for general discussion

According to Bloom's taxonomy, the result of the training was to obtain the following expected learning outcomes (ILO), which are shown in table 1:

Table 1. Expected learning outcomes on topic "An interesting world of functions around us" using "flipped learning" technology

Levels	Expected learning outcomes
Knowledge:	ILO 1: content of the concept "function", "graph of function"
	ILO 2: types of elementary functions
Understanding:	ILO 3: properties of elementary functions
	ILO 4: practical use of functions in everyday life
Application:	ILO 5: perform graphs of elementary functions
	ILO 6: make elementary transformations of function graphs
	ILO 7: define the general kind of function by graph
Analysis	ILO 8: graphs of functions in the environment (nature, science, architecture, medicine, etc.)

Synthesis:	ILO 9: combine and adapt the acquired knowledge and skills in future professional activity
Evaluation:	ILO 10: the quality of the educational project (in the process of independent search)

An example of a developed Moodle lesson is shown in Figure 3.

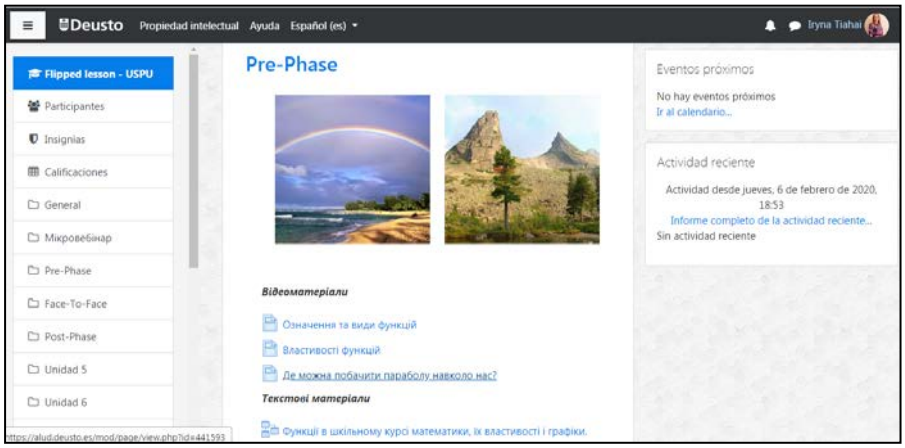

Fig. 3. Developed lesson using the “Flipped learning” technology in Moodle

This form of work in higher education will promote the formation of general and professional competences in students. In addition, to teach future math teachers the use of innovative technologies, we use “Bingo” technology in the frontal survey. This is a fun game that will help to activate students’ mental activity, set them up for active learning. We offer students a QR code that gives them the task of collecting a puzzle or finding matches, etc. Whoever does the task first says Bingo! and becomes a winner in this game. An example of the use of such a task in training elementary mathematics on the topic “An interesting world of functions around us” is shown in Figure 4.

After watching a video clip prepared by the teacher, which provides some examples of graphs of the function in the environment, we suggest students to watch a small video clip of a physical activity break. Such a video (Fig. 5) will be useful for future teachers when learning this topic at school.

The final stage of this class is the reflection. Various online resources were explored to interact with the audience. There are a lot of such cloud resources. To select such a resource, the following three criteria were used: intuitive interface (no need to read the instructions), lack of registration for students (for the content creator it is necessary), multifunctionality (the resource can be used in any part of the lesson performing different tasks). One of these online resources is Mentimeter.

Mentimeter is an online resource for creating presentations, surveys, real-time surveys, allowing you to get instant feedback from the audience.

So, at the end of the lesson, we offer students to answer the following questions:

1. Did you enjoy working with “Flipped learning” technology? (Options: Yes; it was good; not good; no).

2. Will you use today’s online services in your future professional activities? (Options: Yes; rather yes; sometimes; I don’t know; no).

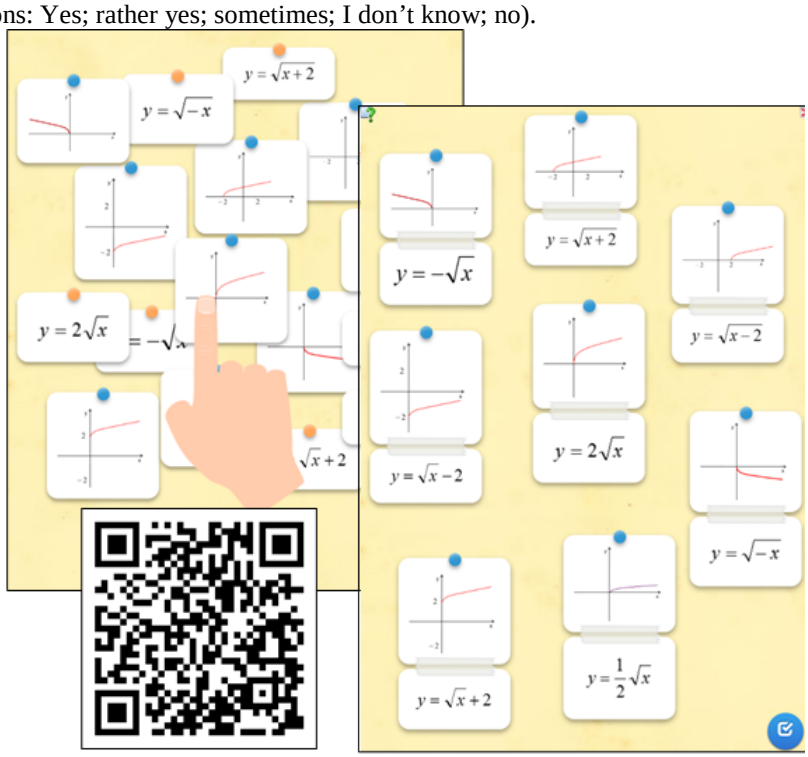

Fig. 4 Using QR Codes during interactive “Bingo” technology

To conduct an audience survey, you need:

- Teacher with PC with the image broadcast on the screen;
- Students with smartphones or tablets with Internet access.

The teacher runs the survey from the PC in the classroom. The screen shows the address and code of the survey for students. Students, using smartphones or tablets, go to www.govote.at, enter the survey code and answer the questions. The survey results are displayed instantly.

It is possible to conduct surveys both in synchronous mode (in the audience, “here and now”), and in asynchronous mode – at any time within the specified interval of the survey.

Anonymous voting can be effectively used as a formative assessment tool when it is necessary to determine the overall level of understanding the topic by students. It has several advantages, such as:

- anonymity allows the respondent to avoid stereotypical thinking and express his or her own opinion;

- lack of criticism or negative evaluation by others makes it easy for respondents to express themselves;
- the results will be more accurate, if there's no pressure on the part of others;
- anonymity allows to avoid negative dominative opinion of one or more voting participants.

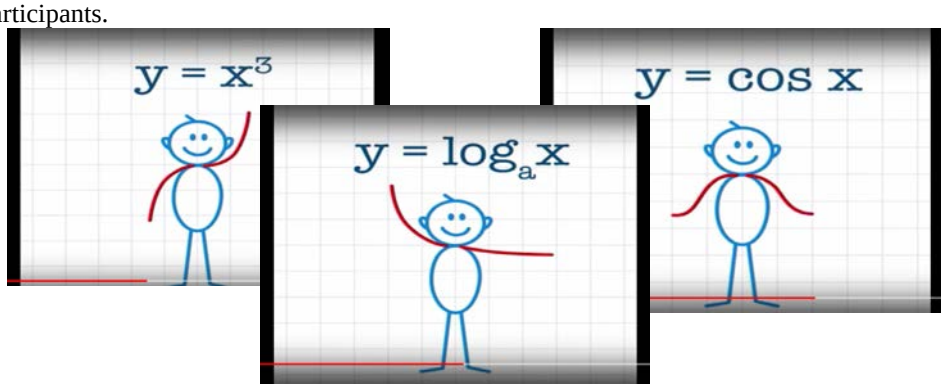

Fig. 5 Video clip-physical activity break

27 students from the Faculty of Physics, Mathematics and Informatics of the Pavlo Tychyna Uman State Pedagogical University participated in the survey. The results of the survey are presented in Figures 6 and 7.

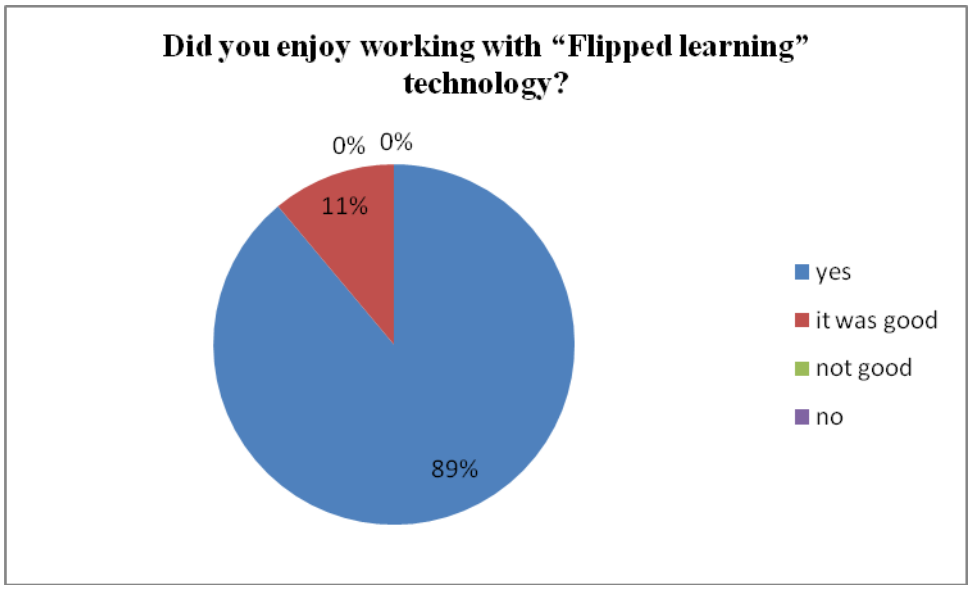

Fig. 6. Student survey results

The interaction of participants of the educational process in an interactive form should be applied at the classes as often as possible, so that future teachers can successfully and skillfully implement them into their professional activities, thus turning learning into a game and engaging students in mathematics, because in such mathematics classes it will be not only be cognitively but also fun and not boring.

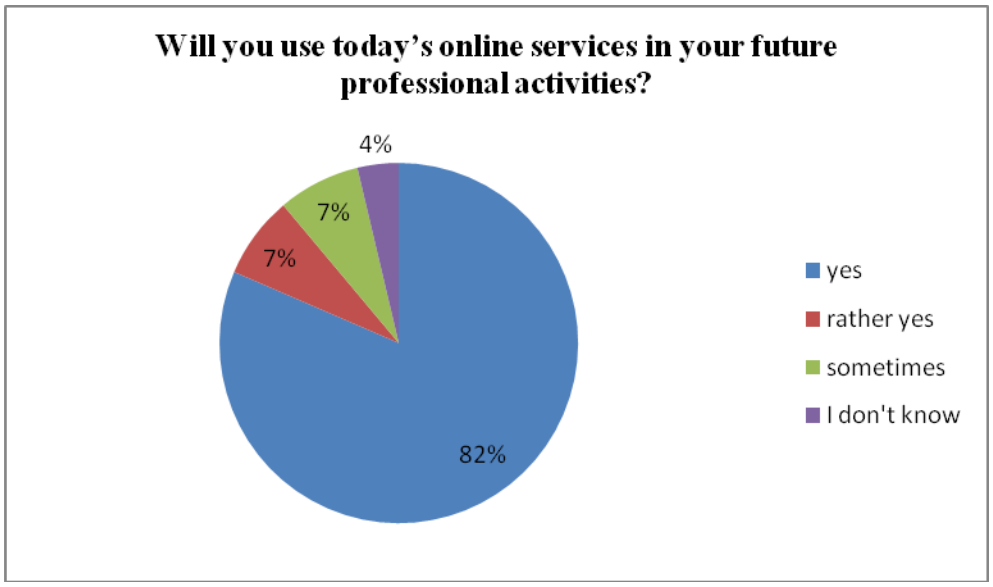

Fig. 7. Student survey results

4 Conclusions

So, one of the important tasks facing the modern teacher of mathematics is to modernize the learning process by providing it with a creative and active character in order to shape students' life competencies. Practical methodological skills of future mathematics teachers should become a tool for building effective pedagogical interaction in the process of teaching mathematics to students. The use of innovative teaching technologies in the process of methodological training of future mathematics teachers promotes students' awareness of the need to create and use of educational spaces, which should become a powerful tool for students to develop critical thinking, self-disclosure of creative abilities, research skills, self-knowledge.

An effective form of organization of the educational process which provides student mastery of pedagogical innovations based on information technology and modern means of communication is flipped learning. This technology creates the conditions under which future teachers of mathematics take responsibility for the process and outcome of personal learning and learn to carry out future professional activities in the context of globalization and informatization of society.

Further research should be directed to the use of the proposed technologies in teaching students of professional disciplines.

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