

**MoPED: Modernization of Pedagogical Higher Education by
Innovative Teaching Instruments**

586098-EPP-1-2017-1-UA-EPPKA2-CBHE-JP

HANDBOOK

TITLE OF THE COURSE:

Innovation technologies in STEM – education

SPECIALITY - *014.05 Secondary education (biology and human health)*

HIGHER EDUCATION DEGREE: *Master's level*

Developer: *Candidate of biological sciences, Associate Professor of biology and ecology department – Hniezdilova Victoriia Igorivna*

Higher Education Institution: *«Vasyl Stefanyk Precarpathian national university»*

Faculty *of Natural Sciences*

2019

Handbook *«Innovation technologies in STEM – education»*

The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

BRIEF SUMMARY OF THE COURSE: *The discipline is intended to train educators and scientists in the field of innovative technologies in teaching STEM- subjects. The educational discipline allows to comprehensively study the specifics of the educational sphere, emphasizes the acquisition of skills and knowledge in the field of modern information technologies in the educational process. Interdisciplinary and multidisciplinary training is based on a combination of theoretical and applied approaches, assimilation of a rich arsenal of laboratory methods of biological research and integration of the acquired biological knowledge with classical and innovative pedagogical technologies.*

KEY WORDS: *STEM – education, interactive techniques: flipped Learning, Project-based learning, Inquiry Based Learning, Inquiry Learning Spaces*

DICTIONARY OF NEW CONCEPTS:

STEM – education - *it is a series or sequence of courses or programs of study that prepares students for successful employment, after-school education, or both, requiring different and more technically complex skills, including the application of mathematical knowledge and scientific concepts. The abbreviation STEM stands for Science, Technology, Engineering and Mathematics. These areas are the basis of this method of education. In this case, these disciplines are studied not separately, as we are accustomed to, but in combination. Of great importance is the practical application of the acquired knowledge.*

Flipped Learning - *it is a form of active learning that allows you to "reverse" the usual learning process as follows: homework for students is to watch the relevant video clips with the teaching material of the next lesson, students go through theoretical material, and in class time is used for practical tasks.*

Project-based learning - *it is a method by which students, for some time researching and responding to real, interesting and complex questions, gain the necessary knowledge and skills. A project is a job that is performed over a period of time; it aims to work on a specific topic and solve a problem. It is best to leave the problem to the students and the teacher to act as a facilitator and helper.*

Dual education *is a type of education that combines the education of individuals in educational institutions with training in the workplace at enterprises, institutions and organizations to acquire a certain qualification.*

Inquiry Based Learning - *it is an approach to learning that involves a process of research that leads to the formulation of questions and new discoveries in search of new understanding. This means that information is not directly offered in the learning process, but must be discovered through the research activities of the students themselves.*

Inquiry Learning Spaces - *is an educational environment that offers students a set of online tools for research-oriented learning, which consists of certain phases:*

- *Virtual laboratories*
- *Specific tools to help students carry out research activities*
- *General tools (calculator, notebook)*
- *Resources. Reference material in the form of texts, videos, photos, diagrams or other means. The reference material contains the information that students need for proper research. ILS may also contain links to resources outside of ILS.*

Modern Educational Technologies - a set of methods and tools used in the learning process.

E-learning - it is a learning system using information and electronic technologies.

Off – line study - it is a method of gaining new knowledge in the audience during direct communication between teacher and student.

On – line study - it is a method of gaining new knowledge via the Internet in real time. Communication between the participants of the process takes place using a computer.

Mass Open Online Courses that broadcast knowledge to a huge number of people through video lectures.

Blended Learning - it is a method of formal education, according to which the student learns one part of the material online, partly independently managing their time, place, path and pace of learning, and the rest of the material is studied in class.

Distance learning - is a form of learning with the use of computer and telecommunication technologies, which provide interactive interaction of teachers and students at different stages of learning and independent work with the materials of the information network.

Synchronous learning - is a process of interaction between students and the teacher in real time.

Asynchronous learning - a method of learning in which contact between teacher and student is delayed.

Adaptive learning - is a learning model that uses technology and new technologies for students' needs as "interactive learning devices."

Inclusive education - education of students with special needs by including them in the general educational environment at their place of residence.

Interactive educational technologies - involve active interaction of all participants in the learning process, their ability to dialogue with anything (computer) or with anyone (person).

Multilevel (differentiated) learning - the organization of the educational process, taking into account the typical individual characteristics of students.

Problem-based learning - is understood as the learning and cognitive activity of students in the acquisition of knowledge and methods of activity based on the creation and solution of problem situations.

Collaborative learning technology. This technology is based on the idea of mutual learning, in the organization of which students take not only individual but also collective responsibility for solving educational problems.

Game learning technologies - the introduction of active forms and methods of learning, among which the leading place is occupied by educational games.

Gamification of learning is the use of game practices and mechanisms to create an educational environment in which participants observe their own progress, compete with each other, help each other and motivate each other.

Web-quest - a project using Internet resources.

Case Study - an interactive method of learning that allows you to bring the learning process closer to real practice. The essence of the method is to use specific cases (situations, stories, the texts of which are called "cases") for joint analysis, discussion or decision-making by students in a particular section of the discipline.

Bring your own devices (BYOD) - this is a method of learning in which smartphones, laptops, tablets are actively used in the classroom.

Bricolage in education is the use of anything for learning except specially designed tools (such as textbooks).

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1. Description of the Course

1.1. The volume of the course in ECTS credits and its distribution in hours by the forms of organization of educational process and types of classes.

3.0 ECTS credits

The number of

content modules is 2.

Total hours: 90, incl. for full-time form of study: 8 lecture hours, 22 hours of practical classes, 60 hours - independent work of students; for part-time form of study - 90, including 4 lecture hours, 8 hours of practical classes, 78 hours - independent work of students.

1.2. Characteristics of the course by form of study:

Full-time, part-time

1.3. Course status:

Normative course

1.4. Prerequisites for studying the course is mastering the following disciplines of the educational program: modern information technology, information technology in the educational process, botany, zoology, anatomy and morphology of plants, pedagogy, methods of teaching biology, innovative biology, physiology and biochemistry of plants.

1.5. Year of study, semester:

First year of studying, semester 1

1.6. Form of final control:

Credit

1.7. Language of the course:

Ukrainian

1.8. Internet address of the permanent placement of educational content of the course .

1.9. Developer

Candidate of biological sciences, Associate Professor of biology and ecology department – Hniezdilova Victoriia Igorivna

1.10. Aims of the course:

To familiarize students with the latest educational trends and methods of creating a research environment for STEM subjects, online laboratories, simulations. Provide future teachers with the necessary amount of theoretical knowledge and practical skills that will enable them to teach biology in secondary schools and institution of higher education in accordance with modern requirements. To teach students to use innovative technologies in teaching biology.

1.11. Competences that are formed during the study of the course

Integral Competence (CI): Ability to solve complex problems in the field of biological education and science or in the studying process, which involves

research and / or

innovation and is characterized by uncertainty of conditions and requirements for professional, educational or research activities.

Generic Competences (GC): Ability to apply knowledge in practical situations. Skills in the use of information and communication technologies.

Professional (Specific) competences (SC):

SC-1. Ability to choose and apply productive innovative technologies in teaching biology, methods, techniques and forms of learning; independently conduct training sessions.

SC-2. Ability to create a system of methods, forms and activities of the teacher and student.

SC-3. Ability and readiness to plan the main types of educational activities in an educational institution, all forms of educational and extracurricular activities in biology.

1.12. Expected learning outcomes of the course .

Professional knowledge

1. To use basic knowledge in the field of computer science and modern information technologies in the professional activity.
2. Apply in practice the innovative means and forms of organization of the educational process.
3. Use the latest educational technologies in the educational and educational process.
4. Apply leading innovative pedagogical technologies to create projects at the lessons of biology.

Professional skills and abilities

1. To be able to create and use ILS in professional activities.
2. To have skills to work with innovative learning tools.
3. To be able to collect information from different sources, analyze and organize it.

Communication

1. To choose effective communication methods with students, parents, and colleagues.
2. To use various forms and methods of communication (oral, written, non-verbal) for the implementation of innovative pedagogical technologies and the latest teaching/learning tools in the educational process in secondary school and higher education institution.

Autonomy and responsibility

1. To independently carry out educational activity in an educational institution.

2. Independently apply

the latest pedagogical technologies and tools of teaching at the interdisciplinary level in secondary school and higher education institution.

3. Ability to self-development and self-improvement.

1.13. Control of academic achievements of students

Diagnostic tools for learning outcomes

Credit, group projects, tasks for independent work, preparation of an individual research task, presentation of an individual research task.

Two intermediate exams for the evaluation of SC -1 (30%)

Preparation of an individual research task (project) (20%) for the evaluation of SC -2, SC -3.

Presentation of an individual research task (project) (10%) for the evaluation of SC -1.

A final exam in which GC-1 will be evaluated (40%)

$$\text{Final Mark} = \text{SC -1 (40\%)} + \text{SC -2 (10\%)} + \text{SC -3 (10\%)} + \text{GC-1 (40\%)}$$

Summative assessment

Competence	Continuous Eval.	Credit	Total
SC -1	40%		40%
SC -2	10%		10%
SC -3	10%		10%
GC -1		40%	40%
<i>Total</i>	60%		100%

SA1. Preparation of an individual research task (project) on one of the suggested topics 20 points

SA2. Module control work 1. 15 points

SA3. Module control work 2. 15 points

SA4. Presentation of an individual research task (project) 10 points

SA5. Final exam 40 points

The total number – 100 points

Information about research of modular control work 1 student can be individually on 5 educational courses.

Information about research modular control work of 2 students can be individually on 10 educational courses.

Information on mastering the results for changing module 1 offers students 5 disciplines.

Information on learning the results for the change of module 2 offered students for 10 weeks of study.

Information about the results of work on individual research tasks is given to students at the last practical lesson

The results of the final certification (Credit) are studied at the last final lesson.

Communication and feedback

Contact information for online help and counseling:

Teacher: Candidate of biological sciences, Associate Professor of biology and ecology department – Hniezdilova Victoriia Igorivna, victoria1975@bigmir.net

Scale of assessment of HEI

The amount of points for all types of educational activities	Mark ECTS	Credit
90 – 100	A	credited
80 – 89	B	
70 – 79	C	
60 – 69	D	
50 – 59	E	
26 – 49	FX	Not included with the possibility of re-assembly
0-25	F	Unsatisfactorily with compulsory repeated study of the course

2. Content and structure of the course

2.1. **Module 1** Modern concept of STEM education

2.1.1. **Theme 1** Innovative tools and forms of organization of the educational process of STEM-education

2.1.2. **Aims:** Master and use in practice the modern concept of STEM-education, master and make perfect use of innovative tools and forms of organization of the educational process of STEM-education.

Expected learning outcomes: Be able to apply in practice innovative tools and forms of organization of the educational process.

2.1.3. **Criteria and forms for evaluating learning outcomes on the theme.**

Forms for evaluating learning outcomes on the theme: current control in practical classes, preparation of an abstract, presentation of an individual research task (project).

Criteria:

Level I - beginner. The answer in the reproduction of educational material is elementary, fragmentary, due to the initial ideas about the subject of study.

Level II – sufficient. The student reproduces the basic educational material, is able to solve problems on a sample, possesses elementary skills of educational activity.

Level III - intermediate. The student independently applies knowledge in standard situations, has mental operations (analysis, abstraction, generalization, etc.), is able to draw conclusions, correct mistakes. The answer is complete, correct, logical, reasonable, although it lacks its own judgments.

Level IV - high. The student's knowledge is deep, strong, generalized, systematic; the student is able to apply knowledge creatively, his educational activity has a research character, marked by the ability to independently assess various facts, identify and defend a personal position.

2.1.4. **Digital tools:** presentations, mind maps

2.1.5. **Innovative Teaching / Learning Technologies:** computer technology

2.1.6. **Lecture 1.**

Topic: Innovative tools and forms of organization of the educational process of STEM-education. (2 hours)

Aims: To get acquainted with innovative tools and forms of organization of the educational process of STEM-education; learn to apply perfectly in future activities.

Plan

1. The purpose and objectives of the course.
2. Definition of "STEM-subjects", "STEM-education".
3. Innovative tools in the learning process.
4. Forms of organization of the educational process of STEM-education.

2.1.7. **Practical class 1.** STEM-education in teaching natural sciences. (2 hours)

Types of student activity: oral examination and group work

Instructions for students:

1. Form groups.
2. Perform task 2.1.8.
3. Justify the feasibility of introducing STEM-education in secondary and out-of-school educational institutions of Ukraine.
4. Get acquainted with the criteria for evaluating the results of group work.

Criteria for evaluating the results of group work:

Satisfactory (3 points): Not all members of the group worked actively. The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): There is no teamwork and cooperation between group members; not all students worked actively. The answers are complete, logical, but lack their own judgments.

Excellent (5 points): When performing group work, mutual respect, coherence and work of each student can be traced. The answers are substantiated, students are able to independently assess the facts and defend their personal position.

2.1.8. **Topics for group tasks:**

- Discussion of methodical recommendations on the introduction of STEM-education in secondary and out-of-school educational institutions of Ukraine

To complete the task, follow the link:

https://osvita.ua/legislation/Ser_osv/56880/

http://timso.koippo.kr.ua/skripka/wp-content/uploads/2018/08/List_IMZO_2573_19072018.pdf

2.1.9. **Tasks for independent work:**

Write an essay on one of the topics (deadline 2 weeks):

- Prerequisites for the creation of an all-Ukrainian network of STEM-centers / laboratories.
- Implementation of STEM education in different countries.

Criteria for evaluating the results of independent work of students (essay):

Satisfactory (3 points): The topic and purpose are not disclosed. Theses are fragmentary in nature, due to a superficial acquaintance with the problem. The abstract does not meet the requirements.

Good (4 points): Theme and purpose are revealed. The text is complete, logical, but lacks its own judgments and sound conclusions. The abstract is designed according to the requirements.

Excellent (5 points): The work is research in nature. The conclusions are substantiated, the student is able to independently assess the facts and defend a personal position.

Recommended literature:

1. Волковський С.С. Освітні концепції та педагогічні технології [Електронний ресурс] / С.С. Волковський. – Режим доступу до журн. : <http://osvita.ua/school/theory/1241>
2. Момот Ю.Ю. Сучасні підходи до впровадження проектної технології у навчально-виховний процес закладів середньої освіти [Електронний ресурс] / Ю.Ю. Момот. – Режим доступу до журн. : http://www.nbu.gov.ua/portal/Soc_Gum/Vpm/2009_6/momot.pdf
3. Нестерова Л.В. Інтерактивні методи навчання як фактор гуманізації професійної підготовки фахівців [Електронний ресурс] / Л. В. Нестерова, С. О. Сараєва. – Режим доступу до журн.: http://conf.vntu.edu.ua/humed/2010/txt/Nesterova_Saraeva.php

2.1.10. Methodological materials and instructions.

The synopsis of the lecture №1 is available at the link [Url].

The presentation of lecture №1 is available at the link..... [Url].

2.1.11. Theme 2. Modern educational technologies in teaching natural subjects in SEI.

2.1.12. Aims: Get acquainted with and master modern educational technologies in teaching natural subjects in SEI.

Expected learning outcomes: Be able to use the latest educational technologies in the educational process.

2.1.13. Criteria and forms for evaluating learning outcomes on the theme.

Forms for evaluating learning outcomes on the theme: current control in practical classes, presentation of an individual research task (project).

Criteria:

Level I - beginner. The answer in the reproduction of educational material is elementary, fragmentary, due to the initial ideas about the subject of study.

Level II – sufficient. The student reproduces the basic educational material, is able to solve problems on a sample, possesses elementary skills of educational activity.

Level III - intermediate. The student independently applies knowledge in standard situations, has mental operations (analysis, abstraction, generalization, etc.), is able to draw conclusions, correct mistakes. The answer is complete, correct, logical, reasonable, although it lacks its own judgments.

Level IV - high. The student's knowledge is deep, strong, generalized, systematic; the student is able to apply knowledge creatively, his educational activity has a research character, marked by the ability to independently assess various facts, identify and defend a personal position.

2.1.14. **Digital tools:** presentations, mind maps, Plickers, Mentimeter, Kahoot, Plantnet.

2.1.15. **Innovative Teaching / Learning Technologies:** computer technology, project-based learning, Inquiry Based Learning, collaborative learning, dual learning, case technology, flipped learning and flipped classroom.

2.1.16. **Lecture 2.**

Topic: Modern educational technologies in teaching natural subjects in SEI.
(2 hours)

Aims: To get acquainted with modern educational technologies in the teaching of natural subjects in SEI and master the features of their use in the educational process.

Plan

1. Inquiry Based Learning
2. Project-based learning
3. Collaborative learning
4. Dual learning
5. Flipped learning and flipped classroom

2.1.17. **Practical class 2.** Use of mobile applications for formative assessment. (2 hours)

Types of student activity: oral examination, individual and group work.

Instructions for students:

1. Form groups.

2. Perform task 2.1.18.
3. Outline the practical foundations of application applications: Plickers, Mentimeter, Kahoot, Plantnet, QR-code.
4. Outline the practical foundations of using the resource Wizer.Me and applications: Plickers, Mentimeter, Kahoot, Plantnet for formative evaluation.
5. Get acquainted with the criteria for evaluating the results of group work.

Criteria for evaluating students' oral answers:

Satisfactory (3 points): The student reproduces the basic educational material, has basic skills of educational activity.

Good (4 points): The student independently applies knowledge in standard situations, has mental operations (analysis, abstraction, generalization, etc.), is able to draw conclusions, correct mistakes. The answer is complete, correct, logical, reasonable, although it lacks its own judgments.

Excellent (5 points): The student's knowledge is deep, strong, generalized, systematic; the student is able to apply knowledge creatively, his educational activity has a research character, marked by the ability to independently assess various facts, identify and defend a personal position.

Criteria for evaluating the results of individual work:

Satisfactory (3 points): The answer and tasks are marked by incomplete performance with the teacher's consultation. Test control of knowledge for pupils of 7-8 grades is developed using only one of the proposed applications; the questions are all the same, which does not allow to evaluate students objectively.

Good (4 points): The answer and tasks are marked by incomplete performance without the help of the teacher. Test control of knowledge for pupils of 7-8 grades is developed using two applications; questions of different types, but with some inaccuracies and do not correspond to the amount of educational material.

Excellent (5 points): The answer or task is marked by completeness without the help of the teacher. Test control of knowledge for students in grades 7-8 was developed using Plickers, Mentimeter, Kahoot and the resource Wizer.Me. Questions of various types, including interactive worksheets. The student has mastered mobile applications at a high level, which allows them to be used in practical pedagogical activities.

Criteria for evaluating the results of group work:

Satisfactory (3 points): Not all members of the group worked actively. The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): There is no teamwork and cooperation between group members; not all students worked actively. The answers are complete, logical, but lack their own judgments.

Excellent (5 points): When performing group work, mutual respect, coherence and work of each student can be traced. The answers are substantiated, students are able to independently assess the facts and defend their personal position.

2.1.18. Topics for group tasks:

- Practical bases of application of: Plickers, Mentimeter, Kahoot, Plantnet, QR-code.

- To read the instructions for use of these applications, follow the links:

<https://vseosvita.ua/library/tehnologia-svidkogo-opituvanna-plickers-prezentacia-70114.html>

<https://newreporter.org/2016/10/25/mentimeter-com-onlajn-oprosy-v-rezhime-realnogo-vremeni/>

<http://teach-hub.com/scho-take-qr-kod-ta-yak-joho-vykorystovuvaty-vchytelyu/>

<http://marinakurvits.com/kahoot/>

<http://i-math.com.ua/vsikt/wizer-instrument-dlya-stvorenniya-interaktivnix-robotichix-arkushiv/>

- To make a test control of knowledge for pupils of 7-8 grades using applications: Plickers, Mentimeter, Kahoot, Wizer.Me.

- Positive and negative features of using the resource Wizer.Me and applications: Plickers, Mentimeter, Kahoot, Plantnet for formative evaluation.

2.1.19. Tasks for independent work.

- Outline the features of the use of mobile applications for formative assessment in universities.

Criteria for evaluating the results of independent work of students :

Satisfactory (3 points): The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): The answers are complete, logical, but lack their own judgments and sound conclusions.

Excellent (5 points): The answers are complete, logical; the student is able to independently assess the facts and defend a personal position, draws sound conclusions.

Recommended literature:

1. Багрова О.В. Інтерактивні технології як об'єкт навчання педагогів у системі післядипломної педагогічної освіти [Електронний ресурс] / О. В. Багрова – Режим доступу до журн. : http://www.loippo.lg.ua/konf_inter.doc
2. Ізбаиш С.С. Науково-теоретичні основи використання технології проектної діяльності в сучасній школі [Електронний ресурс] / С. С. Ізбаиш – Режим доступу до журн. : <http://www.ukrdeti.com/firstforum/h16.html>
3. Шелудякова Н.О. Використання інтерактивних методів навчання при проведенні індивідуальних занять [Електронний ресурс] / Н.О. Шелудякова. – Режим доступу до журн. : <http://intkonf.org/sheludyakova-no-vikoristannya-interaktivnih-metodiv-navchannya-pri-provedenni-individualnih-zanyat/>

2.1.20. **Practical class 3.** Features of the use of the latest educational technologies: Inquiry Based Learning, Project-based learning, collaborative learning, dual learning. (2 hours)

Types of student activity: oral examination and group work.

Instructions for students:

1. Form groups.
2. Perform task 2.1.21.
3. Outline the practical basis for the application of the project method, collaborative learning, dual learning.
4. Highlight the positive and negative features of the project method, collaborative learning, dual learning.
5. Get acquainted with the criteria for evaluating the results of group work.

Criteria for evaluating students' oral answers:

Satisfactory (3 points): The student reproduces the basic educational material, has basic skills of educational activity.

Good (4 points): The student independently applies knowledge in standard situations, has mental operations (analysis, abstraction, generalization, etc.), is able to draw conclusions, correct mistakes. The answer is complete, correct, logical, reasonable, although it lacks its own judgments.

Excellent (5 points): The student's knowledge is deep, strong, generalized, systematic; the student is able to apply knowledge creatively, his educational activity has a research character, marked by the ability to independently assess various facts, identify and defend a personal position.

Criteria for evaluating the results of group work:

Satisfactory (3 points): Not all members of the group worked actively. The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): There is no teamwork and cooperation between group members; not all students worked actively. The answers are complete, logical, but lack their own judgments.

Excellent (5 points): When performing group work, mutual respect, coherence and work of each student can be traced. The answers are substantiated, students are able to independently assess the facts and defend their personal position.

2.1.21. Topics for group tasks:

- Practical bases of application of a Project-based learning, collaborative learning, dual learning.
- Positive and negative features of the project method, collaborative learning, dual learning.

2.1.22. Tasks for independent work.

Outline the features of the use of the latest educational technologies in universities.

Criteria for evaluating the results of independent work of students :

Satisfactory (3 points): The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): The answers are complete, logical, but lack their own judgments and sound conclusions.

Excellent (5 points): The answers are complete, logical; the student is able to independently assess the facts and defend a personal position, draws sound conclusions.

Recommended literature:

1. Багрова О.В. Інтерактивні технології як об'єкт навчання педагогів у системі післядипломної педагогічної освіти [Електронний ресурс] / О. В. Багрова – Режим доступу до журн.: http://www.loippo.lg.ua/konf_inter.doc

2. Ізбаш С.С. Науково-теоретичні основи використання технології проектної діяльності в сучасній школі [Електронний ресурс] / С. С. Ізбаш – Режим доступу до журн.: <http://www.ukrdeti.com/firstforum/h16.html>

3. Шелудякова Н.О. Використання інтерактивних методів навчання при проведенні індивідуальних занять [Електронний ресурс] / Н.О. Шелудякова. – Режим доступу до журн.: <http://intkonf.org/sheludyakova-no-vikoristannya-interaktivnih-metodiv-navchannya-pri-provedenni-individualnih-zanyat/>

2.1.23. **Practical class 4.** Characteristic of Flipped learning and flipped classroom. (2 hours)

Types of student activity: oral examination and group work

Instructions for students:

1. Form groups.
2. Follow the link: <https://vseosvita.ua/library/perevernute-navcanna-ak-odna-z-klucovih-tendencij-osvitnih-tehnologij-sucasnosti-46162.html>
3. Perform task 2.1.24.
4. Outline the practical basis of application of Flipped learning and flipped classroom.
5. Highlight the positive and negative features of the application of Flipped learning and flipped classroom.
6. Develop an "Flipped" lesson, following the requirements for the structure of the lesson (research task (project)).
7. Get acquainted with the criteria for evaluating the results of group work.

Criteria for evaluating students' oral answers:

Satisfactory (3 points): The student reproduces the basic educational material, has basic skills of educational activity.

Good (4 points): The student independently applies knowledge in standard situations, has mental operations (analysis, abstraction, generalization, etc.), is able to draw conclusions, correct mistakes. The answer is complete, correct, logical, reasonable, although it lacks its own judgments.

Excellent (5 points): The student's knowledge is deep, strong, generalized, systematic; the student is able to apply knowledge creatively, his educational activity has a research character, marked by the ability to independently assess various facts, identify and defend a personal position.

Criteria for evaluating the results of group work:

Satisfactory (3 points): Not all members of the group worked actively. The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): There is no teamwork and cooperation between group members; not all students worked actively. The answers are complete, logical, but lack their own judgments.

Excellent (5 points): When performing group work, mutual respect, coherence and work of each student can be traced. The answers are substantiated, students are able to independently assess the facts and defend their personal position.

2.1.24. **Topics for group tasks:**

- Practical bases of application of Flipped learning and flipped classroom.

2.1.25. **Tasks for independent work.**

- Get acquainted with the peculiarities of the use of game technologies in the teaching of STEM - subjects.

Criteria for evaluating the results of independent work of students:

Satisfactory (3 points): The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): The answers are complete, logical, but lack their own judgments and sound conclusions.

Excellent (5 points): Answers are complete, logical; the student is able to independently assess the facts and defend a personal position, draws sound conclusions.

Recommended literature:

1. Сосницька. Н. Л. Вимоги до професійної підготовки вчителя фізики в умовах особистісно-орієнтованого навчання [Електронний ресурс] / Н. Л. Сосницька – Режим доступу до журн. : <http://studentam.net.ua/content/view/7858/97/>, <http://eprints.zu.edu.ua/699/1/03cnloon.pdf>

2. Luis Fernandes (2016). How to have an effective whole-school approach to digital tools in education? School Education Gateway. Available at: https://www.schooleducationgateway.eu/en/pub/viewpoints/experts/how_to_address_the_challenges.htm] (In English)

3. Monitoring of the Integration of Ukrainian Higher Education System into European Higher Education and Research Area: Analytical Report (Ed. T. V. Finikov, O. I. Sharov). Kyiv, 2014, 130 – 143. (in English)

2.1.26. **Practical class 5.** Presentation of an individual research task (project) ("Flipped" lesson). (2 hours)

Criteria for evaluating the presentation:

Level 1 - beginner. *Contents of the presentation.* The project focuses on the topic, but does not cover it. There are factual errors or ambiguities, but they are not significant. There are significant factual errors, ambiguities and misunderstandings of the topic. *Design.* Not all slides used are relevant. No audio-visual effects. Number of slides no more than 5. *Group work.* Misunderstandings often arose between group members; not everyone worked actively.

Level 2 – sufficient. *Contents of the presentation.* The goal is vaguely stated. Not quite correctly selected examples. The logic of presenting the material is violated. The content of the presentation is difficult to perceive. *Design.* The work is overloaded with illustrations that interfere with the perception of the content. Slides are not designed and text is placed on them. Number of slides no more than 7. *Group work.* There is no mutual understanding and cooperation between group members; not everyone worked actively.

Level III - intermediate. *Contents of the presentation.* The goals and objectives are not clearly stated. The logic of presenting the material is violated. Examples are not well chosen. *Design.* Successfully chosen color design. There are no audio-video effects in the work. Number of slides no more than 8. *Group work.* The presentation does not follow the work of all members. The members of the group treated each other with respect during the work.

Level IV - high. *Contents of the presentation.* Clearly defined goals and objectives. The conclusions are clearly stated and correspond to the theme and purpose. The presentation is clear and understandable to the audience. There are no grammatical and stylistic errors. *Design.* The information is logically stated. Successfully used audio and video effects. Charts used. Number of slides more than 10. *Group work.* When performing group work, mutual respect, coherence and work of each student can be traced.

2.1.27. Tasks for independent work.

Answer the following questions:

- What interactive technologies are used in teaching STEM subjects?
- What is an integrated educational technology in the teaching of STEM - subjects?
- What are the technologies for the development of critical thinking in the teaching of STEM - subjects?

Criteria for evaluating the results of independent work of students:

Satisfactory (3 points): The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): The answers are complete, logical, but lack their own judgments and sound conclusions.

Excellent (5 points): Answers are complete, logical; the student is able to independently assess the facts and defend a personal position, draws sound conclusions.

Recommended literature:

1. Bevan, B., Gutwill, J.P., Petrich, M. and Wilkinson, K., (2015), 'Learning Through STEM- Rich Tinkering: Findings From a Jointly Negotiated Research Project Taken Up in Practice', *Science Education*, 99(1), pp.98-120.
2. De Jong, T., Lazonder, A.W., Pedaste, M., & Zacharia, Z.C. (2018). *Simulations, games and modelling tools for learning*. In F. Fischer, C. E. Hmelo-Silver, S. R. Goldman & P. Reimann (Eds.) *International Handbook of the Learning Sciences*, Oxford: Routledge.
3. Fry H., Ketteridge S., Marshall S.. *A handbook for teaching and learning in higher education*// London: Kogan Page, 2000.
4. <https://www.skillsyouneed.com/learn/critical-thinking.html>

2.1.28. Questions for module control work 1:

1. Define the concept of "STEM-subjects", "STEM-education".
2. Innovative tools in the educational process.
3. Forms of organization of the educational process of STEM-education.
4. Justify the feasibility of introducing STEM-education in secondary and out-of-school educational institutions of Ukraine.
5. Implementation of STEM education in different countries.
6. Modern educational technologies in the teaching of natural subjects in SEI.
7. Features of the use of the latest educational technologies: Inquiry Based Learning, Project-based learning, collaborative learning, dual learning.
8. Outline the practical basis of application of Flipped learning and flipped classroom.
9. Highlight the positive and negative features of the application of Flipped learning and flipped classroom.
10. Identify the basic requirements for the structure of the "Flipped" lesson.

Criteria for evaluating the results of module control work 1:

Satisfactory (3 points): The student has the material at the initial level. The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): The answers are complete, logical, but lack their own judgments and sound conclusions. The student can compare, summarize,

systematize information; knowledge is quite complete; freely uses the studied material in standard pedagogical situations.

Excellent (5 points): Answers are complete, logical; the student is able to independently assess the facts and defend a personal position, draws sound conclusions; is able to apply the studied material to make their own reasoned judgments in practical pedagogical activities. The student has systematic, effective abilities in educational activity, uses a wide arsenal of means of proof of the opinion, solves difficult problem tasks; prone to system-scientific analysis and forecasting of phenomena.

2.1.29. **Methodological materials and instructions.**

The synopsis of the lecture №1 is available at the link [Url].

The presentation of lecture №1 is available at the link..... [Url].

2.2 Module 2. Inquiry based learning in the work of a teacher of SEI and a university teacher

2.2.1. **Theme 1. Advantages and difficulties of use the Inquiry based learning**

2.2.2. **Aims:** To learn about the benefits and difficulties of use the Inquiry based learning and use it to teach biological disciplines.

Expected learning outcomes: be able to use the Inquiry based learning in the teaching of biological disciplines.

2.2.3. **Criteria and forms for evaluating learning outcomes on the theme.**

Forms for evaluating learning outcomes on the theme: current control in practical classes.

Criteria:

Level I - beginner. The answer in the reproduction of educational material is elementary, fragmentary, due to the initial ideas about the subject of study.

Level II – sufficient. The student reproduces the basic educational material, is able to solve problems on a sample, possesses elementary skills of educational activity.

Level III - intermediate. The student independently applies knowledge in standard situations, has mental operations (analysis, abstraction, generalization, etc.), is able to draw conclusions, correct mistakes. The answer is complete, correct, logical, reasonable, although it lacks its own judgments.

Level IV - high. The student's knowledge is deep, strong, generalized, systematic; the student is able to apply knowledge creatively, his educational activity has a research character, marked by the ability to independently assess various facts, identify and defend a personal position.

2.2.4. **Digital tools:** presentations

2.2.5. **Innovative Teaching / Learning Technologies:** computer technology

2.2.6. **Lecture 3.**

Topic: Advantages and difficulties of use the Inquiry based learning. (2 години)

Aims: To learn about the benefits and difficulties of use the Inquiry based learning and use it to teach biological disciplines.

Plan

1. Inquiry based learning as one of the innovative learning technologies.
2. Comparative characteristics of traditional technology and Inquiry based learning technology.
3. Components of Inquiry based learning technology.
4. Teacher and student activities in Inquiry based learning.

2.2.7. **Practical class 6.** Inquiry based learning (2 години)

Types of student activity: oral examination and group work

Instructions for students:

1. Form groups.
2. Answer the questions 2.2.8.
3. Fill in Table 1 and Table 2 by following the link http://nbuv.gov.ua/UJRN/pednauk_2017_4_18
4. Familiarize yourself with the criteria for evaluating the results of group work.

Table 1. Comparative characteristics of traditional technology and technology of research-oriented learning

Traditional learning	Inquiry based learning

Table 2. The role of teacher and student in Inquiry based learning

The role of a teacher	The role of a student

Criteria for evaluating students' oral answers:

Satisfactory (3 points): The student reproduces the basic educational material, has basic skills of educational activity.

Good (4 points): The student independently applies knowledge in standard situations, has mental operations (analysis, abstraction, generalization, etc.), is able to draw conclusions, correct mistakes. The answer is complete, correct, logical, reasonable, although it lacks its own judgments.

Excellent (5 points): The student's knowledge is deep, strong, generalized, systematic; the student is able to apply knowledge creatively, his educational activity has a research character, marked by the ability to independently assess various facts, identify and defend a personal position.

Criteria for evaluating the results of group work:

Satisfactory (3 points): Not all members of the group worked actively. The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): There is no teamwork and cooperation between group members; not all students worked actively. The answers are complete, logical, but lack their own judgments.

Excellent (5 points): When performing group work, mutual respect, coherence and work of each student can be traced. The answers are substantiated, students are able to independently assess the facts and defend their personal position.

2.2.8. Topics for group tasks:

1. Comparison of traditional and Inquiry based learning.
2. Theoretical and practical aspects of Inquiry based learning.
3. Difficulties in the implementation of Inquiry based learning.

2.2.9. Tasks for independent work.

Answer the questions:

1. How to form motivation for Inquiry based learning?
2. What ways of creating problem situations do you know?
3. What are the advantages and disadvantages of Inquiry based learning?
4. What are the features of the use of Inquiry based learning in universities of Ukraine and other countries?

Criteria for evaluating the results of independent work of students:

Satisfactory (3 points): The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): The answers are complete, logical, but lack their own judgments and sound conclusions.

Excellent (5 points): Answers are complete, logical; the student is able to independently assess the facts and defend a personal position, draws sound conclusions.

Recommended literature:

1. Третько, В. В. Взаємозв'язок дослідницько-орієнтованого навчання і викладання у вищій школі Великої Британії [Текст] / В. В. Третько // Науковий вісник Ужгородського університету: серія: Педагогіка. Соціальна робота / голов. ред. І.В. Козубовська. – Ужгород: Видавництво УжНУ «Говерла», 2015. – Вип. 36. – С. 179–183. – Бібліогр.: с. 182 (7 назв).

2. Papaevripidou M., Zacharia Z.C. *Using Teachers' Inquiry-oriented Curriculum Materials as a Means to Examine their Pedagogical Design Capacity and Pedagogical Content Knowledge for Inquiry-based Learning*, 2017.

3. De Jong, T., Lazonder, A.W., Pedaste, M., & Zacharia, Z.C. (2018). *Simulations, games and modelling tools for learning*. In F. Fischer, C. E. Hmelo-Silver, S. R. Goldman & P. Reimann (Eds.) *International Handbook of the Learning Sciences*, Oxford: Routledge.

4. Слободянюк Н.Г. Упровадження особистісно орієнтованого навчання та виховання: проблеми і перспективи розвитку [Електронний ресурс] / Н. Г. Слободянюк – Режим доступу до журн. : http://narodnaosvita.kiev.ua/Narodna_osvita/vupysku/4/statti/4slobodyanuk/4slobodyanul.htm

2.2.10. **Practical class 7.** On-line laboratories: variety and features of functioning. (2 hours)

Types of student activity: individual work

Instructions for students:

1. Follow the link: <https://www.golabz.eu/labs>
2. Check out the available On-line Labs.
3. Get acquainted with On-line laboratories on biological subjects.
4. Get acquainted with the criteria for evaluating the results of individual work.

Criteria for evaluating the results of individual work of students:
Satisfactory (3 points): The answer and the task are marked by incomplete performance in consultation with the teacher. The student owns the material at the initial level (a significant part of the material is mastered at the reproductive level). With the help of a teacher is able to reproduce the logic of scientific propositions, can independently master most of the educational material. Can analyze educational material, compare and draw conclusions; his answer is correct, but not meaningful enough.

Good (4 points): The answer and the task are marked by incomplete performance without the help of the teacher. The student can compare, summarize, systematize information under the guidance of the teacher; knowledge is quite complete; freely uses the studied material in standard pedagogical situations. His answer is complete, logical, reasonable, but with some inaccuracies.

Excellent (5 points): The answer or task is marked by completeness without the help of the teacher. The student has generalized knowledge of the subject, reasonably uses them in non-standard situations; is able to apply the studied material to make their own reasoned judgments in practical pedagogical activities. The student has systematic, effective abilities in educational activity, uses a wide arsenal of means of proof of the opinion, solves difficult problem tasks; prone to system-scientific analysis and forecasting of phenomena; is able to pose and solve problems.

2.2.11. **Tasks for independent work.**

1. Check out the on-line laboratories for general biology and ecology.
2. Which of them do you suggest to use when teaching in SEI? What determines your choice? Justify the answer.

Criteria for evaluating the results of independent work of students:

Satisfactory (3 points): The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): The answers are complete, logical, but lack their own judgments and sound conclusions.

Excellent (5 points): Answers are complete, logical; the student is able to independently assess the facts and defend a personal position, draws sound conclusions.

Recommended literature (Link):

1. <https://support.golabz.eu/support/teachers-support-manual>

2.2.12. Methodological materials and instructions.

The synopsis of the lecture №1 is available at the link [Url].

The presentation of lecture №1 is available at the link..... [Url].

2.2.13. Theme 2. Features of creation of Inquiry learning spaces

2.2.14. **Aims:** To get acquainted with the peculiarities of creation of Inquiry learning spaces and apply them in practice.

Expected learning outcomes: be able to create Inquiry learning spaces.

2.2.15. Criteria and forms for evaluating learning outcomes on the theme.

Forms for evaluating learning outcomes on the theme: current control in practical classes, preparation and presentation of an individual research task (project).

Criteria:

Level I - beginner. The answer in the reproduction of educational material is elementary, fragmentary, due to the initial ideas about the subject of study.

Level II – sufficient. The student reproduces the basic educational material, is able to solve problems on a sample, possesses elementary skills of educational activity.

Level III - intermediate. The student independently applies knowledge in standard situations, has mental operations (analysis, abstraction, generalization, etc.), is able to draw conclusions, correct mistakes. The answer is complete, correct, logical, reasonable, although it lacks its own judgments.

Level IV - high. The student's knowledge is deep, strong, generalized, systematic; the student is able to apply knowledge creatively, his educational activity has a research character, marked by the ability to independently assess various facts, identify and defend a personal position.

2.2.16. **Digital tools:** presentations

2.2.17. **Innovative Teaching / Learning Technologies:** computer technology

2.2.18. **Lecture 4.**

Topic: Features of creation of Inquiry learning spaces. (2 години)

Aims: To get acquainted with the features of creating Inquiry learning spaces, learn to create ILS and apply them in the practice of teachers.

Plan

1. Applications and their use in creating ILS.
2. Inquiry phases and their sequence (inquiry cycle).
3. Variety of inquiry scenarios.

2.2.19. **Practical classes 8-10.** The methodology of creating the Inquiry learning spaces. (6 hours)

Types of student activity: individual work.

Instructions for students:

1. Follow the link: <https://www.golabz.eu/labs>
2. Familiarize yourself with available ILS.
3. Familiarize yourself with available ILS on biological topics.
4. Follow the link: <https://support.golabz.eu/videos?category=5>
5. Watch educational videos on how to create an ILS.
6. Create an ILS on one of the biological topics.
7. Get acquainted with the criteria for evaluating the results of individual work.

Criteria for evaluating the results of individual work of students:

Satisfactory (3 points): The answer and the task are marked by incomplete performance in consultation with the teacher. The student owns the material at the initial level (a significant part of the material is mastered at the reproductive level). With the help of a teacher is able to reproduce the logic of scientific propositions, can independently master most of the educational material. Can analyze educational material, compare and draw conclusions; his answer is correct, but not meaningful enough.

Good (4 points): The answer and the task are marked by incomplete performance without the help of the teacher. The student can compare, summarize, systematize information under the guidance of the teacher; knowledge is quite complete; freely uses the studied material in standard pedagogical situations. His answer is complete, logical, reasonable, but with some inaccuracies.

Excellent (5 points): The answer or task is marked by completeness without the help of the teacher. The student has generalized knowledge of the subject, reasonably uses them in non-standard situations; is able to apply the studied material to make their own reasoned judgments in practical pedagogical activities. The student has systematic, effective abilities in educational activity, uses a wide arsenal of means of proof of the opinion, solves difficult problem tasks; prone to system-scientific analysis and forecasting of phenomena; is able to pose and solve problems.

2.2.20. Tasks for independent work.

1. Creation and presentation of own ILS.

Criteria for evaluating the results of independent work of students:

Satisfactory (3 points): *Content of the presentation.* The goal is vaguely stated. Not quite correctly selected examples. The logic of presenting the material is violated. The content of the presentation is difficult to perceive. *Design.* The work is overloaded with illustrations that interfere with the perception of the content. Slides are not designed and text is placed on them. Number of slides no more than 7.

Good (4 points): *Content of the presentation.* The goals and objectives are not clearly stated. The logic of presenting the material is violated. Examples are not well chosen. *Design.* Successfully chosen color design. There are no audio-video effects in the work. Number of slides no more than 8.

Excellent (5 points): *Content of the presentation.* Clearly defined goals and objectives. The conclusions are clearly stated and correspond to the theme and purpose. The presentation is clear and understandable to the audience. There are no grammatical and stylistic errors. *Design.* The information is logically stated. Successfully used audio and video effects. Charts used. The number of slides is more than 10.

2.2.21. **Practical class 11.** Presentation of an individual research task (project) (ILS). (2 години)

Types of student activity: individual work.

Instructions for students:

1. Present your own ILS.
2. Get acquainted with the criteria for evaluating the results of individual work.

Criteria for evaluating the results of individual student work (ILS):

Mark Criteria	Satisfactory (3 points)	Good (4 points)	Excellent (5 points)
Using inquiry cycle phases	All phases are used, but there are some inaccuracies in the content of individual phases	Proper use of cycle phases. They include the basic properties of each stage, but there is some lack of consistency	Proper use of cycle phases. All phases can be clearly defined. There are specific properties for each phase
Using tools (apps)	Tools are used, but there is no information on how students can use this tool	The tools are used correctly, but in some cases students may have problems using them	The tools are used correctly. Students can easily use them
Using a virtual (on-line) laboratory	A virtual laboratory was used; it is related to the topic of the lesson, but there are no instructions for its use.	A virtual laboratory was used; it is related to the topic of the lesson; there are recommendations for users, but it is not detailed.	Successfully selected virtual laboratory; it is closely related to the topic of the lesson; there are detailed instructions for its use.
Evaluation	Only two types of questions are used (for example, right / wrong; and multiple choice), but the questions are at a low cognitive level and have little to do with the topic.	Different types of questions are used; they are related to the topic, but reveal only the level of knowledge or understanding.	Different types of questions are used (eg open, correct / incorrect, multiple choice or matching); they are related to the topic and they reveal different cognitive levels (knowledge, analysis,

			understanding, etc.)
Maintaining students' attention	Students' attention is distracted during the tasks	Only some phases contain tasks that attract students' attention	Each phase contains tasks that stimulate students' attention
Previous experience and knowledge	ILS tasks are not based on prior knowledge of students.	The tasks of ILS are based in part on previous knowledge and practical experience	ILS tasks activate previous knowledge and experience, explain new terms, using dialogues or virtual tips
Working memory capacity	ILS uses long-lasting videos (more than 6 minutes) as well as inappropriate visual information	ILS used videos lasting 3-6 minutes; in some phases there are hidden clues that give additional explanations to students.	ILS uses videos lasting up to 3 minutes; students' attention is focused on important information

2.2.22. Questions for module control work 2:

1. Advantages and difficulties of using Inquiry based learning.
2. Compare traditional and Inquiry based learning.
3. Outline the theoretical and practical aspects of Inquiry based learning.
4. What difficulties arise in the implementation of Inquiry based learning at school.
5. What are the features of the use of Inquiry based learning in higher education.
6. Outline ways to create problem situations and motivate students.
7. Features of the functioning of ILS.
8. Features of creating ILS.

Criteria for evaluating the results of module control work 1:

Satisfactory (3 points): The student has the material at the initial level. The answers are fragmentary, due to a superficial acquaintance with the problem.

Good (4 points): The answers are complete, logical, but lack their own judgments and sound conclusions. The student can compare, summarize, systematize information; knowledge is quite complete; freely uses the studied material in standard pedagogical situations.

Excellent (5 points): Answers are complete, logical; the student is able to independently assess the facts and defend a personal position, draws sound conclusions; is able to apply the studied material to make their own reasoned judgments in practical pedagogical activities. The student has systematic, effective abilities in educational activity, uses a wide arsenal of means of proof of the opinion, solves difficult problem tasks; prone to system-scientific analysis and forecasting of phenomena.

2.2.23. Methodological materials and instructions.

The synopsis of the lecture №1 is available at the link [Url].

The presentation of lecture №1 is available at the link..... [Url].

3. Tasks for summative assessment

3.1. List of questions for summative assessment.

1. Define the concept of "STEM-subjects", "STEM-education".
2. Innovative tools in the educational process.
3. Forms of organization of the educational process of STEM-education.
4. Prerequisites for the creation of an all-Ukrainian network of STEM-centers / laboratories.
5. Implementation of STEM education in different countries.
6. Features of the use of the latest educational technologies: Inquiry Based Learning, Project-based learning, collaborative learning, dual learning.
7. Outline the practical basis of application of Flipped learning and flipped classroom
8. Features of the use of the latest educational technologies in universities.
9. Game technologies in teaching STEM - subjects.
10. Interactive technologies in teaching STEM - subjects.
11. Integral educational technology in teaching STEM - subjects.
12. Technology for the development of critical thinking in the teaching of STEM - subjects.
13. Advantages and difficulties of using Inquiry based learning.
14. Comparison of traditional and Inquiry based learning.
15. The role of teacher and student in Inquiry based learning.
16. Theoretical and practical aspects of Inquiry based learning.
17. Formation of motivation as one of the tasks of Inquiry based learning.
18. Ways to create problem situations.
19. Advantages and disadvantages of Inquiry based learning.
20. Features of the use of Inquiry based learning in higher education.
21. Inquiry phases and their sequence (inquiry cycle).
22. Variety of inquiry scenarios.

4. List of recommended literature (including electronic resources).

Basic:

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