Methodology for using Cloud-oriented Environment for Flipped Learning of the Future IT Specialists

Olena G. Glazunova[1][a], Valentyna I. Korolchuk[1][b], Oleksandra V. Parhomenko[1][c], Tetiana V. Voloshyna[1][d], Natalia V. Morze[2][e] and Eugenia M. Smyrnova-Trybulska[3][f]
[1]*National University of Life and Environmental Sciences of Ukraine, 15 Heroiv Oborony Str., Kyiv, 03041, Ukraine*
[2]*Borys Grinchenko Kyiv University, 18/2 Bulvarno-Kudriavska Str., Kyiv, 04053, Ukraine*
[3]*University of Silesia in Katowice, 53 Grażyńskiego Str., 40-126 Katowice, Poland*

Keywords: Flipped Learning, Cloud-oriented Environment, Future IT Specialists, Collective Projects.

Abstract: The article substantiates the components of a cloud-oriented environment for flipped learning in the process of training future information technology specialists in higher education institutions. The methodology for using services and resources of the cloud-oriented environment of the university, including mass open online courses, educational portal of the university, professional-oriented software and services for project management for flipped learning in the process of training future professionals is presented in three stages: preparatory, basic and integrated. In these stages, the necessary professional and personal skills were formed during the project tasks performing using the appropriate cloud resources and services of the university environment. At the preparatory stage, students worked on collective projects within one discipline using the cloud service Microsoft Teams in order to form and develop general competencies. At the basic stage, students were offered to perform tasks of mini-projects, group and individual projects during studying professionally-oriented disciplines using the GitHub cloud service. The integrated stage was implemented during work on interdisciplinary projects, the tasks for which were formed on the basis of the study of several disciplines using the Jira service. This paper investigates the effectiveness of the application of the developed methodology for flipped learning using the components of the university's cloud-oriented environment.

1 INTRODUCTION

Sustainable development depends on innovation and the introduction of ICT in various sectors of the economy and livelihoods (Lobanova et al., 2020). That is why providing inclusive and equitable quality education, promoting lifelong learning for all, is one of the global goals of sustainable development. The issue of training quality IT professionals is especially relevant in the context of achieving sustainable development goals, as modern innovation is based on the widespread use of IT. Higher education institutions are constantly confronted with the educational and technological challenges involved in preparing future IT specialists. Teachers are faced with the task of finding new approaches to solving the problem of improving the quality of the educational process, developing students' professional and personal skills. Moreover, employers' expectations of professional qualification requirements must be met. In addition to professional competencies, teamwork, problem-solving and communication skills, so-called soft skills, should be addressed in the future IT specialists (Semerikov et al., 2020; Varava et al., 2021).

We are looking at flipped learning as a way of creating a learning ecosystem, we realise how effective it is. Flipped classrooms connect people and provide them with a variety of content and technology. This increases the engagement of the learners as there is activity-based, practical learning in classroom time. Flipped learning also boosts healthy interaction between members, in a mutually beneficial manner, which is the essential function of an ecosystem. Blended learning (Bondarenko et al., 2018; Polhun et al., 2021; Kucher et al., 2022; Bukreiev

[a] https://orcid.org/0000-0002-0136-4936
[b] https://orcid.org/0000-0002-3145-8802
[c] https://orcid.org/0000-0002-0136-4936
[d] https://orcid.org/0000-0001-6020-5233
[e] https://orcid.org/0000-0002-0136-4936
[f] https://orcid.org/0000-0003-1227-014X

Glazunova, O., Korolchuk, V., Parhomenko, O., Voloshyna, T., Morze, N. and Smyrnova-Trybulska, E.
Methodology for using Cloud-oriented Environment for Flipped Learning of the Future IT Specialists.
DOI: 10.5220/0010925100003364
In *Proceedings of the 1st Symposium on Advances in Educational Technology (AET 2020) - Volume 1*, pages 445-460
ISBN: 978-989-758-558-6

et al., 2022), interaction between members and informal learning are other characteristics of a flipped classroom that take you closer to developing a learning ecosystem.

Case studies are emerging, in ever greater numbers, which document measurable improvements in student and teacher motivation, increased attendance in class, and better grades, as a result of using the flipped approach (Hamdan et al., 2013; Bishop and Verleger, 2013; Davies et al., 2013).

Innovative approaches in higher education are shifting away from teacher centered instruction to student-centered learning (Béres and Kis, 2018).

The purpose of this article is to substantiate the components of the cloud-oriented environment and methods of its use for flipped learning in the process of training future specialists in information technology, and to study the effectiveness of the developed methodology for project learning.

2 THEORETICAL BACKGROUND

The number of alternative teaching methods being explored in Computer Science (CS) education is increasing in an attempt to address both pedagogical and financial challenges, such as creating active learning experiences with increasing financial pressures (Kaner and Fiedler, 2005; Semerikov et al., 2021).

There are two common characteristics which encapsulate a flipped classroom:

1) an easily adaptable learning environment that facilitates active learning and allows students to develop different skills and competencies (DeLozier and Rhodes, 2017; Smyrnova-Trybulska et al., 2017; McLaughlin et al., 2013; Little, 2015);
2) a student-centred learning culture (Bishop and Verleger, 2013; de Bruin et al., 2014).

According to the Flipped Learning Network the flipped classroom approach has four pillars (Flipped Learning Network (FLN), 2014). In order for teachers to achieve this approach, they have to take these four elements into consideration:

- Flipped learning requires flexible environments
- Flipped learning requires a shift in learning culture
- Flipped learning requires intentional content
- Flipped learning requires professional educators.

The concept of flipped learning is to provide to student's lectures in a video format and other supportive materials to review as their homework, get the maximum of it, and then, use the next class time for in-class activities and problem-solving exercises. The flipped classroom serves as a platform to achieve a collaborative and organic learning environment. To meet the challenges and complexities of the 21st century workplace environment, there has been a shift and adoption of an organic learning environment in the business community. Similarly, universities and accreditation bodies in business schools are moving towards developing competency-based curricula where learners foster lifelong learning skills through a process of self-directed learning (Rajaram, 2019).

Maher et al. (Maher et al., 2015) presented experiences in developing flipped courses: the temporal structure, alternative sources for video instruction and strategies for active learning. Video instruction precedes skills development and concept learning, in-class lab activities scaffold for open ended homework projects and promote peer learning, and in-class quizzes lead to discovery of misconceptions.

The article (Silva et al., 2018) is aimed at analyzing the effects of learning analytics on engineering students' self-regulated learning in a flipped classroom. Results demonstrate that learning analytics can be used to promote self-regulated learning in flipped classrooms, helping students identify strategies that can increase their academic performance. Flipped learning approaches have students use technology to access the lecture and other instructional resources outside the classroom in order to engage them in active learning during in-class time (Nam and Giang, 2017).

Scenarios and collaboration tools for students' practical activity, provides examples of learning objects representing resources for independent study and research, and criteria for assessing the effectiveness of the proposed model of flipped learning are described by Smyrnova-Trybulska et al. (Smyrnova-Trybulska et al., 2017).

The active learning techniques integrate the student centered learning methods such as cooperative learning, problem-based learning, project based learning and peer assisted learning. These learning approaches mean that students work in groups in order to develop and reach their learning goals (Béres and Kis, 2018).

One of the aims of the flipped learning technology is the transition of the educational process organization from passive student learning to the active one, in which future specialists participate in collaborative work, carry out team projects, discuss and solve practical problems in the classroom, applying the theoretical knowledge they have acquired prior to the classroom lessons. By providing students with basic theoretical knowledge prior to the class, the teacher becomes a facilitator, thus enabling students to deepen their knowledge and practical skills during the class and independently manage their own educational process.

The scheme of the educational process organization under the flipped learning technology of future specialists in information technologies is presented in figure 1.

Prior to the classes, students need to acquire basic theoretical knowledge in each academic subject using the resources of the e-learning course (ELC), further deepen the acquired knowledge independently by studying the various MOOCs recommended by teachers. During the classes, students plan joint activities, work on the project as a team, performing practice-based tasks. In the classroom, students consult the teacher on the problematic issues. After classes, the student teams performed tasks assigned to each participant within the project and addressed controversial issues if they arouse among the team members regarding the project tasks.

The use of modern information technologies further enriches the flipped learning process and foster the skills needed by future IT specialists. At the World Economic Forum in 2019, it was determined that it is important to pay attention to the ways and forms of the educational process organization, out of which they single out the study of information technologies with an emphasis on teamwork and creativity, learning through games that develop critical thinking, support of students' initiative outside the educational programs.

A cloud-based environment for organizing the learning process through the technology of flipped learning should provide e-support for the activities of students and teachers at the stages "before class", "in class", "after class". The essence of the notion and the possibility of using a learning environment are considered in (Bondarenko et al., 2020; Kolgatin et al., 2022; Korotun et al., 2020; Lavrentieva et al., 2021; Merzlykin et al., 2017; Nosenko et al., 2016; Pererva et al., 2020; Saad and Rana, 2014; Salam and Sardar, 2015; Shyshkina, 2016, 2018; Shyshkina and Popel, 2013; Vlasenko et al., 2020; Zelinska et al., 2018).

Cloud environment for the study of the "Computer Networks" academic discipline are described in article (Spirin et al., 2019), which was deployed at the Faculty of Physics and Mathematics of Ternopil Volodymyr Hnatyuk National Pedagogical University and investigate the effectiveness of blended learning in such an environment.

Supported by the information and communication technologies, teachers have many options for improving the effectiveness of teaching, in particular the organization of teamwork projects in the process of training future IT specialists.

The cloud-oriented environment was designed at the National University of Life and Environmental Sciences (NULES) of Ukraine for training the future IT specialists under the flipped learning technology (figure 2). Selection criteria for cloud services and resources that will be appropriate in the process of training future IT professionals are analysed in (Korolchuk, 2019). The university's cloud-oriented environment provides students, who major in IT with a variety of types of resources and services that make it possible to use:

- prior to classes within the framework of independent work with e-resources: e-learning courses (ELC) in accordance with the curriculum for training specialists using the Moodle LMS; Khan Academy; online courses from Microsoft and Cisco leading technology companies, respectively, Microsoft Imagine Academy, Cisco Networking Academy; Massive Open Online courses (MOOC), such as Coursera, Udemy, Prometheus, edX, Khan Academy and others;
- in the classroom: professionally-oriented software and cloud services, namely: Microsoft Office 365; Visual Studio; draw.io; services for collective IT development (GitHub, Bitbucked, DeployBot, Phabricator, BeanStalk); Miro;
- for the cooperation outside the university, services to manage collective projects such as: Microsoft Teams, Jira, Trello, Asana, YouTrack.

The design of a cloud-oriented environment for the implementation of projects enables teachers to choose the means available to complete the project's tasks, integrate the necessary services and resources into the created environment, and provide communication between the educators, who teach the project disciplines and the teams of students; students have the opportunity to effectively plan project implementation steps, distribute tasks among team members and monitor their implementation, organize teamwork to create the end product of the project.

To understand the attitude of students to the cloud-oriented environment of the university, we have defined 3 criteria for evaluating them from the standpoint of functionality of the cloud-oriented environment:

1) to perform professional tasks;
2) to implement the flipped learning technology;
3) to manage project implementation.

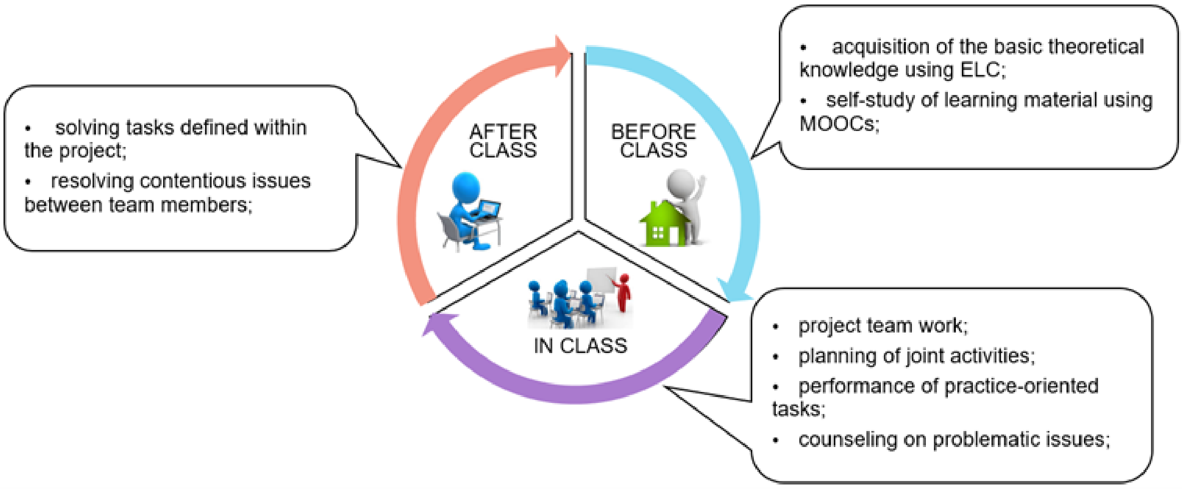

Figure 1: The scheme of the educational process organization under the flipped learning technology.

Indicators under the first criterion include: accessibility (ability to work from any device); reliability (high-quality functioning of the cloud-oriented environment); flexibility (designed and used in line with learning objectives); expediency (need for use to solve problems); convenience (clarity and ease of use); support for processes (communication, collaboration, cooperation, planning and control); teamwork (the ability to organize teamwork, create team projects); integrity (ensuring a continuous educational process); integration with other cloud services; support of various programming technologies; the ability to access open code software.

Indicators under the second criterion are the following: availability of training resources in a cloud-oriented environment; completeness of educational material for students to acquire theoretical knowledge independently; completeness of training material necessary for practical tasks; convenience for independent preparation for the class; convenience of interaction of team members in practical activity; convenience for self-control; convenience for checking the level of acquired knowledge.

Indicators under the third criterion are the following: ease of team work organization; convenience in planning the work on a collaborative project; ease of roles and areas of responsibility allocation for each team member; the convenience of controlling the timing of each task; convenience of communication among the team members; ease of interaction of team members during team development; ease of checking completed tasks; ease of managing software versions.

In the article (Glazunova et al., 2020) the efficiency of the cloud-oriented environment is determined by the three above-mentioned categories and evaluation indicators by interviewing students, before and at the end of the collective project on the technology of flipped learning using cloud-oriented environment.

In evaluating the performance of a cloud-oriented environment, students identified the following most important indicators: support for the process, support of various programming technologies, integration with other cloud services, and accessibility. The concordance coefficient was 0.693, which indicates the average degree of agreement of experts' opinions. Evaluation of the results for determining the performance of a cloud-oriented environment in table 1. The weights of the considered parameters were calculated on the basis of the sums obtained.

When evaluating the performance of a cloud-oriented environment, the teaching staff found out that flexibility, support for the process, teamwork, and integration with other cloud services were the most important indicators. The concordance coefficient was 0.742, which indicates a high level of agreement of experts' opinions. Evaluation of the results of determining the effectiveness of the cloud-oriented environment for the project activity in table 2.

When evaluating the effectiveness of a cloud-oriented environment for the project activity, teachers singled out the following indicators as the most important ones: convenience of organizing teamwork, the ease of interaction of team members in team development, and the ease of planning for a team project. According to the students, the most important indicators are the ease of teamwork organization, the ease of interaction of team members during team development and the ease of managing software (program code) versions. Evaluation of the results of de-

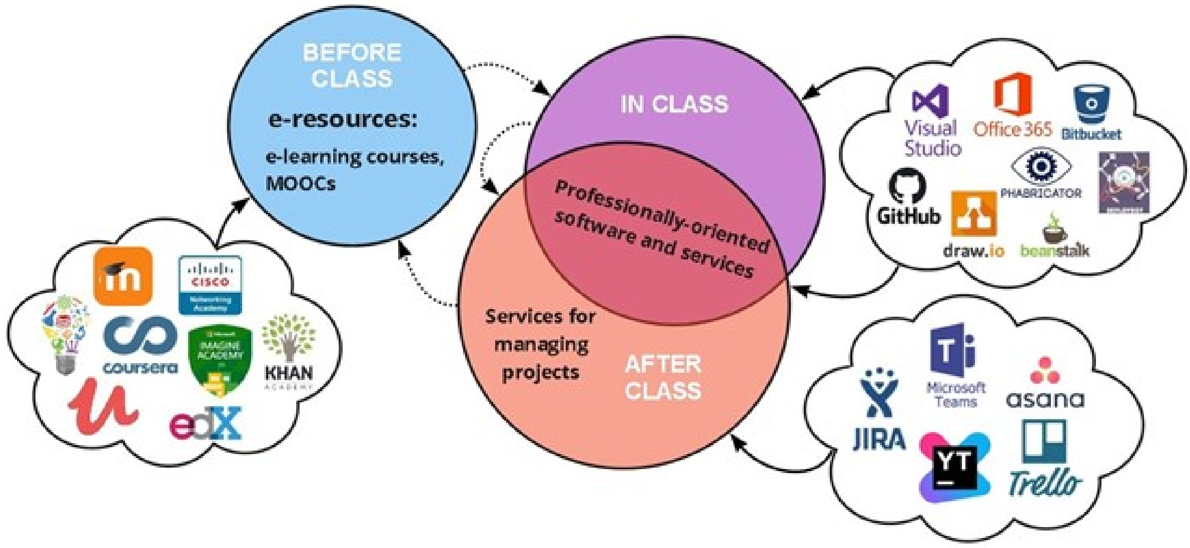

Figure 2: Components of the cloud-oriented environment for flipped learning.

termining the effectiveness of a cloud-oriented environment for flipped learning in table 3.

Evaluating the effectiveness of the cloud-oriented environment for flipped learning, the teachers noted that the convenience of checking the level of acquired knowledge, completeness of educational material for students' independent mastering of theoretical knowledge and completeness of educational material needed to perform practical tasks were the most important indicators.

3 METHOD

The designed cloud-oriented environment of the university is the main component of the flipped learning system for the training of future IT professionals. According to students' opinion, this environment should meet the following requirements: process support (communication, collaboration, cooperation, planning and control), ease of distribution of roles and areas of responsibility of each team member. At the same time, teachers with more weight, compare to students, identified the following indicators of the effectiveness of this environment: the convenience of checking the level of acquired knowledge, flexibility (designed and used according to learning objectives), ease of teamwork, completeness of educational materials for practical tasks. Thus, we used the appropriate environment taking into account the relevant requirements for the development and justification of the methodology, which consists of three stages: basic, preparatory and integrated. During these stages, the necessary professional and personal skills were formed during the performance of project tasks using cloud resources and services of the university environment.

The purpose of the first (preparatory) stage of the methodology for using cloud-based environment for flipped learning of future specialists in information technology is the formation of teamwork skills, communicative and management skills during the performance of collective projects within one discipline with the use of services for project management. The preparatory stage is important for the formation of different students' competences, not only professional competencies in the development of IT projects. The need for independent performance of a part of the project and collaboration contributes to the formation of soft skills, in particular, communication and leadership.

In the preparatory phase, the Microsoft Teams cloud service was used to perform tasks and organize team work, as this service allows you to create an environment for teamwork, set tasks for team members, plan collaboration and integrate additional tools needed to complete project tasks.

In the curriculum for training IT specialists at the first stage, which is the beginning of the methodology, it is necessary to form soft skills that are needed for successful project implementation: teamwork skills, communication and management skills. For this purpose, the discipline "Information Technology" was chosen, during which the project to perform was proposed within the educational practice. During each of the stages of project work within the discipline, stu-

Table 1: Evaluation of the results for determining the performance of a cloud-oriented environment.

Indicators	**Teaching staff Weight**	**Students Weight**
accessibility (ability to work from any device)	0.02	0.11
reliability (high-quality functioning of the cloud-oriented environment)	0.08	0.04
flexibility (designed and used in line with learning objectives)	0.18	0.07
expediency (need for use to solve problems)	0.08	0.03
convenience (clarity and ease of use)	0.08	0.06
support for processes (communication, collaboration, cooperation, planning and control)	0.15	0.17
teamwork (the ability to organize teamwork, create team projects)	0.12	0.09
integrity (ensuring a continuous educational process)	0.11	0.02
integration with other cloud services	0.12	0.13
support of various programming technologies	0.05	0.16
the ability to access open code software	0.01	0.10
Total	1	1
Concordance coefficient	0.742	0.693
Calculated χ^2	59.36	235.62
Table χ^2 (k=10, α = 0.05)	18.309	18.309

Table 2: Evaluation of the results for determining the performance of a cloud-oriented environment.

Indicators	**Teaching staff Weight**	**Students Weight**
ease of teamwork organization	0.24	0.23
convenience in planning the work on a collaborative project	0.19	0.12
ease of roles and areas of responsibility allocation for each team member	0.06	0.03
convenience of controlling the timing of each task	0.04	0.09
convenience of communication among the team members	0.01	0.12
ease of interaction of team members during team development	0.22	0.21
ease of checking completed tasks	0.14	0.02
ease of managing software (program code) versions	0.06	0.18
Total	1	1
Concordance coefficient	0.918	0.813
Calculated χ^2	51.48	193.49
Table χ^2 (k=7, α = 0.05)	14.068	14.068

dents develop the ability to organize joint activities and form a capable team, the ability to form a communication system in a team, using appropriate cloud services, the ability to take control of the situation, the ability to unite a group and build an effective team interaction to solve certain tasks, etc.

Since the educational practice (technological, project-technological) is carried out after the completion of theoretical training, it is important to form tasks for educational practice on the basis of practice-oriented approach. Thus, educational practice is the stage of students' educational activity, during which the acquired skills in certain disciplines are applied. Educational practice in the university is an important tool for professional self-determination and future professional development.

During the educational practice, special attention is paid to modern methods, forms, tools, instruments and services in the field of their future profession in accordance with the educational degree; formation of knowledge, professional skills and abilities for independent decision-making while working in real market-oriented and production-oriented conditions, education of the need to systematically update their knowledge and creatively apply it in practice. At this stage, the focus should be on the application of problem-based, project-based and practice-oriented methods in student learning. Along with the listed methods, the flipped learning method should be used, as in educational practices students study theoretical

Table 3: Evaluation of the results for determining the performance of a cloud-oriented environment.

Indicators	**Teaching staff Weight**	**Students Weight**
availability of training resources in a cloud-oriented environment	0.11	0.19
completeness of educational material for students to acquire theoretical knowledge independently	0.23	0.04
completeness of training material necessary for practical tasks	0.17	0.25
convenience for independent preparation for the class	0.06	0.13
convenience of interaction of team members in practical activity	0.14	0.10
possibility of self-control	0.02	0.24
convenience for checking	0.27	0.04
Total	1	1
Concordance coefficient	0.728	0.748
Calculated χ^2	34.944	152.592
Table χ^2 (k=6, α = 0.05)	12.593	12.593

material independently outside the classroom, and directly during the classroom practice time they perform practice-oriented tasks. The procedure for using the cloud service MS Teams for flipped learning is shown in the figure 3.

Thus, organizing the collective project using the cloud service MS Teams, students develop professional competencies and soft skills in all components, namely the formation of teamwork skills, communication and management skills during the performing of collective projects by future IT professionals using flipped learning method.

At the basic stage, the GitHub cloud service was used, as this service allows students to use the built-in code editor, work collaboratively on program code, manage code versions and discuss it with other team members. This meets the criteria for the effectiveness of a cloud-based environment, namely: the ability to access open source software, the convenience of managing software versions and the convenience of team members‘ collaboration in practice performance.

The purpose of the second stage is the development of future IT professionals’ professional competencies and personal effectiveness as a result of participation in mini-projects, group and individual project tasks, course projects within professional disciplines using services for collective IT development. During the second stage, the proposed method offers collective mono-projects during the study of professional disciplines or course work within such disciplines, which will ensure the formation of future IT professionals‘ professional competencies and soft skills using services for collective IT development for flipped learning, namely: the ability to define the goal and achieve the goal, the ability to properly prioritize tasks within a limited time, to rationally estimate their own time and skills in developing an IT project, etc. At this stage, disciplines for the effective formation of these skills are identified. Such disciplines include “Object-Oriented Programming”, “Software Development Technologies”, “Cross-Platform Programming”, etc.

According to the defined content of such projects, it is necessary to choose forms and methods of teaching that will allow students to form the necessary skills and abilities at this stage. Along with the project method, to study the theoretical material and perform the tasks the method of blended learning should be use, in which part of the material students will learn online, partly independently managing their time and pace of learning and completing tasks. For the organization of projects in combination with the method of flipped learning, it is advisable to use ELC in combination with cloud services for the development of IT projects. Figure 4 shows the procedure for using the GitHub cloud service for flipped learning during the implementation of a mono-project within professionally-oriented disciplines.

Within this process, students develop professional competencies as a result of performing tasks in professionally-oriented disciplines, as well as soft skills, such as: the ability to set goals and achieve goals, the ability to properly prioritize tasks within a limited time, rationally calculate their own time, etc.

At the integrated stage, project management services such as Jira, Trello, Asana were used, as these services allow students to plan collaborative work during performing of interdisciplinary project. At this stage, IT students develop professional competencies, strategic management, personal effectiveness and information management, IT project management skills in the process of participating in interdisciplinary projects using services for project management and collective IT development. Another type of

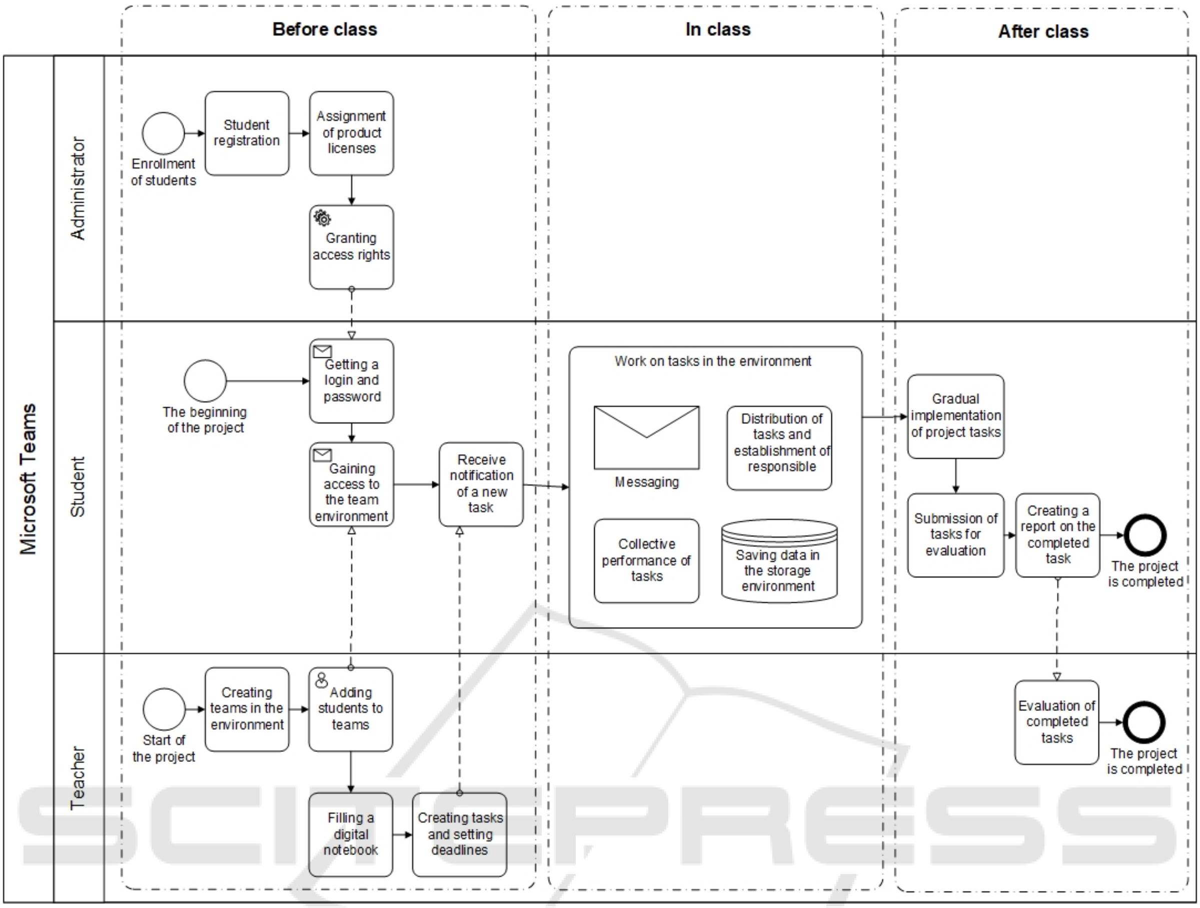

Figure 3: Procedure for using the MS Teams cloud service for flipped learning.

projects that are recommended for implementation at the 3rd stage of the methodology are interdisciplinary projects. At this stage, the content of an interdisciplinary project in three disciplines: “Systems Analysis”, “Web Technology and Web Design”, “Economics and Business” was determined for the formation of personal effectiveness skills, strategic and information management skills, as well as IT project development and project management skills.

According to the content of the interdisciplinary project defined by the teachers, it is necessary to choose methods and forms of teaching, both traditional and cloud-oriented. Traditional forms and methods of teaching should be used in the study of theoretical material and practical work in the disciplines involved in the project. In particular, the method of flipped learning should be used to develop theoretical material using the resources of the ELC during independent work. During the classroom work it is necessary to organize the work of students in groups on the implementation of practice-oriented tasks that are part of the project. Cloud-oriented teaching methods should be used for communication, joint work on project tasks in a cloud-oriented environment. Thus, it is necessary to combine the project method and the method of flipped learning, when students will study theoretical material and perform practical work independently, and in the classroom will work on solving project problems. The procedure for using the cloud service for inverted learning during the implementation of an interdisciplinary project is developed on the example of the Jira service, which is shown in figure 5.

The use of this process allows forming in future information technology professionals professional competencies in the professional disciplines involved in the project and soft skills, namely: strategic management skills, personal effectiveness, information management and IT project management skills.

The students were offered to implement the cross-disciplinary project on the topic of “Web-oriented system for the IT industry”, with the purpose of carrying out systematic analysis, developing a web-oriented system and evaluating the investment attrac-

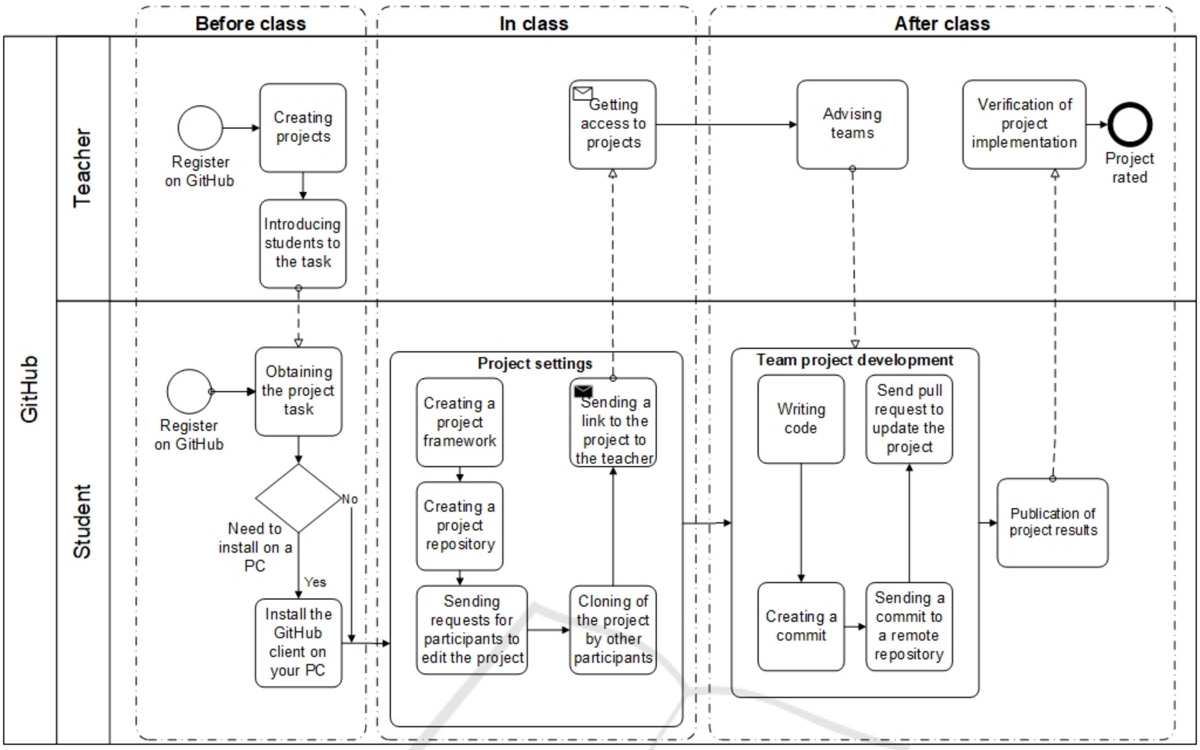

Figure 4: Procedure for using the GitHub cloud service for flipped learning.

tiveness of the developed system. The content of the project was to develop a project for starting their own IT-business, namely: conducting an analysis of the IT services market; carrying out structural, functional and object-oriented analysis of the domain; designing the database and system functionality; developing a web-based system for the IT company; creating a business plan for the company and accordingly calculating the payback of the project as well as strategizing the company's development.

We distinguish the following 8 stages of such a collaborative project implementation under the flipped learning technology: setting a task and processing theoretical material (1); structuring the task and subdividing it into specific tasks (2); role distribution, definition of terms and responsibilities (3); performance of basic tasks (4); joint work of the task team (5); assessment of the quality of the task (6); drawing up a report on the work performed (7); presentation of results (8).

The teamwork was subdivided into 3 parts, according to the tasks of each academic discipline that were part of the cross-disciplinary project. In the course of completing the tasks in the "System Analysis" academic discipline, the students had to conduct an analysis of the IT services market, to choose the profile of the future company, to develop the functionality of the future business, to carry out structural-and-functional and object-oriented analysis, to design information support and to describe the specification of management processes. In the course of "Web Design and Web Technologies" academic disciplines, the students developed the website of the future company and integrated it into the information management system of the company. The tasks in the "Economics and Business" academic discipline required students to analyze the necessary tools to start their own business, to develop a business plan for the future company, to formulate a strategy for its further development, to calculate the basic income and expenditure, as well as to evaluate its economic efficiency and investment attractiveness.

Prior to the commencement of training (before class): instructions were developed for each task of the project beforehand, and necessary training materials were placed in electronic training courses (ELCs) for each academic discipline. The teaching materials at ELCs were designed according to the students' learning styles. Often the same material was offered in different formats according to the research provided in (Morze and Glazunova, 2014). Thus, the students studied basic theoretical materials in the ELC of the corresponding academic disciplines, got acquainted with the project objectives, registered and

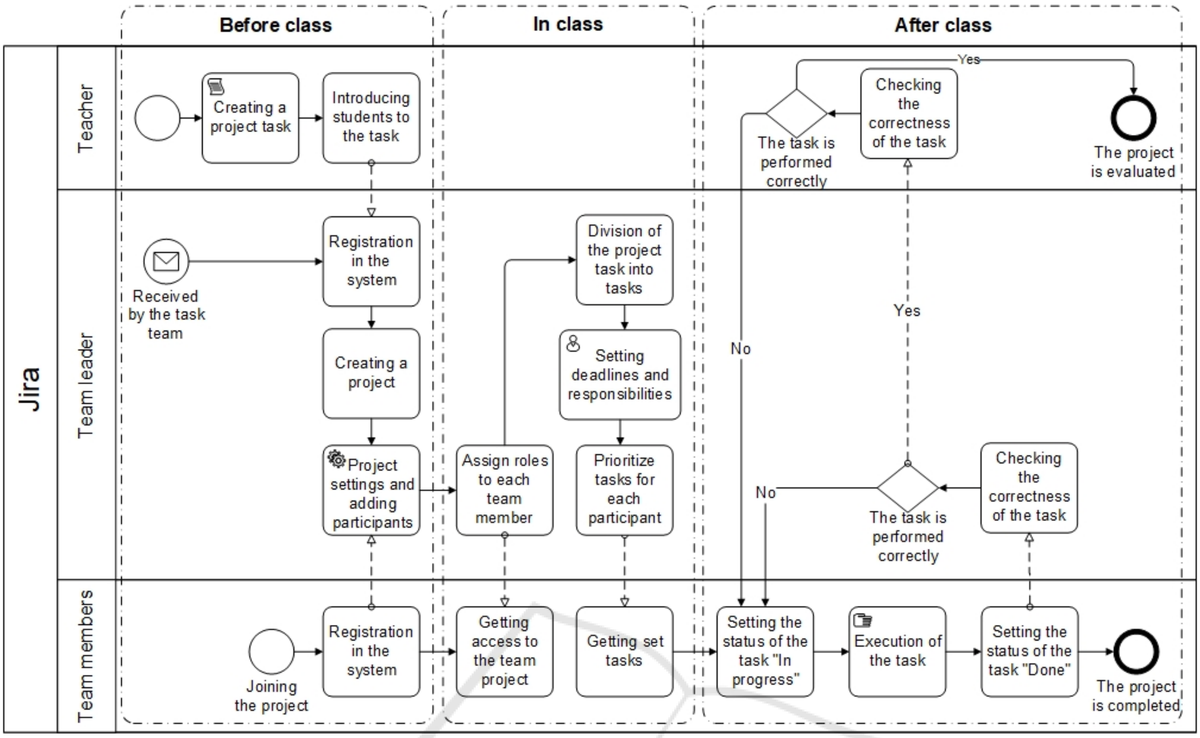

Figure 5: Procedure for using the Jira cloud service for flipped learning.

selected MOOCs for the independent study of the required material in accordance with their learning style. An in-depth study of the theoretical material, required for students to complete the assignments, took place in lectures alternately in each academic discipline as per schedule. The students studied the selected professionally oriented software and project management services offered by the teachers for each stage of the cross-disciplinary project.

In class: all the students were required to participate weekly in interactive lectures and laboratory work. During such classes, students were asked to develop a project based on the tasks of three identified academic disciplines of the cross-disciplinary project. The first session involved getting acquainted with the subject and tasks of the project in detail in each academic discipline. The students were divided into teams of 4 people, then within the team they were assigned roles and areas of responsibility of each team member; further the team members defined the terms of implementation and appointed those responsible for each project task. The task of the students was to understand the problem, to evaluate the complexity of the works, to find options for their solution, to divide the received tasks into separate tasks, to apply the theoretical and practical knowledge acquired before the beginning of classes to solve the project's tasks. In class the students were advised by the teacher on the progress of the course; they acquired basic skills in performing specific tasks via professionally oriented software and services of the university cloud-oriented environment.

After class: team members jointly performed project tasks in each academic discipline, collaborated using project management and IT-team services. In the course of the project, the students evaluated the tasks completed personally as well as those completed by other team members. If necessary, they refined the tasks to the appropriate professional level, created reports in the form of a presentation, which reflected the results of the team at all stages of the project. In the end, each team presented the results of their project, and teachers and participants of other teams evaluated the readiness for the implementation.

Figure 6 shows a diagram of one of the cycles of fulfilling the tasks of a cross-disciplinary project under the flipped learning technology using the cloud-oriented university environment.

Table 4-6 defines in more detail the types of activities in the process of the implementation of each stage of the project, during which the students develop professional, integrated, self-educational competences and soft skills, for each of the above stages of the cross-disciplinary project using a cloud-oriented environment.

Thus, the implementation of such cross-

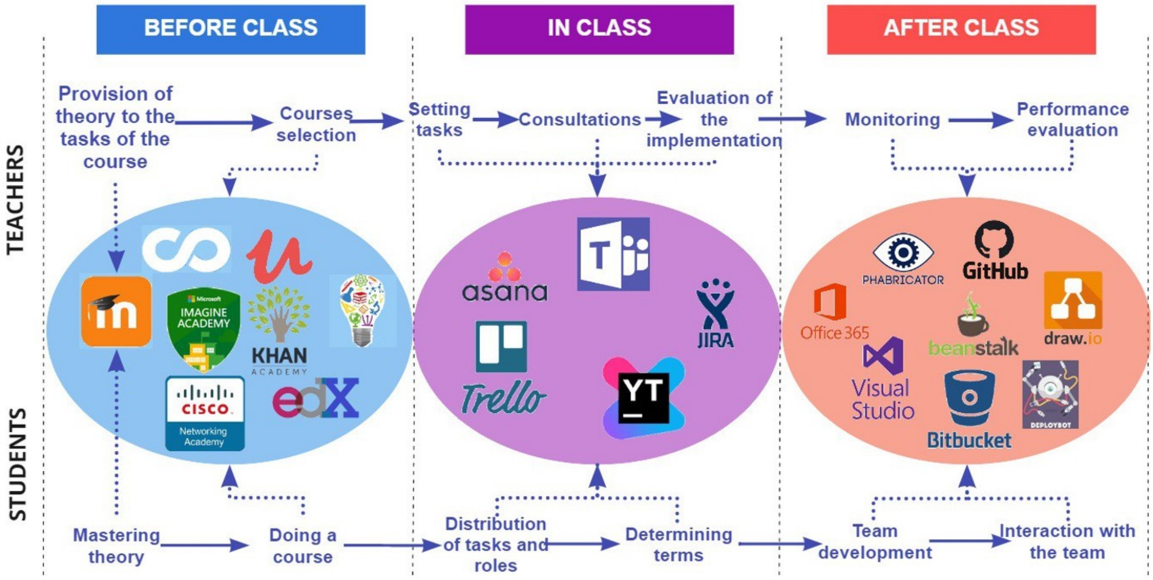

Figure 6: The diagram of one cycle of the cross-disciplinary project under the flipped learning technology using the cloud-oriented university environment.

Table 4: Organization of the cross-disciplinary project under the flipped learning technology using the cloud-oriented environment before class.

Contents of the stage	Activity	Tools	Competence
Setting tasks and mastering of the theoretical material	getting acquainted with the aim and tasks of the project; studying the theoretical material in ELC; registration and selection of MOOC; doing online courses	LMS Moodle; Cisco Academy; Prometheus; Coursera; Microsoft Imagine Academy; Udemy; Khan Academy	self-educational; professional; ability to search, process and analyze information from various sources

disciplinary project tasks involved activities at certain stages, which resulted in the development of professional, integrated, self-educational competences, as well as communication, interpersonal, leadership, teamwork and time management skills, the so-called “soft skills”.

4 RESULTS

The timeframe of the study is 3 years. The pedagogical experiment involved students of the 3rd year of Computer Science and Computer Engineering specialty at the Faculty of Information Technologies of NULES of Ukraine.

Students were divided into two groups: experimental group $N = 115$ (students majoring in Computer Science and control group $N = 109$ (students majoring in Computer Engineering). The control group of students did not have access to the resources and services of the cloud-oriented environment and studied the technology of flipped learning, performing project tasks in accordance with the stages. Students of the experimental group studied according to the methodology of using the components of the cloud-oriented environment for inverted learning in three stages: preparatory, basic and integrated. Levels of student success were assessed at the end of each project according to the proposed methodology. To test the effectiveness of such an environment for inverted learning, a null hypothesis was put forward that the average learning score in the control and experimental groups did not differ. The rejection of this hypothesis will allow us to argue that the use of such a cloud-oriented environment for flipped learning of future IT specialists will increase student academic performance. Student’s t-test was used to test the proposed statistical hypothesis. When applying this criterion for independent samples, two conditions must be met: exceeding the required minimum sample size and equality of variances. To determine the sufficiency of the sample size for the t-criterion with a significance level of 0.05, a power of 80% and a standard

Table 5: Organization of the cross-disciplinary project under the flipped learning technology using the cloud-oriented environment in class.

Contents of the stage	**Activity**	**Tools**	**Competence**
Structuring the material and dividing it into specific tasks	evaluation of the task complexity; search for solutions to the problem; division of the task into separate tasks	Microsoft Teams; Jira; Trello; Asana; YouTrack	ability to work in a team; knowledge and understanding of the subject area; ability to make decisions
Allocating roles, appointing people in charge, setting the date	allocation of roles and areas of responsibility of each team member; appointment of those responsible for each task	Microsoft Teams; Jira; Trello; Asana; YouTrack	ability to work in a team; ability to make decisions
Performing basic tasks	solving practical tasks according to the aim of the task performance consultation with the teacher on problematic issues	GitHub; Bitbucked; DeployBot; Phabricator; BeanStalk; professionally-oriented software and services	professional; integral; the ability to apply knowledge in practical situations

mean effect, an analysis of the value of the selection was conducted, which is presented in figure 7.

```
pwr.t.test(d=0.5, sig.level=0.05, power=0.80)

##      Two-sample t test power calculation
##               n = 63.76561
##               d = 0.5
##       sig.level = 0.05
##           power = 0.8
##     alternative = two.sided
```

Figure 7: Estimation of the sample size.

Estimation shows that at least 64 people are required to apply this method in each of the two samples of students (control and experimental).

To verify the second condition, a test for the equality of variances was performed, which is presented in figure 8.

```
var.test(rating~group,data=Data)

## F test to compare two variances
## data:  rating by group
## F = 1.132, num df = 344, denom df = 326, p-value = 0.258
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.9130388 1.4024852
## sample estimates:
## ratio of variances
##          1.131957
```

Figure 8: Test for equality of variances.

The calculations showed that the probability of obtaining an error of the first kind is 25.8% with a permissible 5%, to reject the null hypothesis. Therefore, the variances are statistically equal, which allows to estimate the averages by the t-test.

The estimation of the t-test for the general averages in the two groups is presented in figure 9.

Descriptive characteristics of samples on grades (academic performances) are shown in table 7.

```
t.test(rating~group,data=Data, var.equal = TRUE)
##  Two Sample t-test
## data:  rating by group
## t = 7.7655, df = 670, p-value = 3.054e-14
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  4.804434 8.056249
## sample estimates:
## mean in group Experimental  mean in group Control
##                  79.90435               73.47401
```

Figure 9: Estimation of the general averages in control and experimental groups on Student's t-test.

Comparing the groups' total average, we see a difference of 6.4 points on the overall score. The biggest difference was at the 3rd stage – 8.

Analyzing, we see the difference in the medians, as well as the distribution of scores – the experimental group shows the better results for both the general result and results by stages (figure 10).

According to the results, the Student t-test calculated according to experimental data exceeds the critical value of – $7.77 > 1.967$ for a given level of significance (0.05), which is necessary for reject the null hypothesis of equality of the two means. Therefore, we can conclude that the difference between the average grades between the control and experimental groups (6.4 points) is statistically significant. In this case, with a probability of 95%, this difference will be from 4.8 to 8.1 points. Accordingly, based on the results of analysis of variance, we can say that the method of using a cloud-based environment for inverted learning of IT students affects their academic achievements.

5 CONCLUSIONS

In the study which lasted for 3 years a cloud-based environment was used to implement flipped learning

Table 6: Organization of the cross-disciplinary project under the flipped learning technology using the cloud-oriented environment after class.

Contents of the stage	Activity	Tools	Competence
Tem work on task completion	step-by-step implementation of project tasks in each academic discipline (domain analysis, site development, project cost-performance calculation)	GitHub; Bitbucked; DeployBot; Phabricator; BeanStalk; professionally-oriented software and services	professional; integral; the ability to apply knowledge in practical situations
Evaluation of the quality of the task performed	evaluation of independently completed tasks; evaluation of tasks performed by other team members; refinement of tasks	GitHub; Bitbucked; DeployBot; Phabricator; BeanStalk; professionally-oriented software and services	ability to be critical and self-critical; the ability to evaluate and ensure the quality of work performed
Report generating on the work performed	generating a team work report on the project	Power Point Online; Sway	the ability to visualize, formulate, solve problematic situations, making the right decisions, taking into account available information
Presentation of results	report placement; evaluation	Miro	the ability to present the project to investors or your own team

Table 7: Descriptive characteristics of samples on grades.

Stage	Group		Total average	Difference
	Experimental	Control		
Stage 1	81.3	74.6	78.1	6.7
Stage 2	78.2	73.6	76	4.6
Stage 3	80.2	72.2	76.3	8
Total average	79.9	73.5	76.8	6.4

projects in the education process of future IT specialists. The developed methodology is based on the use of services for project management and collective IT development during three activity stages: preparatory, basic and integral.

One of the most important results obtained during the study was the identification of performance indicators for the developed cloud-based environment model, which cover the functionality of the environment by 3 criteria, namely: for the professional activity, for the implementation of the flipped learning technology and for the project management. The cloud-oriented environment of the university designed on the basis of determined coteries and indicators is the main component of the flipped learning system for the training of future IT professionals. The design of this cloud-oriented environment for the implementation of projects enables teachers to choose the means available to complete the project's tasks, integrate the necessary services and resources into the created environment, and provide communication between the educators, who teach the project disciplines and the teams of students; students have the opportunity to effectively plan project implementation steps, distribute tasks among team members and monitor their implementation, organize teamwork to create the end product of the project.

Procedures for using Microsoft Teams, GitHub, Jira cloud services are developed on the basis of process models, make it possible to regulate these processes and provide the effective use of the methodology at three stages.

In these stages, the necessary professional and personal skills were formed during the project tasks performing using the appropriate cloud resources and services of the university environment. During each of the stages students develop the ability to organize joint activities and form a capable team, the ability to form a communication system in a team, using appropriate cloud services, the ability to take control of the situation, the ability to unite a group and build an effective team interaction to solve certain tasks, etc.

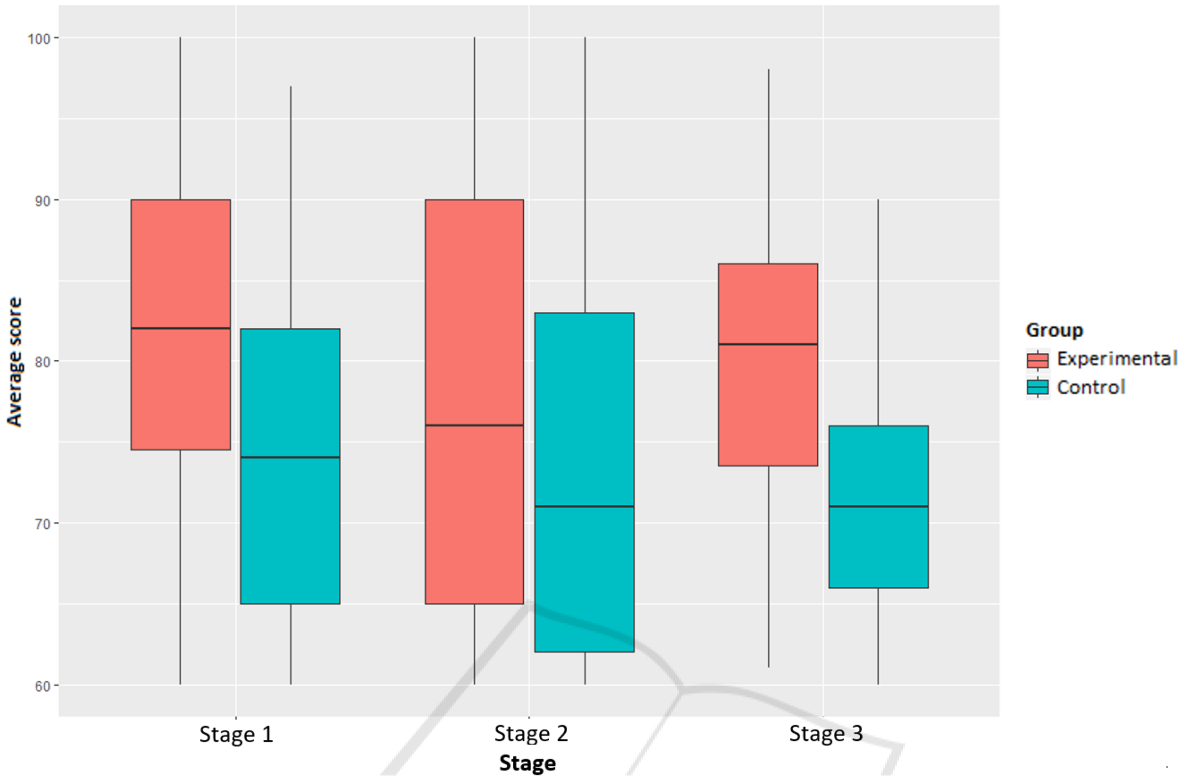

Figure 10: Box plot diagram of grades by stages and groups.

As a result of pedagogical experiment the students' grades increased by 6.4 points, which is confirmed by the results of statistical processing of research results. The developed methodology can be used by higher education institutions for the implementation of project training in the education of future IT professionals.

REFERENCES

Béres, I. and Kis, M. (2018). Flipped classroom method combined with project based group work. In Auer, M. E., Guralnick, D., and Simonics, I., editors, *Teaching and Learning in a Digital World*, pages 553–562, Cham. Springer International Publishing.

Bishop, J. and Verleger, M. A. (2013). The flipped classroom: A survey of the research. In *ASEE National Conference Proceedings*, volume 30, pages 23.1200.1 – 23.1200.18. Atlanta. https://peer.asee.org/22585.

Bondarenko, O., Mantulenko, S., and Pikilnyak, A. (2018). Google Classroom as a tool of support of blended learning for geography students. *CEUR Workshop Proceedings*, 2257:182–191.

Bondarenko, O., Pakhomova, O., and Lewoniewski, W. (2020). The didactic potential of virtual information educational environment as a tool of geography students training. *CEUR Workshop Proceedings*, 2547:13–23.

Bukreiev, D. O., Chorna, A. V., Serdiuk, I. M., and Soloviev, V. N. (2022). Features of the use of software and hardware of the educational process in the conditions of blended learning. In Semerikov, S., Osadchyi, V., and Kuzminska, O., editors, *Proceedings of the Symposium on Advances in Educational Technology, AET 2020*, Kyiv. University of Educational Management, SciTePress.

Davies, R. S., Dean, D. L., and Ball, N. (2013). Flipping the classroom and instructional technology integration in a college-level information systems spreadsheet course. *Educational Technology Research and Development*, 61(4):563–580.

de Bruin, C. T., Albertyn, R. M., and Machika, P. (2014). Changing the departmental learning culture to enable student-centred learning in large classes. *Mediterranean Journal of Social Sciences*, 5(8). https://www.mcser.org/journal/index.php/mjss/article/view/2570.

DeLozier, S. J. and Rhodes, M. G. (2017). Flipped classrooms: a review of key ideas and recommendations for practice. *Educational Psychology Review*, 29(1):141–151.

Flipped Learning Network (FLN) (2014). The Four Pillars of F-L-I-P™. https://flippedlearning.org/wp-content/uploads/2016/07/FLIP_handout_FNL_Web.pdf.

Glazunova, O., Voloshyna, T., Korolchuk, V., and Parhomenko, O. (2020). Cloud-oriented environment for flipped learning of the future IT specialists. *E3S Web of Conferences*, 166:10014.

Hamdan, N., McKnight, P., McKnight, K., and Arfstrom, K. M. (2013). A review of flipped learning. http://web.archive.org/web/20160325071007/http://www.flippedlearning.org/cms/lib07/VA01923112/Centricity/Domain/41/LitReview_FlippedLearning.pdf.

Kaner, C. and Fiedler, R. L. (2005). Inside out: a computer science course gets a makeover. In *Proceedings of the Association for Educational Communication and Technology International Conference*, volume 2, pages 254–264. Orlando, FL.

Kolgatin, O. H., Kolgatina, L. S., Ponomareva, N. S., Shmeltser, E. O., and Uchitel, A. D. (2022). Systematicity of students' independent work in cloud learning environment of the course "Educational Electronic Resources for Primary School" for the future teachers of primary schools. In Semerikov, S., Osadchyi, V., and Kuzminska, O., editors, *Proceedings of the Symposium on Advances in Educational Technology, AET 2020*, Kyiv. University of Educational Management, SciTePress.

Korolchuk, V. (2019). Cloud services for the implementation of collective projects in the process of preparation of future it specialists: analysis and selection criteria. *New pedagogical thought*, 100(4):46–51.

Korotun, O., Vakaliuk, T., and Soloviev, V. (2020). Model of using cloud-based environment in training databases of future IT specialists. *CEUR Workshop Proceedings*, 2643:281–292.

Kucher, S. L., Horbatiuk, R. M., Serdiuk, O. Y., Ozhha, M. M., Hryniaieva, N. M., and Fridman, M. M. (2022). Use of information and communication technologies in the organization of blended learning of future vocational education professionals. In Semerikov, S., Osadchyi, V., and Kuzminska, O., editors, *Proceedings of the Symposium on Advances in Educational Technology, AET 2020*, Kyiv. University of Educational Management, SciTePress.

Lavrentieva, O., Horbatiuk, R., Skripnik, L., Kuchma, O., Penia, V., and Pahuta, M. (2021). Theoretical and methodological bases of designing the educational institution information and consulting environment. *Journal of Physics: Conference Series*, 1840(1):012060.

Little, C. (2015). The flipped classroom in further education: literature review and case study. *Research in Post-Compulsory Education*, 20(3):265–279.

Lobanova, A., Bayura, V., Viznytsia, Y., Bratchenko, L., and Karitka, V. (2020). Intelligent specialization as a promising strategy for the sustainable development of industrial regions of ukraine (the case of kryvyi rih industrial region). *E3S Web of Conferences*, 166:10020.

Maher, M. L., Latulipe, C., Lipford, H., and Rorrer, A. (2015). Flipped classroom strategies for cs education. In *Proceedings of the 46th ACM Technical Symposium on Computer Science Education*, SIGCSE '15, page 218–223, New York, NY, USA. Association for Computing Machinery.

McLaughlin, J., Griffin, L., Esserman, D., Davidson, C., Glatt, D., Roth, M., Gharkholonarehe, N., and Mumper, R. (2013). Pharmacy student engagement, performance, and perception in a flipped satellite classroom. *American Journal of Pharmaceutical Education,*, 77(9):196.

Merzlykin, P., Popel, M., and Shokaliuk, S. (2017). Services of SageMathCloud environment and their didactic potential in learning of informatics and mathematical disciplines. *CEUR Workshop Proceedings*, 2168:13–19.

Morze, N. V. and Glazunova, O. G. (2014). Design of electronic learning courses for it students considering the dominant learning style. In Ermolayev, V., Mayr, H. C., Nikitchenko, M., Spivakovsky, A., and Zholtkevych, G., editors, *Information and Communication Technologies in Education, Research, and Industrial Applications*, pages 261–273, Cham. Springer International Publishing.

Nam, N. H. and Giang, V. T. (2017). Flipped classroom model for improving computer skills of students majoring in pedagogy. *Journal of vocational education and training,*, 51(12):44–49. https://tailieu.vn/doc/flipped-classroom-model-for-improving-computer-skills-of-students-majoring-in-pedagogy-2070299.html.

Nosenko, Y., Shyshkina, M., and Oleksiuk, V. (2016). Collaboration between research institutions and university sector using cloud-based environment. *CEUR Workshop Proceedings*, 1614:656–671.

Pererva, V., Lavrentieva, O., Lakomova, O., Zavalniuk, O., and Tolmachev, S. (2020). The technique of the use of Virtual Learning Environment in the process of organizing the future teachers' terminological work by specialty. *CEUR Workshop Proceedings*, 2643:321–346.

Polhun, K., Kramarenko, T., Maloivan, M., and Tomilina, A. (2021). Shift from blended learning to distance one during the lockdown period using Moodle: test control of students' academic achievement and analysis of its results. *Journal of Physics: Conference Series*, 1840(1):012053.

Rajaram, K. (2019). Flipped classrooms: Scaffolding support system with real-time learning interventions. *Asian Journal of the Scholarship of Teaching and Learning*, 9(1):30–58. https://nus.edu.sg/cdtl/docs/default-source/engagement-docs/publications/ajsotl/archive-of-past-issues/year-2019/pdf_n9n1_article2_rajaram-k.pdf?sfvrsn=f17f7d1a_2.

Saad, O. and Rana, M. E. (2014). Use of cloud-based learning environment in enhancing the teaching and learning process for software engineering courses. In *The Third International Conference on E-Learning and E-Technologies in Education (ICEEE2014)*, pages 246–252, Kuala Lumpur, Malaysia.

Salam, A. and Sardar, N. K. (2015). Cloud based learning environment. *International Journal of Advanced Information Science and Technology*, 4(6). http://www.ijaist.com/wp-content/uploads/2018/08/Cloudbasedlearningenvironment.pdf.

Semerikov, S., Striuk, A., Striuk, L., Striuk, M., and Shalatska, H. (2020). Sustainability in Software Engineering Education: A case of general professional competencies. *E3S Web of Conferences*, 166.

Semerikov, S. O., Teplytskyi, I. O., Soloviev, V. N., Hamaniuk, V. A., Ponomareva, N. S., Kolgatin, O. H., Kolgatina, L. S., Byelyavtseva, T. V., Amelina, S. M., and Tarasenko, R. O. (2021). Methodic quest: Reinventing the system. *Journal of Physics: Conference Series*, 1840(1):012036.

Shyshkina, M. (2016). The hybrid cloud-based service model of learning resources access and its evaluation. *CEUR Workshop Proceedings*, 1614:241–256.

Shyshkina, M. (2018). The general model of the cloud-based learning and research environment of educational personnel training. *Advances in Intelligent Systems and Computing*, 715:812–818.

Shyshkina, M. P. and Popel, M. V. (2013). Cloud based learning environment of educational institutions: The current state and research prospects. *Information Technologies and Learning Tools*, 37(5):66–80. https://journal.iitta.gov.ua/index.php/itlt/article/view/903.

Silva, J. C. S., Zambom, E., Rodrigues, R. L., and Ramos, J. L. C. (2018). Effects of learning analytics on students' self-regulated learning in flipped classroom. *International Journal of Information and Communication Technology Education,*, 14(3). https://www.igi-global.com/gateway/article/205624.

Smyrnova-Trybulska, E., Morze, N., and Kuzminska, O. (2017). Flipped learning model: Tools and experience of its implementation in higher education. *The New Educational Review*, 49(3):189–200.

Spirin, O., Oleksiuk, V., Balyk, N., Lytvynova, S., and Sydorenko, S. (2019). The blended methodology of learning computer networks: Cloud-based approach. *CEUR Workshop Proceedings*, 2393(1):68–80.

Varava, I. P., Bohinska, A. P., Vakaliuk, T. A., and Mintii, I. S. (2021). Soft skills in software engineering technicians education. *Journal of Physics: Conference Series*, 1946(1):012012.

Vlasenko, K., Chumak, O., Achkan, V., Lovianova, I., and Kondratyeva, O. (2020). Personal e-learning environment of a mathematics teacher. *Universal Journal of Educational Research*, 8(8):3527–3535.

Zelinska, S., Azaryan, A., and Azaryan, V. (2018). Investigation of opportunities of the practical application of the augmented reality technologies in the information and educative environment for mining engineers training in the higher education establishment. *CEUR Workshop Proceedings*, 2257:204–214.