MoPED: Modernization of Pedagogical Higher Education by Innovative Teaching Instruments

HANDBOOK

Academic discipline:

Innovation technologies in teaching of physics

For students of specialty *"014.08 secondary education (Physics) specialty"*

Degree: *Master*

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2019 p.

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.

Abstract of the subject:

The course is aimed at preparing future teachers of physics to implement the concepts of STEM-education using innovative learning technologies, such as: ILS (Inquiry Learning Spaces), PBL (problem-based learning), BYOD (Bring Your Own Device), flipped learning, making, etc. The feature of the training course is that innovative technologies are not only a subject of study, but also a means of learning, studying with the use of these technologies. The course is implemented in the ecosystem ICR (Innovation Classroom).

Key words

STEM-education, innovative technologies, physics education, ILS (Inquiry Learning Spaces), PBL (problem-based learning), BYOD (Bring Your Own Device), Flipped learning, make-up.

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1. Description of the discipline

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

6.0 ECTS credits.

Total number of hours: 180

For full-time education: 10 lecture hours, 50 hours of practical classes; 120 hours - independent work of students ;.

For distance learning: 8 lecture hours; 8 hours of practical classes; 164 hours - independent work of students.

1.2. Characteristics of the discipline by form of study.

Students are taught full-time and part-time forms of study during the study of the discipline, in particular with the use of blended learning technology.

1.3. Discipline status.

Discipline is a mandatory component of the educational program

1.4. Prerequisites for studying the discipline.

None.

1.5. Year of preparation, semester.

Year of preparation - 1, semester - 2

1.6. Form of final control.

Credits.

1.7. Language of instruction.

Ukrainian.

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

https://pdpu.edu.ua/

1.9. Developers.

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1.10. The purpose of studying the discipline.

To acquaint future teachers and teachers of physics with the best European and world pedagogical practices and methods of STEM education; to ensure the ability of future teachers and instructors of physics to implement, use, disseminate innovative learning technologies in the educational process.

1.11. Competences that are formed in the process of studying the discipline.

Integral competence (IC). Ability to solve complex problems and problems in the organization and monitoring of the educational process in physics and mathematics in general secondary education or in the process of training specialists in institutions of higher education, which involves research and / or innovation in situations characterized by uncertainty conditions and requirements

General competencies (GC):

GC 5. Ability to work in a team and independently

GC 6. Ability to use information and communication technologies

GC 7. Ability to generate new ideas (creativity)

Special competencies (SC):

SC 6. Ability to organize the educational process using modern tools, methods, techniques, technologies

SC 8. Ability to organize the distance learning.

1.12. Learning outcomes of the discipline.

PR 3. Know and accurately apply modern techniques and technologies, including information, for the successful and effective implementation of professional activities and quality assurance of research in the field

PR 5. To design various types of educational occupations, in particular in the conditions of distance education, to select strategy of management of educational process

PR 8. Have pedagogical techniques for forming and maintaining the appropriate level of motivation of students

PR 9. Demonstrate skills of independent work with different sources of information, skills of self-education, ability to design specific areas of their own professional development.

PR 13. Demonstrate practical skills of teamwork, skills of analysis of someone else's professional activity, skills of introspection.

1.13. Control of students' academic achievements

Means of diagnostics of results of training (current and final estimation) Assessment for the each content module includes scores for the results achieved by the student at practical classes, also during performance of independent work. Final evaluation

The final assessment in the form of a credit is carried out according to the assessment of the results obtained by students during the course and has the following weights:

Content module 1- max 50 points (3 ECTS credits)

Content module 2 - max 50 points (3 ECTS credits)

Total: max 100 points

Communication and feedback Students receive information about learning outcomes (grades, comments) in the Google Classroom grade journal.

Students can ask questions and get advice personally and remotely via corporate email, online messengers, and webinars.

higher education institutions assessment scale For credit

90 - 100 A «Credited»

82 - 89 B

74 - 81 C

64 - 73 D

60 - 63 E

35 - 59 FX «Not credited»

1 - 34 F

2.1. Content module 1. INNOVATIVE TECHNOLOGIES IN PHYSICS IN SECONDARY EDUCATION INSTITUTIONS

2.1.1. TOPIC 1. STEM-education: basic principles, concepts, educational trends, methods and technologies.

2.1.2. Purpose and expected results.

Objective: To form in students of future physics teachers of physics ideas about the modern concept of STEM-education, knowledge about innovative tools and forms of organization of the educational process of STEM-education, practical skills of using technologies Flipped learning, BYOD (Bring Your Own Device), PBL (Problem-based learning), making.

Expected results:

knowledge of the basic principles, methods and technologies of the concept of STEM-education, their awareness from the standpoint of implementation in the educational process in physics; mastering technologies Flipped learning, BYOD, PBL, making.

2.1.3. Evaluation criteria and forms

Forms of evaluation: formative evaluation of messages, essays, presentations of the completed project on the topic

Evaluation criteria Quantitative and / or qualitative characteristics

knowledge of the basic principles, methods and technologies of the concept of STEM-education, their awareness from the standpoint of implementation in the educational process in physics.

High level: the student has a systematic, reasoned, in-depth knowledge of the study material, is able to independently assess some new facts and phenomena, uses a variety of sources of information

Sufficient level: the student has the educational material at a sufficient level, reasonably teaches its main content during the answers, but without a comprehensive analysis and argumentation

Intermediate level: the student partially has the study material, but shows basic knowledge. During the answers he teaches the educational material in fragments, superficially, insufficiently reveals the content of theoretical questions and practical tasks.

Entry level: the student partially or insufficiently owns the educational material, operates with the initial ideas during the answers, does not sufficiently disclose the content of theoretical questions, while making inaccuracies and errors.

Ability to develop and present a project of a physics lesson independently using technologies Flipped learning, BYOD, PBL, make-up High level (20 points) The developed project is executed completely with observance of technology. A variety of technological tools are adequately used. The presented information is scientific, meets the program requirements. No errors.

Sufficient level (16 points)

The developed project is executed completely with observance of technology. Two technological tools have been used, but the expediency of using one of them is insufficiently substantiated, or only one technological tool has been used in compliance with the methodological requirements of its expediency. The presented information is scientific, meets the program requirements. There are minor flaws in the information provided.

Intermediate level (10 points)

The developed project is executed mainly with observance of technology. One or two technological tools have been used, but the expediency of their use of technological tools is insufficiently substantiated. The information provided is scientific, but sometimes the software requirements are not met. There are no more than two errors in the presented information.

Low level (4 points)

In the developed project there are significant flaws in compliance with the technology. One technological tool is used, but the expediency of its use is insufficiently substantiated. The information provided is scientific, but the program requirements are not met. There are more than two errors in the presented information.

2.1.4. Digital tools. LMS Google Classroom, Padlet, Kahoot

2.1.5. Innovative learning technologies. Group work using a mind map, individual and group work on Flipped learning technology, surveys on BYOD technology.

2.1.6. Lecture 1. STEM-education: basic principles, concepts, educational trends, methods and technologies (2 hours)

Plan:

1. Prerequisites and goals of STEM-education in the Ukrainian educational space.

2. The concept of "STEM-education" and "STEM-training".

3. Comparison of STEM-education with traditional education.

4. Educational trends in traditional and STEM education.

2.1.7. Tasks for independent work of students.

(Pre-phase to the topic of practical lesson 1.1)

1. Prepare a report and / or essay "Modern educational trends from the standpoint of their implementation in the educational process in physics."

2.1.8. Practical lesson 1.1. STEM-education: basic principles, concepts, educational trends, methods and technologies (2 hours)

2.1.9. Topics of individual and / or group tasks

(Face-to-Face Phase) 1. Individual work using the Kahoot tool: survey of students on the basic concepts of the topic (Interactive Learning Area).

2. Group work to create a map of opinions on the advantages and disadvantages of the implementation of modern educational trends in the educational process in physics using the tool Padlet (Interactive learning area; brainstorming area).

(Post Phase) 3. Group work: discussion in the format of "Round table" on the results of group work (Interactive learning area).

2.1.10. Tasks for independent work of students.

(Pre-phase to the topic of practical lesson 1.2)

1. Prepare a report and / or essay "Technology Flipped learning".

2.1.11. Practical lesson 1.2. Flipped learning technology in the educational process in physics in secondary schools (2 hours)

2.1.12.Topics of individual and / or group tasks.

(Face-to-Face Phase) 1. Individual work of students to develop a conceptual map of a physics lesson on a particular topic (chosen at will or by lot) using Flipped learning technology (Interactive learning area; brainstorming area).

2. Approbation of students' developments in the format "students" - "teachers". (Interactive learning area).

(Post Phase)

3. Discussion with the use of synectic assault: one part of students should speak from the position of students, and the other part - from the position of physics teachers on the availability or complexity, volume of teaching material, feasibility of using Flipped learning technology, clarity of proposed tasks. phase), promoting a better understanding of physical knowledge (during Face-to-face, Post-phase), etc. (Interactive learning area).

2.1.13. Tasks for independent work of students.

(Pre-phase to the topic of practical lesson 1.3)

1. Prepare a report and / or essay "BYOD Technology".

2.1.14 Practical lesson 1.3. BYOD (Bring Your Own Device) technology in the educational process in physics in secondary schools (2 hours)

2.1.15. Topics of individual and / or group tasks.

(Face-to-Face Phase) 1. Individual work of students on the development of a test project on the topic of school physics course in online services (LearningApps, Kahoot, etc.) (Interactive learning area);

2. Mutual testing by students of developed projects (Interactive Learning Zone).

(Post Phase) 3. Reflection: discussion of features of use of online services for testing, comparison of online testing with traditional forms (Interactive learning area).

2.1.16. Tasks for independent work of students.

(Pre-phase to the topic of practical lesson 1.4)

1. Prepare a report and / or essay "BYOD Technology".

2.1.17 Practical lesson 1.4. PBL (Problem-based learning) technologies and make-up in the educational process in physics in secondary schools (2 hours)

2.1.18. Topics of individual and / or group tasks.

(Face-to-Face Phase) 1. Group work of students with the use of brainstorming to create problem situations and their solution with the help of making on a specific topic of the school physics course (Interactive learning area, brainstorming area);

2. Mutual approbation of student developments (Zone of technical design, zone of interactive learning)

(Post Phase) 3. Discussion using synectic assault: one part of students should speak from the position of students, and the other part - from the position of physics teachers on the accessibility, complexity, clarity of the proposed tasks, the feasibility of using technology, promoting better understanding of physical knowledge and more. (Interactive learning area).

2.1.19.Tasks for independent work of students.

Develop an individual project of a physics lesson using technologies Flipped learning, BYOD, PBL, making.

2.1.20. Practical lesson 1.5. Presentation and approbation of the project of a physics lesson with the use of technologies Flipped learning, BYOD, PBL, making in the educational process in physics (2 hours)

2.1.21.Topics of individual and / or group tasks.

1. Presentation of an individual project of a physics lesson with the use of technologies Flipped learning, BYOD, PBL, making. (Interactive learning area)

2. Group work: round table discussion with the map of opinions created at the beginning of the study on the advantages and disadvantages of the implementation of modern educational trends in the educational process in physics using the tool Padlet (Interactive Learning Area)

2.1.22. Topic 2. ILS TECHNOLOGY (INQUIRY LEARNING SPACES) IN THE EDUCATIONAL PROCESS OF PHYSICS IN SECONDARY EDUCATION INSTITUTIONS.

2.1.23. Purpose and expected results.

Objective: To form in students of future physics teachers knowledge and skills of using ILS technology (Inquiry Learning Spaces) using Go-Lab, Graasp ILS platform

Expected results:

mastering ILS technology using Go-Lab training and research spaces, Graasp ILS platform

2.1.24. Criteria and forms of evaluation of learning outcomes on the topic.

Forms of evaluation: formative evaluation of the completed project on the topic

Evaluation criteria Quantitative and / or qualitative characteristics

General didactic and methodological Scientific, compliance with regulations, expediency of use.

Accessibility, taking into account the level of knowledge and personal qualities of students High level (10 points): The content of educational material presented in the ILS project is completely scientific, meets regulatory requirements, suitable for use in the educational process of physics in secondary education. The educational material presented in the ILS project is presented in a clear and interesting form for students; the level of knowledge and features of perception and memorization of information are fully taken into account; interdisciplinary information was used.

Sufficient level (8 points): The content of the educational material presented in the ILS project is completely scientific, meets regulatory requirements, but some elements of the content do not seem appropriate for use in the educational process in secondary education. The educational material presented in the ILS project is mainly presented in a clear and interesting form for students; the level of knowledge and peculiarities of perception and memorization of information are mainly taken into account.

Intermediate level (5 points): The content of educational material presented in the ILS project is scientific, but some elements of the content do not meet regulatory requirements and do not seem appropriate for use in the educational process in secondary education. The educational material presented in the ILS project is presented in a form difficult for students to perceive, only some elements can arouse students' interest; the level of knowledge and features of perception and memorization of information are partially taken into account.

Entry level (2 points): The content of the educational material presented in the ILS project is scientific, but many elements of the content do not meet regulatory requirements and do not seem appropriate for use in the educational process in secondary education. The educational material presented in the ILS project is presented in a form difficult for students to perceive, does not arouse students' interest; the level of knowledge and features of perception and memorization of information are almost not taken into account.

Technological	Adherence to the phases of the technologies used (in particular, the phases of Flipped learning, "Inquiry cycle"). Use of various tools (digital, material).	High level (10 points): The developed project is completed in full compliance with ILS technology. The various technological tools of the Graasp environment are adequately used. Sufficient level (8 points): The developed project is completed in full compliance with ILS technology. Only one technological tool of the Graasp environment is used in compliance with the methodological requirements of its expediency. Intermediate level (5 points): The developed project was performed mainly in compliance with ILS technology. Technological tools of the Graasp environment are not used or it is doubtful whether they are used from a methodological point of view. Entry level (2 points): The developed project was performed

		mainly in compliance with ILS technology. Graasp technology tools are not used or the use of technology tools does not seem appropriate from a methodological point of view.

Visually and aesthetics	High level (10 points): Information is adequately presented in different ways (text, pictures, photos, videos, simulations, etc.). The requirements of visibility and aesthetics are fully met. Sufficient level (8 points): Information is presented in different ways (text, pictures, photos, videos, simulations, etc.), but in some cases this diversity is excessive. The requirements of visibility and aesthetics are mostly met. Intermediate (5 points): Information is presented in one or two ways (for example, only text and pictures or photographs) or the variety of information is excessive. Visibility and / or aesthetics requirements are sometimes not met. Entry level (2 points): Information is presented in only one way (for example, only text, or only a video fragment). Visibility and / or aesthetic requirements are generally not met.

2.1.25. Digital tools. LMS Google Classroom, Go-Lab ecosystem (Go-Lab portal, Graasp environment), Phet.Coorado portal

2.1.26. Innovative learning technologies.
Work with the electronic interactive panel, use of virtual laboratories, use of technology of research and cognitive training (IBL)

2.1.27. Lecture 2-3. ILS (Inquiry Learning Spaces) technology in the educational process of physics in secondary schools (4 hours)

Plan:

1. The use of ILS technology in the teaching of STEM-disciplines
2. Implementation of ILS technology in the Go-Lab ecosystem
3. Creating research learning spaces in the Graasp environment
4. An example of developing a research learning space in Graasp

2.1.28. Tasks for independent work of students.

1. Prepare a report and / or essay "Comparison of traditional and experiential learning."

2.1.29. Practical lesson 2.1. Go-Lab Training and Research Spaces (2 hours)

2.1.30. Topics of individual and / or group tasks.

1. Individual or group work in the portal Go-lab, Phet.Colorado (Interactive Learning Zone).

2. Reflection: discussion of the peculiarities of the use of simulations, computer models of physical phenomena and processes (Interactive learning area).

2.1.31.Tasks for independent work of students.

1. Fill in the Google-table "Catalog of simulations in physics portal Phet.Colorado"

2.1.32. Practical classes 2.2–2.5. Graasp ILS platform (8 hours)

2.1.33. Topics of individual and / or group tasks.

1. Individual or group work with the ILS-platform Graasp (Interactive Learning Zone).

2. Individual work on mastering digital Graasp tools (Interactive Learning Zone).

3. Individual work on the modification of the existing ILS from the school physics course (Interactive Learning Zone).

4. Individual work on creating a new ILS from the school course of physics (Interactive learning area; technical design area - if necessary).

5. Reflection (at the end of each practical lesson): discussion of the peculiarities of the implementation of ILS technology by Graasp in the educational process in physics in general secondary education (Interactive learning area).

2.1.34. Tasks for independent work of students.

Using ILS technology, develop your own research learning space (ILS) project on a self-selected topic of a school physics course in a Graasp environment.

2.1.35. Practical classes 2.6– 2.7. Presentation, testing and evaluation of individual ILS from the school course of physics (4 hours)

2.1.36. Topics of individual and / or group tasks.

1. Presentation of an individual research learning space (ILS) in a school physics course. (Interactive learning area)

2. Group work: discussion with the use of synectic assault: one part of students should speak from the position of students, and the other part - from the position of physics teachers on accessibility, complexity, proposed tasks in ILS, the feasibility of their use in the educational process of physics, understanding of physical knowledge, etc. (Interactive learning area).

2.2. Content module 2. INNOVATIVE TECHNOLOGIES IN PHYSICS IN HIGHER EDUCATION INSTITUTIONS

2.2.1. TOPIC 3. Features of the application of innovative technologies in pedagogical institutions of higher education.

2.2.2. Purpose and expected results.

Objective: To form in future teachers of physics knowledge about the peculiarities of the application of innovative technologies, in particular, Flipped learning technologies in higher education institutions.

Expected results:

Knowledge of theoretical and practical foundations of innovative learning; composition, structure, principles of implementation and functioning of innovative technologies, in particular, Flipped learning technologies in higher education institutions. Ability to apply innovative learning technologies in order to organize and implement the educational process in physics.

2.2.3. Criteria and forms of evaluation of learning outcomes on the topic.

Forms of evaluation: formative evaluation of messages, essays, presentations of the completed project on the topic.

Evaluation criteria	Quantitative and / or qualitative characteristics
Knowledge of theoretical and practical foundations of innovative learning; composition, structure, principles of implementation and functioning of innovative technologies in higher education institutions.	High level: the student has a systematic, reasoned, in-depth knowledge of the study material, is able to independently assess some new facts and phenomena, uses a variety of sources of information Sufficient level: the student has the educational material at a sufficient level, reasonably teaches its main content during the answers, but without a comprehensive analysis and argumentation. Intermediate level: the student partially owns the study material, but shows basic knowledge. During the answers he teaches the educational material in fragments, superficially, insufficiently reveals the content of theoretical questions and practical

	tasks. Entry level: the student partially or insufficiently owns the educational material, operates with the initial ideas during the answers, does not sufficiently disclose the content of theoretical questions, while making inaccuracies and errors.

Ability to apply innovative learning technologies in order to organize and implement the educational process in physics, independently develop and present a project of lectures and practical classes in physics using innovative methods and technologies, in particular, Flipped learning technology.	High level (20 points) The developed project is executed completely with observance of technology. The presented information is scientific, meets the program requirements. No errors. A variety of technological tools are adequately used. Sufficient level (16 points) The developed project is executed completely with observance of technology. The presented information is scientific, meets the program requirements. There are minor flaws in the information provided. Two technological tools have been used, but the expediency of using one of them is insufficiently substantiated, or only one technological tool has been used in compliance with the methodological requirements of its expediency. Intermediate level (10 points) The information provided is scientific, but sometimes the software requirements are not met. There are no more than two errors in the presented information. The developed project is executed mainly with observance of technology. One or two technological tools have been used,

	but the expediency of using technological tools is insufficiently substantiated. Low level (4 points) In the developed project there are significant flaws in compliance with the technology. The information provided is scientific, but the program requirements are not met. There are more than two errors in the presented information. One technological tool is used, but the expediency of its use is insufficiently substantiated.

2.2.4. Digital tools. LMS Google Classroom, Padlet, Kahoot, Phet.Coorado portal, Go-Lab portal, tools for creating mental and concept maps: Coggle, MindMeister, Mind42, Bubbl.

2.2.5. Innovative learning technologies. Individual and group work on Mind Mapping and Flipped learning technologies, survey on BYOD technology.

2.2.6. Lecture 3. Features of application of innovative technologies in pedagogical establishments of higher education (2 hours)

Plan

1. Priorities for the development of higher education in the context of European integration.

2. Features of application of innovative technologies in educational process on physics in pedagogical ZVO.

3. Virtual experiment and its role and place in the teaching of physics.

4. Mind Mapping technology in teaching physics in high school.

5. Technology Flipped learning in the educational process of physics in pedagogical institutions of higher education.

2.2.7. Tasks for independent work of students.

(Pre-phase to the topic of practical lesson 3.1)

Prepare a report and / or essay "Comparison of the features of the use of innovative technologies in the educational process in physics in secondary and higher education."

2.2.8. Practical lesson 3.1. Innovative technologies and features of their application in the educational process in physics in pedagogical institutions of higher education (2 hours)

2.2.9. Topics of individual and / or group tasks.

(Face-to-Face Phase) 1. Individual work using the Kahoot tool: survey of students on the basic concepts of the topic (Interactive Learning Area).

2. Group work on the creation of a "wall" on the topic "Innovative technologies in the teaching of physics in ZVO" using the online board Padlet (Interactive learning area; brainstorming area).

(Post Phase) 3. Group work: discussion in the format of "Round table" on the results of group work (Interactive learning area).

2.2.10. Tasks for independent work of students.

(Pre-phase to the topic of practical lesson 3.2)

1. Prepare a report and / or essay "Virtual experiment. For and against"

2.2.11. Practical lesson 3.2. The ratio of full-scale and virtual experiment in teaching physics in high school

(2 hours)

2.2.12. Topics of individual and / or group tasks.

(Face-to-Face Phase) 1. Individual work of students in virtual online laboratories, analysis of possibilities of visualization of real phenomena, processes, imaginary experiments with the help of simplified computer models and simulations (Interactive learning area).

2. Group work on creating a "wall" on the topic "Virtual experiment in teaching physics" using the online board Padlet (Interactive learning area; brainstorming area).

(Post Phase) 3. Discussion on the feasibility and methods of using selected simulations to study certain topics in general physics (Interactive Learning Area).

2.2.13. Tasks for independent work of students.

(Pre-phase to the topic of practical lesson 3.3)

Prepare a general physics lesson plan using a virtual experimenter.

2.2.14. Practical lesson 3.3. Use of computer simulations in practical problem-solving classes (2 hours)

2.2.15. Topics of individual and / or group tasks.

(Face-to-Face Phase) 1. Individual work of students in virtual online laboratories, analysis of the possibilities of using virtual simulations in practical classes on solving problems (Interactive learning area).

2. Group work on compiling different types of problems from the course of general physics on the basis of virtual simulations (Interactive learning area; brainstorming area).

(Post Phase) 3. Round table discussion on the feasibility and possibilities of using virtual simulations to organize practical classes on solving problems (Interactive Learning Area).

2.2.16. Tasks for independent work of students.

(Pre-phase to the topic of practical lesson 3.4)

Prepare a general physics lesson plan using a virtual experimenter.

2.2.17. Practical lesson 3.4. Use of Mind mapping technology in teaching physics in high school.

2.2.18. Topics of individual and / or group tasks.

(Face-to-Face Phase) 1. Individual work of students on the development of the service Coggle.it of conceptual map of a particular topic of general physics (chosen at will or by lot) using computer simulations (Interactive learning area; brainstorming area).

2. Group work of students to develop a common conceptual map of the selected topic of general physics (Interactive learning area).

(Post Phase) 3. Group work: discussion in the format of "Round table" on the results of group work (Interactive learning area).

2.2.19. Tasks for independent work of students.

(Pre-phase to the topic of practical lesson 3.5)

1. Prepare a report and / or essay "Application of Flipped learning technology in higher education".

2.2.20. Practical lesson 3.5. Flipped learning technology in the educational process in physics in higher education institutions (2 hours)

2.2.21.Topics of individual and / or group tasks.

(Face-to-Face Phase) 1. Individual work of students on the development of a conceptual map of a lecture on physics on a particular topic (chosen at will or by lot) using the technology Flipped learning (Interactive learning area; brainstorming area).

2. Approbation of students' developments in the format "students" - "teachers" (Interactive learning area).

(Post Phase) 3. Discussion using synectic assault on accessibility or complexity, volume of educational material, expediency of using Flipped learning technology, clarity of the proposed tasks (during Pre-phase), promoting better understanding of physical knowledge (during Face-to - face, Post-phase) etc. (Interactive learning area).

2.2.22. Tasks for independent work of students.

1. To develop a mental map of a practical lesson on a certain topic (optional) of general physics.

2.2.23. Topic 4. Problem-based learning. Technologies PBL (Problem based learning), ILS (Inquiry Learning Spaces) in the educational process in physics in higher education.

2.2.24. Purpose and expected results.

Goal:

To form in students-future teachers of physics theoretical knowledge and practical skills of use of technologies PBL, ILS in educational process on physics in institutions of higher education.

Expected results:

Mastering the methods of application of problem-based and research learning technologies in higher education, in particular, Case technology, PBL (Problem-based learning), ILS (Inquiry Learning Spaces) ILS using Go-Lab, ILS-Graasp platform.

2.2.25. Criteria and forms of evaluation of learning outcomes on the topic.

Forms of evaluation: formative evaluation of the completed project on the topic.

Evaluation criteria		Quantitative and / or qualitative characteristics
General didactic and methodical	Scientific, compliance with regulations, feasibility of use. Accessibility, taking into account the level of knowledge and personal qualities of students	High level (10 points): The content of educational material presented in the ILS project is completely scientific, meets the regulatory requirements and the level of higher education, suitable for use in the educational process of physics in pedagogical institutions of higher education. The educational material presented in the project is presented in a clear and interesting form for students; the level of knowledge and features of perception and memorization of information are fully taken into account; interdisciplinary information was used. Sufficient level (8 points): The content of educational material presented in the ILS project is completely scientific, meets regulatory requirements, but some elements of the content do not seem appropriate for use in the educational process in pedagogical free economic zones. The educational material presented in the ILS project is mainly presented in a clear and interesting form for students; the level of knowledge and peculiarities of perception and memorization of information are mainly taken into account.

		Intermediate level (5 points): The content of educational material presented in the ILS project is scientific, but some elements of the content do not meet regulatory requirements and do not seem appropriate for use in the educational process in higher education institutions. The educational material presented in the ILS project is presented in a form difficult for students to perceive, only some elements can arouse interest; the level of knowledge and features of perception and memorization of information are partially taken into account. Entry level (2 points): The content of the teaching material presented in the ILS project is scientific, but many elements of the content do not meet regulatory requirements and do not seem appropriate for use in the educational process in higher education institutions. The educational material presented in the ILS project is presented in a form difficult for students to perceive, does not arouse their interest; the level of knowledge and peculiarities of perception and memorization of information are almost not taken into account.
Technological	Adherence to the phases of the technologies used (in particular, the phases of Flipped learning, “Inquiry cycle”). Use of various	High level (10 points): The developed project is completed in full compliance with ILS technology. The problem that served as the basis for project development was clearly formulated. The various technological tools of the Graasp

	tools (digital, material)	environment are adequately used. Sufficient level (8 points): The developed project is completed in full compliance with ILS technology. Only one technological tool of the Graasp environment is used in compliance with the methodological requirements of its expediency. Intermediate level (5 points): The developed project was performed mainly in compliance with ILS technology. Technological tools of the Graasp environment are not used or it is doubtful whether they are used from a methodological point of view. Entry level (2 points): The developed project was performed mainly in compliance with ILS technology. Graasp process technology tools are not used or the use of technology tools does not seem appropriate from a methodological point of view.

Visuality and aesthetics	High level (10 points): Information is adequately presented in different ways (text, pictures, photos, videos, simulations, etc.). The requirements of visibility and aesthetics are fully met. Sufficient level (8 points): Information is presented in different ways (text, pictures, photos, videos, simulations, etc.), but in some cases this diversity is excessive. The requirements of visibility and aesthetics are mostly met. Intermediate level (5 points): Information presented in one or two ways (for example, only text and pictures or photographs) or the

	variety of information is excessive. Visibility and / or aesthetic requirements are sometimes not met. Entry level (2 points): Information is presented in only one way (for example, only text, or only a video fragment). Visibility requirements and / or aesthetics is mostly not observed.

2.1.26. Digital tools. LMS Google Classroom, Go-Lab ecosystem (Go-Lab portal, Graasp environment), Phet.Coorado portal.

2.1.27. Innovative learning technologies. Work with the electronic interactive panel, use of virtual laboratories, use of methods and technologies of problem-oriented training (Case-study method, PBL technology), technologies of research and cognitive training (IBL).

2.2.28. Lecture 4. Case-study method, PBL (Project Based Learning) - PtBL (Project Based Learning) and PtBL (Problem Based Learning) - problem-based learning (problem-oriented learning) in the educational process in physics in higher education institutions education (2 hours)

Plan

1. Problem-oriented learning. Specifics and tasks of the Case-study method in teaching physics in pedagogical higher education institutions.

2. Application of PtBL (Problem Based Learning) and PBL (Project Based Learning) methods in the educational process in physics in higher education institutions.

3. ILS (Inquiry Learning Spaces) technology in higher education institutions.

2.2.29. Tasks for independent work of students.

(Pre-phase to the topics of practical classes 4.1-4.2)

1. To prepare a report and / or essay "Application of technology of problem-oriented teaching of physics in higher education institutions".

2.2.30. Practical classes 4.1–4.2. Specifics and tasks of the Case-study method in teaching physics in pedagogical free economic zones (4 hours)

2.2.31. Topics of individual and / or group tasks.

(Face-to-Face Phase1. Group work with the use of brainstorming to create problem situations to formulate problems that may arise in the process of teaching physics in higher education institutions and become a basis for the development of cases (Interactive Learning Zone).

Individual and group work of students to find reference material that can be offered to solve the formulated problems, and ways to solve them (Brainstorming area, interactive learning area.)

(Post Phase) 3. Discussion of developments in the format of "Round table"

2.2.32. Tasks for independent work of students.

Write a concise case (3-5 pages of text) that contains a problem related to teaching physics in high school.

2.2.33. Practical lesson 4.3. Application of PBL (Project Based Learning) methods - PtBL (Project Based Learning) and PtBL (Problem Based Learning) methods in the educational process in physics in higher education institutions (2 hours)

2.2.34. Topics of individual and / or group tasks.

(Face-to-Face Phase) 1. Group work of students with the use of brainstorming on the analysis of possible scenarios of using the project approach to teaching and research work on the implementation of qualification work (Interactive learning area, brainstorming area).

2. Individual and group work of students from the preparatory stage of development of the educational project: choice of a theme, definition of the purpose (task), nomination of hypotheses of the decision of a problem; substantiation of research methods; development of a research plan (Interactive learning area, brainstorming area).

(Post Phase) 3. Discussion of developments in the format of "Round table"

2.2.35. Tasks for independent work of students.

1. Develop an individual project to study a particular physical phenomenon.

2.2.36. Practical classes 4.4. – 4.6. ILS (Inquiry Learning Spaces) technology in the educational process in physics in higher education institutions (6 hours)

2.2.37. Topics of individual and / or group tasks.

1. Individual or group work with the ILS-platform Graasp (Interactive Learning Zone).

2. Individual work on creating a new ILS for the course of general physics (Interactive learning area; technical design area - if necessary).

3. Reflection (at the end of each practical lesson): discussion of the features of the implementation of ILS technology by Graasp in the educational process in physics in ZVO (Zone of interactive learning).

2.2.38. Tasks for independent work of students.

Using ILS technology, develop your own research learning space (ILS) project on a self-selected general physics course topic in a Graasp environment.

2.2.39. Practical classes 4.7. – 4.8. Presentation, testing and evaluation of individual ILS in the course of general physics. (4 years)

2.2.40. Topics of individual and / or group tasks.

1. Presentation of an individual research learning space (ILS) for a general physics course (Interactive Learning Zone).

2. Group work: discussion with the use of synectic assault on the accessibility, complexity, proposed tasks in the presented ILS, the feasibility of their use in the educational process in physics, promoting a better understanding of physical knowledge, etc. (Interactive learning area).

3. List of recommended literature (including electronic resources)

1. Annex 2 to the letter of MOIPPO № 999 / 15-32 dated 28.09.2015. - Access mode: http://osvitakrda.mk.ua.

2. Letter № 869-16 / 02.2 MOIPPO on the implementation of STEM-education in secondary schools from 05.10.2015. - Access mode: http: //osvita-krda.mk.ua.586098-EPP-1-2017-1-UA-EPPKA2-CBHE-JP

3. Sharko V. Modernization of the system of teaching students STEM-disciplines as a methodological problem. Scientific notes. Series: Problems of methods of physical-mathematical and technological education. - Volume 3, № 10, 2016. - P. 160-165.

4. New directions in STEM disciplines (natural sciences, technologies, engineering and mathematics). - Access mode: http://iipdigital.usembassy.gov/st/russian/publication/2014/01/20140109290208.html#ixzz4MHxzXHSz

5. STEAM-education: an innovative scientific and technical system of education ". - Access mode: http: //ippo.kubg.edu.ua/content/11373

6. STEM education. - Access mode: URL: http://www.imzo.gov.ua/stem-osvita/.

7. Training in Natural, Technical, Engineering and Mathematical Sciences in the USA: STEM Program; translation of the report // Psychological science and education. - 2011. - № 4. - P. 32-38.

8. Morse N. Presentation of STEAM-education. - Access mode: http://www.stemschool.com/.

9. Wember VP The use of the Go-Lab ecosystem for the organization of research learning / Open educational e-environment of modern University, № 5 (2018)

10. Gurevich RS Innovative educational technologies in the educational process of higher education / RS Gurevich // Modern information technologies and innovative teaching methods in training: methodology, theory, experience, problems. - 2013. - Vip. 36. - P. 7-12.

11. White B.Y., Frederiksen J.R. Inquiry, modeling, and metacognition: making science accessible to all students. Cognition and Instruction, 16. 1998. P. 3-118.

12. Rodger W. Bybee, Joseph A. Taylor, April Gardner, Pamela Van Scotter, Janet Carlson Powell, Anne Westbrook, and Nancy Landes. The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications. 2006. URL: http://pdspalooza.pbworks.com/f/bscs5eexecsummary.pdf

13. Mariia Gladun, Dariya Buchynska. Tools for inquiry-based learning in primary school. Open educational e-environment of modern University, 3. 2017. P.43-54.

14. Ton De Jong. Innovations in STEM education: the Go-Lab federation of online labs // Smart Learning Environments. 2014. URL: https://slejournal.springeropen.com/articles/10.1186/s40561-014-0003-6