Flipped Learning: Strategies and Technologies in Higher Education

Viktoriia Miziuk[1], Rimma Berdo[2], Larysa Derkach[3], Olha Kanibolotska[4], Alla Stadnii[5]

[1] Izmail State University of Humanities, Ukraine
[2] Dnipro State University of Humanities, Ukraine
[3] Lesya Ukrainka Volyn National University, Ukraine
[4] Zaporizhzhia National University, Ukraine
[5] Vinnytsia National Technical University, Ukraine

Abstract
Flipped learning is necessary for modern education but quite difficult to implement. In pedagogical science, the question remains to what extent the practical work of the teacher in combination with the technologies of flipped learning will improve the quality of higher education. **The aim of this article** is to study the effectiveness and feasibility of using flipped learning technologies, assessing their perception by students (advantages and problems), identified an algorithm for introducing flipped learning technology in higher education institutions. **Research methods.** The main method is an experiment. An evaluation of the effectiveness of the study was conducted using a questionnaire and observation method. Statistical methods were used to evaluate the results of the experiment. The research **hypothesis** is that flipped learning allows the teacher to spend more time on an individual approach, to understand the real needs of students, and provide effective feedback, thereby improving the quality of learning and motivation of students, especially while studying complex material. **The results** of the study are to prove the effectiveness of the technology of flipped education in the study of complex disciplines, courses, topics. The use of flipped learning strategies improves the self-regulation of the educational process, group work skills, improves students' ability to learn, overcome difficulties. The technology of flipped learning in the presence of modern technical means and constant work on improving the level of digital literacy is an effective means for students to master complex topics and problematic issues that require additional consideration and discussion. **The perspective** of further research is the consideration of integrated approaches to the application of flipped learning technologies to the principles of STEAM-education, multilingual and multicultural programs, etc. It is also worth continuing to develop a set of methods aimed at enhancing the student's learning activities, the formation of group work skills, direct participation in creating the foundations of higher education.

Key words: *flipped learning, active learning transformation, frontal, instructional teaching, flipped classroom teaching, feedback loops.*

1. Introduction

The difficulties of involving students in active learning, the organization of a quality educational process are associated with the use of traditional learning technologies in the organization of lectures and in conducting practical and seminar classes. This determined the relevance of the introduction of flipped learning technologies in the educational process. The search for more effective and technological teaching methods contributed to the opening of individual institutions that would develop and implemented the flipped learning technology in the global educational process (Lesley University, 2021; Khan Academy, 2020). No less important is the research on creating comprehensive university programs that are universal and based on modern digital technologies. The movement in this direction raises several issues that need to be addressed and researched in higher education. These are, first of all, different learning strategies and contents that researchers invest into the flipped learning technologies. That is why there are different positions in the interpretation of "flipped learning". In this study, flipped learning is interpreted as a form of interactive learning that makes it possible to change the usual teaching process, i.e. "reverses the sequence of actions". First, students have a look and get acquainted with the study material of the next lesson in the form of video files, independently pass the theoretical material, and (in the classroom and laboratories) perform only practical tasks and work (theoretical material passed previously as homework). The value of flipped learning technology lies in the possibility of using study time to work in a group, students discuss what they see and learn at home, determine the content of the seminar, practical classes, test their knowledge and skills in group interaction in practice.

One of the problematic issues of research is also the consideration of ways to implement flipped learning strategies. In addition, this involves a review of the role, positions performed by the teacher, the lecturer in the discipline. For this work, a facilitator, trainer, or consultant should encourage students to independent research work, group activities, finding common answers to problematic questions of the course.

2. Aims

The study aims to establish the effectiveness and feasibility of using flipped learning technologies in higher education institutions. The defined goal requires the performance of such research tasks as

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– to establish the expediency of the use of flipped learning technologies and how students assess the benefits and problems of flipped learning;

– to compare the results of tests of control and experimental groups to determine how students' performance has changed at the initial and final stage of the experiment;

– to consider the algorithm of transition to flipped learning in higher education.

3. Methods

The main research method in the study is the method of questionnaires and the method of observation, in order to analyze the success of students used a number of statistical methods to evaluate experimental data.

The experiment involved 44 first-year students of the first (bachelor's) educational level, studying in the 2nd year on the educational and professional programs "English Language and Literature" (Faculty of Foreign Philology) and "Secondary Education (Physics, Informatics)" (Faculty of Physics and Mathematics) of Kamyanets-Podilsky National University (Ukraine). All students were divided into 2 groups. First group was selected as an experimental (EG1) and, during the educational process, actively used the technology of flipped learning.

All students were divided into 2 groups. In the 1st semester, the method of flipped learning was used in the study of disciplines belonging to the elective unit (student's choice) and designed for 2nd-year students with the main areas of modern pedagogy, linguistics, computer science, as well as disciplines that promote active citizenship and the formation of moral principles of socio-pedagogical activities. In the experimental group (EG2), the technology of flipped learning was actively used in the educational process. The choice of this technology is since modern concepts that were not familiar to students in school cause the greatest difficulties and require additional efforts from students. These difficulties also require an individual approach to each individual and updating teamwork skills take a lot of study time in the control group (CG1). The traditional training was carried out using the usual approach in higher education: lecturing, conducting practical and laboratory work, consolidation of what was studied and listened to in classrooms and laboratories.

The experiment included three stages.

At the first stage, active preparation of teaching materials, technical teaching aids were carried out, teachers were consulted and their actions were coordinated, the participants of the experiment were acquainted with the concept of flipped learning, and teaching methods were adjusted. At the beginning of the semester, the students of the experimental group were interviewed about the positive aspects of the technology of flipped learning and possible difficulties. According to the results of the survey, the students' general assessment of the implementation of flipped learning in the educational process was determined: the percentage of students who mentioned some problems they faced, as well as the percentage of students who identified positive and promising moments in the introduction of flipped learning. The calculations were performed according to the following formula:

$$P = \frac{n}{N} * 100\%$$

where

n – number of respondents who mentioned problems (or positive aspects of flipped learning implementation),

N – total number of respondents.

At the second stage (mid-semester) the performance of success in both groups was measured, the results of which presented the first indicators of the feasibility of using flipped learning for students.

At the third stage, the final analysis of the received results is carried out, the data are processed and used so that they can be a basis of the definition of efficiency of the introduced experiment, the answer to problematic questions of research.

At the final stage, methods of observation, survey, analysis of data obtained during the survey, and evaluation by students of the positive and problematic aspects of flipped learning were used.

Students and teachers agreed to participate in the experiment voluntarily, prepared all the materials for the survey, during the experiment followed the principles of privacy of participants, no measures were taken that could affect the honesty and objectivity of the results of the experiment.

4. Literature review

In recent decades, researchers have explored new approaches to learning (Ko, 2013; Kiki-Papadakis, 2016), including the possibility of implementing flipped learning (Mason, 2013; Weimer, 2016), created comprehensive university programs in flipped learning. The degree of students' involvement in the formation of educational strategies was considered separately, ways to increase cognitive activity, how students can learn more, and be well prepared for the difficulties of the future profession were identified (Love, 2014). Leicht et al. (2012) and Weimer (2016) consider flipped learning as a way to increase the interaction between teacher and students, the formation of the student's own research position during self-mastery of the material, a series of lectures. This gives the student more opportunities in the formation of an individual learning trajectory, allows better orientation in the labor market (Hovland, 2019; Ivanova et al., 2020).

Several studies compare active and traditional teaching and control methods (Carr et al., 2015; Clark et al.,

2018). It turned out that both students and teachers prefer active learning strategies, in which the lecture course is transformed, several types of educational equipment are used (flipcharts, PowerPoint presentations), tests with an interactive component are introduced, supplemented by electronic media (Wieman, 2014; Chism et al., 2010).

A separate area of development of flipped learning technology is its use in the process of STEM education (Fung, 2020). The flipped learning facilitates students' practical activities, allows teachers to spend more time on individual guidance and creating mechanisms for effective interaction with each student in the classroom, and promotes close feedback (Jensen et al., 2015; Jones, 1999). Miller-Young & Yeo (2015) described the technology of "turning over – practical discussion", in which previewing the video, reading the training material before the lesson improves the learning process.

Many researches have been devoted to teaching STEM courses using the capabilities of flipped learning technology, as traditional lectures have proved ineffective in the context of integrated subject presentation (Mason, 2006; Cisco, 2020).

Damian et al. (2017), Synorub & Medynska (2019) consider the problems of forming curricula and university educational programs that would take into account innovative learning technologies.

Researchers do not pay attention to the problems of determining the effectiveness of flipped learning with an emphasis on the technological component, the introduction of a comprehensive individual approach to students, developing their skills in the group work.

5. Results

At the beginning of the experiment, the research group divided the students into two groups – a control group and an experimental group (EG2). In both groups, students studied according to the same curriculum, studied the same subjects with the same number of hours. Extracurricular activities were carried out during the experiment. Control measures were also taken to master the study material (after the end of the first half of the semester – 12 weeks) and at the final stage of the experiment.

Stage 1 (preparatory). At the beginning of the experiment, the experimental group surveyed the positive aspects and difficulties of introducing flipped learning technology. At the preparatory stage, based on methodological recommendations developed by the research group, teachers were trained to work with students of the experimental group. The level of methodical (own developments), digital and professional training of teachers is determined. The experience gained during the flipped training is generalized and taken into account while forming the questionnaire.

A general model for the introduction of flipped learning is planned, which provides for viewing a block of pre-recorded video lectures lasting 15-17 minutes each. Theoretical blocks are completed by online surveys, control tasks to check the level of assimilation of educational material by students. Unclear points were immediately recorded and, if necessary, corrected in the classroom. Revision of video lectures is provided. During the training in the classrooms and laboratories, digital technologies, flipcharts, game methods, audio and video support of the studied topics were actively used.

In parallel with the educational process, a survey of students of the experimental group was conducted on the benefits and problems of flipped learning. The answers "yes" are presented in percent (Table 1). The survey was conducted using the Google Forms.

Table 1. Advantages and problems of flipped learning

Advantages of flipped learning	Problems of flipped learning
Students are always prepared before class (60%)	It takes a lot of time to study in extracurricular activities (30%)
Learning materials can be viewed at a pace and sequence convenient for the student (54%)	It is difficult to make quality video content to answer comprehensively all questions on the topic (75%)
It is possible to view additional difficult to understand questions and topics (43%)	It is difficult to adapt flipped learning to the requirements for knowledge and skills that are present in examination and test tasks. (57%)
It is easier for a teacher to control the level of assimilation of material by students (57%)	It is not always objective for a teacher to evaluate the work of an inactive student (43%)
Advanced diagnostic tools are used (27%)	Lack of technical capacity to watch video lectures and all educational content in general (6%)

Students see the biggest problem in creating quality content. This indicates the need to improve the methodological skills of teaching staff in creating educational video content. Students also have doubts about the possibility of adapting the technology of flipped learning to the bureaucratized assessment system in higher education institutions.

At the 2nd stage of the experiment control measures were carried out in both groups of students, the level of their knowledge was determined, the formation of group work skills, work with new technologies and methods of control (introduction of tests, writing creative and research projects). Scores were set in the ECTS grading system.

Table 2. The results of the students' success in the experimental and control groups.

Learning outcomes	EG1	CG1
Minimum score	55	58
GPA	76	75
Maximum score	89	90

In general, the educational achievements of the experimental and control groups are similar, are on the same level, minimal scores represent unsatisfactory grades in both groups.

For teachers participating in the experiment, a questionnaire was created, which helped to determine the algorithm for implementing methodological steps, to name the main mechanisms for implementing the technology of flipped learning, placing them in sequence from the beginning of implementation to its final stage. As a result of the survey, the following algorithm-rating of actions for the introduction of flipped education in higher education was compiled.

Table 3. The sequence of steps to implement flipped learning in higher education institutions.

№	Steps to introduce flipped learning
1.	Availability of fully formed video content (or video lectures) and materials from the discipline; the chance to update it regularly.
2.	Availability of a set of online didactic materials, practical exercises (tests, quizzes, exercises in the form of games, surveys)
3.	Choice of communication system and educational process management (website, telegram channel, blogs, etc.).
4.	Availability of training materials for all group members.
5.	Establishing clear deadlines for mastering the topic, completing tasks.
6.	Regular information and involvement of the management of the educational institution on the implementation of flipped learning

At the second stage, the results of the questionnaire of teachers are also analyzed, the impact of the use of flipped learning on the involvement of teachers in the introduction of new learning technologies is determined; the algorithm of transition to flipped learning in higher education is presented.

At the third (final) stage, control measures were carried out in both groups and the level of success of students of the experimental and control groups was determined.

Table 4. The results of the students' success in the experimental and control groups.

Learning outcomes	EG 2	CG 1
Minimum score	68	62
GPA	86	79
Maximum score	98	92

As we can see, in the experimental group the success rate increased by 12%, while in the control group there was also a slight improvement in performance by an average of 5%.

At the final stage of the experiment, students were asked to write down the advantages and problems that, in their opinion, characterize flipped learning. The survey was conducted using the Google Forms, and the results were calculated as a percentage. Thus, a rating of the advantages and problems that arise during the introduction of flipped education technology was created.

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Table 5. Advantages and problems of flipped learning.

Advantages of flipped learning	Problems of flipped learning
Students are always prepared before class (73%)	It takes a lot of time to study in extracurricular activities (18%)
Learning materials can be viewed at a pace and in a sequence that is convenient for the student (62%)	It is difficult to make quality video content to answer comprehensively all questions on the topic (67%)
It is possible to view additional difficult to perceive positions and topics (46%)	It is difficult to adapt flipped learning to the requirements for knowledge and skills that are in the exam and test tasks (33%)
It is easier for the teacher to control the level of mastering the material (69%)	Not always objectively, the teacher can evaluate the work of an inactive student (24%)
Advanced diagnostic tools are used (45%)	Lack of technical capacity to watch video lectures and all educational content in general (4%)

The problems and difficulties that were during the 1st semester in the attitude of students to the use of flipped education in higher education decreased by a total of 15%. The biggest problem, however, is the creation of quality educational content (video lectures, training, and control materials). In Ukraine, there is a problem of lack of Internet connection in some regions, as well as a small number of students (4%), who did not have the necessary technical means. The number of such students decreased from 6% to 4%. In the future, this problem should be solved by using the possibilities of administrative resources: providing students and teachers with the necessary equipment, looking for ways to transfer educational materials, to improve the communication capabilities of the institution in particular.

6. Discussion

Recently, some interesting results of comprehensive research on the application of flipped learning in the educational process have been published. This is a research project, an experiment (Mastmeyer, 2020), which was conducted with a group of students 25 (persons) who studied in intensive courses. The group with a traditional style of teaching was immersed in a "flipped classroom" using the tools of flipped education. The second group (25 students) remained on traditional teaching methods. Before and after each lecture, an anonymous survey was conducted and assessment tasks were given. Parallel learning of 2 groups: one – according to the traditional scheme and the other – according to the flipped learning. Both learning styles were reviewed and evaluated by students. At the end of the semester, repeated measurements of the success of students in the experimental group were conducted, which showed that the qualitative and quantitative results of students increased by 15%. The researcher determined that the format of flipped learning promotes self-regulation of learning, is effective, and also gives more satisfaction, improves group interaction, guarantees success in mastering the course materials.

In our study, these results were confirmed in the experimental group, the overall success rate increased by 15%, and students positively assessed the introduction of flipped learning technology in the educational process. On average, the level of difficulty in the use of flipped learning has decreased by 20%.

Also popular in modern pedagogy are complex experimental studies. Thus, Fung (2020) considers the use of flipped learning tools in STEM education. Where the main strategy was a combination of STEM-education guidelines and the possibilities of flipped learning technology, where the latter acted as a means of transferring the necessary knowledge and skills that can serve as an intensifier of practical work in the classroom. According to the researcher, the interaction of the educational components of STEM education has been improved by the previous (extracurricular preparation) and strengthens the effect of watching videos in the classroom and their further discussion, laboratory work, and discussion. Our research has shown that despite some difficulties caused by the use of flipped learning, the positive effect prevails. Students approve of the use of a large number of technical means; in general, a high level of technologicalization of education also helps to improve the level of knowledge and skills, as well as makes the learning process more comfortable.

The proposed study has many limitations. First of all, it is sufficient duration of the project (1 semester, i.e. 6 months), limited resources, the lack of opportunity for long in-depth analysis with focus group surveys, in-depth interviews, etc.

7. Conclusion

The strategy of flipped learning is based on its ability to acquire the necessary knowledge and skills through the intensification of cognitive activity, active communication of previously informed and prepared to work with the topic of students. This greatly facilitates the practical work and discussion of the topics being studied.

Flipped learning is one of the effective technologies in modern higher school pedagogy. This is

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also evidenced by the results of the study, in the experimental group of students, success increased by 15%, and a positive perception of flipped learning – by 20%. This confirms the thesis about the expediency of using flipped learning technologies in higher education institutions.

In general, at the end of the experiment, 15% fewer students saw the problem of implementing flipped learning. The biggest problem students called the preparation of quality educational content, especially videos.

The mechanism for introducing flipped learning technology involves such steps as the creation of educational materials (video content, collection of educational data, sources of educational information, games, tests, etc.); choice of the communication channel, training platform; work on the development of modern methods for assessing the knowledge and skills of students; work on further introduction of new educational technologies to traditional European university education, which is the technology of flipped learning.

Despite the preliminary consideration of theoretical issues in the discipline, the problematic questions that arise in the course of independent acquaintance with the educational material can be the basis for subsequent practical classes in the group, in the classroom. Then students are more interested in specific answers to their own questions and will be able to be more focused and prepared. This will potentially work to enhance the effect of flipped learning, promote the quality practice, discussion, collective finding the right answers.

The problem of finding effective ways to further the introduction of flipped learning in the educational practice of higher education remains open. In our opinion, it is especially promising to improve the strategy of the introduction of flipped learning: development of a comprehensive approach to modern educational technologies (STEM-education, STEAM-education, multicultural and postmodern trends in pedagogy).

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