# HANDBOOK

**Title of the Course:** *Basic principles of STEM-education*
Specialty**:** *"013" Primary Education"*
Higher education degree: *Bachelor*

Developers:
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**Annotation of the discipline:** Within the discipline students will get acquainted with the integrated approach to learning, the concept of STEAM - education and ways to implement it in the educational process of primary school, innovative pedagogical technologies: PBL (educational projects), PrBL (problem-based learning), IBL (research- cognitive learning), blended and inverted learning, making, computing (computation thinking), which are used in the widespread use of digital technologies and will learn to use them in teaching children. Gain skills to create simple algorithms, program in Scratch environment, create simple programs to manage educational work, use 3D printer, involve students in technical creativity, new technologies and research in interdisciplinary areas, use ILS space GoLab to create research projects for students, modern digital tools for the implementation of blended learning, formative assessment. They will learn to implement group and pair methods of teaching and assessment, to form digital competencies in primary school students, in particular, related to the safe Internet. The program is aimed at the development of intellectual abilities in the process of cognitive activity and involvement in scientific and technical creativity. Training is based on research, practice-oriented and competency-based approaches, involves the formation of life competencies.

**Key words:** STEAM education, project activity (PrBL), integrated learning, cross-cutting lines, problem-based learning (PBL), inquiry-based learning in education, virtual and remote laboratories, ILS space for research and learning, robotics, blended learning, inverted learning, formative assessment, 3d printer, making, group work, pair assessment, GoLab, computational thinking.

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

2.2.2.3. Digital tools and services.

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2.3.1.1. Aims and expected learning outcomes.

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

2.3.1.3. Digital tools and services.

2.3.1.4. Innovative learning technologies.

2.3.1.5. Lecture 3.

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2.3.2.1. Aims and expected learning outcomes.

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

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2.3.2.6. Practical class 6.

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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.**

ECTS credits - 3.0.

Content modules - 3, 3 of them in the 2nd semester.

Total number of hours: 90, including 6 lecture hours, 22 hours of practical classes, 8 seminars, 6 hours of laboratory classes, 42 hours - individual work of students, 6 hours - modular control.

**1.2. Characteristics of the discipline by form of study. Form of study** - full-time.

**1.3. Discipline status.** Required

**1.4. Prerequisites for studying the discipline.** Missing

**1.5. Year of preparation, semester.** Year of preparation - 2, 2 semester

**1.6. Form of final control.** Test

**1.7. Language of instruction.** English, Ukrainian

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

https://elearning.kubg.edu.ua/course/view.php?id=20050 (guest access with moped password)

**1.9. Developer (s).**

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**1.10. The aim of studying the discipline.**

**The aim** is to ensure the ability to use and implement appropriate technologies and a high level of formation of methodological competencies of future primary school teachers for the implementation of STEAM-education and innovative pedagogical, including digital technologies.

**The task** is to form the competencies of future teachers in designing methods for integrated classes and project activities of students aimed at developing their research and cognitive skills; selection of innovative pedagogical technologies and various forms of education; use of modern digital resources and services of the global Internet for educational purposes; assessment of learning outcomes in computer science and technology on the basis of tools and means of formative assessment; selection and analysis of profile courses in computer science in accordance with the educational objectives of a particular educational institution and the acquisition of general and professional competencies listed below.

**1.11. Program competencies that are formed in the process of studying the discipline.**

| Integral competence (IC) | The ability to solve complex specialized problems and practical problems in professional and pedagogical activities, involving the application of theoretical principles and methods of pedagogy, psychology and individual teaching methods and characterized by complexity and uncertainty of conditions |
|---|---|
| General Competences (GC) | **GC** 12.Ability to use modern means of information and computer technology to solve communicative problems in professional activities |
| Professional competencies (PC) | **PC** 1. Ability to apply knowledge, skills and abilities from the cycle of professional and scientific disciplines, which is the basis for building the content of educational areas of the State Standard of Primary Education<br>**PC** 4. Ability to solve standard and problem methodological problems during the training of students in educational areas defined by the State Standard of the Primary Education |

**1.12. Learning outcomes of the discipline.**

Program learning outcomes:

**PLO 1**. To know the content of regulations governing primary education.

**PLO 3.** To know methodical training systems of pupils of elementary school of educational branches/defined by the State standard of primary education.

**PLO 4**. To have the skills and abilities that form the theoretical basis of educational areas defined by the State Standard of Primary General Education, while solving professionally-oriented tasks.

**PLO 7**. To design the process of learning the subject in the form of calendar-thematic planning for a particular class, topic.

**PLO 8**. To model the process of teaching primary school students a certain subject: to develop lesson plans, methods of working on certain types of tasks.

To reproduce the basic knowledge of the theoretical principles of STEM-education, acquired in the process of learning and independent educational activities. Interpret what has been learned in the educational process of primary school, using appropriate innovative strategies for the application of STEM-education in primary school.

Consciously use digital technologies and digital devices to form digital competence in children. Solve and interpret the tasks of STEM-education, with a view to their further use in professional pedagogical activity. Use the studied material from the course in new situations and integrate it into the educational process during the study of primary school subjects.

Be able to interact effectively and work in a team during the implementation of creative educational projects on STEM-education. Produce creative ideas and effectively communicate them to the perception of listeners, team members. Be able to independently manage complex actions and collective projects, determine the leading communication strategies of cooperation and activities. Demonstrate responsibility for making decisions in unusual situations.

**1.13. Control of students' academic achievements.**

| Means of diagnosing learning outcomes | Assessment for each content module includes points for the current work of the student in seminars, practical and laboratory classes, for Individual work. |
|---|---|
| Final assessment | The final assessment in the form of a test is carried out according to the assessment of the obtained learning outcomes of students during the course and has the following weights:<br>Module 1 - 70 points (1.13 ECTS credit)<br>Module 2 - 100 points (1.13 ECTS credit)<br>Module 3 - 95 points (0.73 ECTS credit)<br>Total: 265 points. Coefficient: 2.65 |
| Communication and feedback | Ratings and comments will be displayed in the MOODLE.<br>The "MOODLE" Forum resource for questions and answers allows participants to have asynchronous discussions.<br>The messenger of the MOODLE system will allow to realize instant communication with students.<br>The use of corporate mail of each teacher and student provides an additional opportunity for communication. |
| Rating Scale: National and ECTS Rating | **Score for 100 point** / **Rating evaluation** / **Raiding Value**<br>100-90 points — A — Excellent<br>82-89 points — B — Very good<br>75-81 points — C — Good<br>69-74 points — D — Satisfactory<br>60-68 points — E — Enough<br>35-59 points — FX — Unsatisfactory<br>0-34 points — F — Unsatisfactory |

**2. CONTENT AND STRUCTURE OF THE COURSE**

**2.1. Content module 1. Innovative technologies and approaches in STEAM education**

**2.1.1. Topic 1. Modern educational trends. STEAM approaches in education**

**2.1.1.1. Aims and expected learning outcomes.**

**Aims:** to acquaint future primary school teachers with the peculiarities of the digital transformation of education, to form an idea of educational trends, to review current educational trends that are gaining popularity in Ukraine and the world. Analyze the process of popularization of STEM and STEAM education.

**Expected results:**

**1) formation of competencies:**

**GC** 12. Ability to use modern means of information and computer technology to solve communicative problems in professional activities

**PC** 1. Ability to apply knowledge, skills and abilities from the cycle of professional and scientific disciplines, which is the basis for building the content of educational areas of the State Standard of Primary Education

**PC** 4. Ability to solve standard and problem methodological problems during the training of students in educational areas defined by the State Standard of Primary Education

**2) Program learning outcomes:**

**PLO** 1. Know the content of regulations governing primary education.

**PLO** 3. To know methodical systems of training of pupils of elementary school of educational branches / defined by the State standard of primary education.

**PLO** 4. To have the skills and abilities that form the theoretical basis of educational areas defined by the State Standard of Primary General Education, while solving professionally-oriented tasks.

**2.1.1.2.** Criteria and forms of evaluation of learning outcomes on the topic.

Forms of assessment of learning outcomes:

- formative assessment using forums in LMS Moodle and Internet resources;

- peer evaluation of the results of the seminar according to the criteria provided by the teacher;

- final assessment by the teacher based on the results of the tasks.

The total maximum score for the topic is 10 points, in particular:

| Type of task | Maximum points | Evaluation criteria | Quantitative and / or qualitative characteristics |
|---|---|---|---|
| Seminar №1 | 10 | Ability to search the Internet, summarize the results of information | *High level* - the student quickly finds relevant information on the Internet, is able to analyze educational trends that are |

| | | retrieval and analyze educational trends that are gaining popularity in Ukraine and the world. Ability to explain the need to promote STEM and STEAM education. | gaining popularity in Ukraine and the world, understands the need to promote STEM and STEAM education.<br><br>*Intermediate level* - the student does not quickly find relevant information on the Internet, is partially able to analyze educational trends that are gaining popularity in Ukraine and the world, understands the need to promote STEM and STEAM education.<br>*Low level* - the student slowly finds relevant information on the Internet, has a general idea of educational trends and STEAM-education. |
|---|---|---|---|

**2.1.1.3.** Digital tools.

Moodle e-learning course, online documents (Google Drive), knowledge mapping services (MindMeister, Bubble.us, etc.), online video viewing services, information retrieval tools (browser, search engines, catalogs) ), forums in LMS Moodle for communication and formative assessment.

**2.1.1.4.** Innovative learning technologies.

Problem-based learning; storytelling; group work with the use of knowledge maps, virtual boards; selection of teaching methods and digital tools; peer interaction of students, in particular peer evaluation; video hosting; use of e-learning environments; technologies of media literacy formation; inverted class; integrated learning.

**2.1.1.1.** Lecture 1.

**Topic:** Modern educational trends.

**Aims:** to acquaint students with the concept of digital transformation, changes in the field of IT; to involve students in the discussion of digital transformation in the education system; consider current trends in education and innovative technologies that will help implement them.

**Lecture plan:**

1. Digital transformation of society.
2. Changes in the IT sphere.

3. Digital transformation in education.

4. Modern trends in education.

5. Innovative technologies that will help implement modern trends.

**2.1.1.2.** Seminar 1.

**Topic:** Modern educational trends. STEAM approaches in education.

**Aims**: to get acquainted with and analyze modern educational trends that are gaining popularity in Ukraine and the world, to explore the need to promote STEM and STEAM education and its connection with scientific inventions.

**Plan**:

1. Presentation at the forum. Description of the invention of a known scientist. Group work, discussion.

2. Creating a Google document to post the results.

3. Research of educational trends and creation of a mind map with analysis.

4. Work with text and video materials, discussion and group work.

**2.1.2. Topic 2. Basic methods and technologies of teaching during the implementation of STEAM approaches**

2.1.2.1. Aims and expected learning outcomes.

**Aims**: to form the concept of STEM and STEAM, to consider the main methods and technologies of teaching during the implementation of STEAM approaches, to teach

**Expected results:**

**1) formation of competencies:**

**GC 12.** Ability to use modern means of information and computer technology to solve communicative problems in professional activities

**PC 1**. Ability to apply knowledge, skills and abilities from the cycle of professional and scientific disciplines, which is the basis for building the content of educational areas of the State Standard of Primary Education

**PC 4**. Ability to solve standard and problem methodological problems during the training of students in educational areas defined by the State Standard of Primary Education.

**2) program learning outcomes:**

**PLO** 3. To know methodical systems of training of pupils of elementary school of educational branches / defined by the State standard of primary education.

**PLO** 7. To design the process of learning the subject in the form of calendar-thematic planning for a particular class, topic.

**PLO** 8. To model the process of teaching primary school students a certain subject: to develop lesson plans, methods of working on certain types of tasks.

**2.1.2.2.** Criteria and forms of evaluation of learning outcomes on the topic.

Forms of assessment of learning outcomes:
- formative assessment using Internet resources;
- peer evaluation of the results of the discussion during the lecture;
- availability of a certificate and progress of the MOOC course when performing Individual work;

The total maximum score for the topic is 30 points, in particular:

| Type of task | Maximum points | Evaluation criteria | Quantitative and / or qualitative characteristics |
|---|---|---|---|
| Individual work -1-6 | 30 | Ability to apply the design thinking approach when implementing STEAM approaches. | *High level* - availability of a certificate of completion of the relevant MOOC, course progress in the range from 90% to 100% *Intermediate level* - availability of a certificate of completion of the relevant MOOC, course progress in the range from 75% to 89% *Low level* - availability of a certificate of completion of the relevant MOOC, course progress in the range from 61% to 74% |

**2.1.2.3.** Digital tools.

E-learning course (ENC) on the Moodle platform, training videos, tools for communication and formative assessment (Mentimeister, Answergarden), cloud service for web-conferences, MOOC, research and learning environment for learning.

**2.1.2.4.** Innovative learning technologies.

Work on inverted class technology; organization of group work; peer interaction of students; storytelling; use of e-learning environments; technologies of media literacy formation; integrated learning, microlearning.

**2.1.2.5.** Lecture 2.

**Topic:** Innovative technologies and STEAM-education

**Aims:** to form an idea of innovative pedagogical technologies and STEAM-education, to determine the needs of society in STEAM-education and its benefits, to consider active learning, making, method of educational projects, research and cognitive learning, to analyze resources for STEAM-education, to acquaint students with a research and cognitive environment for learning.

**Lecture plan:**

1. The concept of STEAM-education.

2. Society's need for STEAM-education.

3. Advantages of STEAM-education.

4. Innovative pedagogical technologies and STEAM-education.

5. Active learning. Making.

6. Method of educational projects.

7. Method of research and cognitive learning. Model 5E.

8. Research and cognitive environment for learning.

9. Resources for STEAM education.

**2.1.2.6.** Tasks for Individual work of students.

Individual work №1-6.

**Topic:** The method of "design thinking" during the implementation of STEAM approaches.

**Aims**: to get acquainted with the peculiarities of the implementation of design thinking during the implementation of STEAM approaches.

**Plan:**

Passing the course "Design-thinking at school" (https://courses.prometheus.org.ua/courses/course-v1:MIT+DTLL101+2018_T3/about) and obtaining a certificate.

## 2.1.3. Topic 3. STEAM-projects
### 2.1.3.1. Aims and expected learning outcomes.

**Aims:** to consider the features of the use of project technology in primary school. To acquaint students with the directions of effective use of project technology, the main stages of work in the project.

**Expected results:**

1) **formation of competencies:**

**GC 12.** Ability to use modern means of information and computer technology to solve communicative problems in professional activities

**PC 1.** Ability to apply knowledge, skills and abilities from the cycle of professional and scientific disciplines, which is the basis for building the content of educational areas of the State Standard of Primary Education

**PC 4.** Ability to solve standard and problem methodological problems during the training of students in educational areas defined by the State Standard of Primary Education.

2) **program learning outcomes:**

PLO 8. To model the process of teaching primary school students a certain subject: to develop lesson plans, methods of working on certain types of tasks.

**2.1.3.2.** Criteria and forms of evaluation of learning outcomes on the topic.

Forms of assessment of learning outcomes:

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- formative assessment using forums in LMS Moodle and Internet resources;

- peer evaluation of the results of seminar and practical classes according to the criteria provided by the teacher;

- final assessment by the teacher based on the results of the tasks.

The total maximum score for the topic is 30 points, in particular:

| Type of task | Maximum points | Evaluation criteria | Quantitative and / or qualitative characteristics |
|---|---|---|---|
| Seminar №1 | 20 | Ability to analyze existing STEAM-project developments, determine the stages of project activities, components and pedagogical methods and techniques of the project. | *High level* - the student is able to analyze existing developments of STEAM-projects, determines the stages of project activities, components and pedagogical methods and techniques of the project. *Intermediate level* - the student is able to partially analyze existing developments of STEAM-projects, determines the stages of project activities, components and pedagogical methods and techniques of the project. *Low level* - the student has a general idea of project activities. |
| Practical lesson №1 | 10 | Ability to analyze and select ILS for project activities in primary school, to prepare instructions for using a virtual or remote laboratory for a specific lesson. | *High level* - the student is able to analyze and select ILS for project activities in primary school, to prepare instructions for using a virtual or remote laboratory for a specific lesson. *Intermediate level* - the student is partially able to analyze and select ILS for project activities in primary school, to prepare instructions for using a virtual or remote laboratory for a particular lesson. *Low level* - the student has a general idea of ILS. |

**2.1.3.3.** Digital tools.

E-learning course (ENC) on the Moodle platform, training videos, online services for organizing project activities, Internet services for communication and formative assessment, cloud service for web-conferences, research and learning environment for learning, virtual and remote laboratories.

**2.1.3.4.** Innovative learning technologies.

Project training; problem-based learning; group work; selection of teaching methods and digital tools; peer interaction of students, in particular peer evaluation; use of e-learning environments; integrated learning.

**2.1.3.5.** Seminar 2.

**Topic**: STEM-projects for primary school

**Aims:** to analyze the existing developments of STEAM-projects, to investigate the stages of project activities, to determine the components and pedagogical methods and techniques.

**Plan:**

1. Grouping.

2. Execution of the first project: keeping a workbook, photo-fixation of the created products, preparation of presentation materials.

3. Execution of the second project: keeping a workbook, photo-fixation of the created products, preparation of presentation materials.

**2.1.3.6.** Practical lesson №1

**Topic:** Research and cognitive environments

**Aims:** to get acquainted with research-cognitive environments (ILS) in Go-labz, to analyze environments for primary school, to create instructions for using a virtual or remote laboratory for a specific lesson. To analyze existing STEAM-project developments, to investigate project activities methods and techniques.

**Plan:**

1. Introduction to ILS in Go-labz.

2. ILS analysis for primary school.

3. Selection of ILS.

4. Research of virtual and remote laboratories

**2.2. Content module 2. Robotics as an element of STEAM-education**

**2.2.1. Topic 4. Fundamentals of robotics**

**2.2.1.1. Aims and expected learning outcomes.**

**Aims:** to get acquainted with the concept of robotics, to explore the application of robotics, to form skills in selecting robotic sets, to consider the purpose of component designers, to consider methods of studying robotics to encourage students in the coding process and to develop engineering and maker movement in education. engineering, technology, computer science, physics; to

form the ability to be creative in solving problems; to develop the ability to independently acquire knowledge and skills in the application of fundamental knowledge in modern production, new technologies, innovation and invention, design, basics of robotics, solving important life problems.

**Expected results:**

**1) formation of competencies:**

**GC 12.** Ability to use modern means of information and computer technology to solve communicative problems in professional activities

**PC 1.** Ability to apply knowledge, skills and abilities from the cycle of professional and scientific disciplines, which is the basis for building the content of educational areas of the State Standard of Primary Education

**PC 4.** Ability to solve standard problems and methodological problems during the training of students in educational areas defined by the State Standard of Primary Education.

**2) program learning outcomes:**

PLO 7. To design the process of learning the subject in the form of calendar-thematic planning for a particular class, topic.

PLO 8. To model the process of teaching primary school students a certain subject: to develop lesson plans, methods of working on certain types of tasks.

**2.2.1.2.** Criteria and forms of evaluation of learning outcomes on the topic.

Forms of assessment of learning outcomes:

- formative assessment using forums in LMS Moodle and Internet resources;

- peer evaluation of the results of practical classes according to the criteria provided by the teacher;

- final assessment by the teacher based on the results of the tasks.

The total maximum score for the topic is 30 points, in particular:

| Type of task | Maximum points | Evaluation criteria | Quantitative and / or qualitative characteristics |
| --- | --- | --- | --- |
| Practical lesson №2 | 20 | Ability to give examples of areas of application of robotics, the ability to analyze and select robotic kits, describe a project using robotics | *High level* - the student gives examples of areas of application of robotics, is able to analyze and select robotic kits, describe the project. *Intermediate level* - the student partially gives examples of areas of application of robotics, is able to analyze and select robotic kits, describe the project using robotics. *Low level* - the student has a general idea of robotics. |

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| Practical lesson №3 | 10 | Ability to create projects in the environment microbit.org, distinguish between Micro: bit and Arduino boards and use them in the preparation of project activities. | *High level* - the student understands the difference between Micro: bit and Arduino boards, creates projects in the microbit.org environment. *Intermediate level* - the student understands the difference between Micro: bit and Arduino boards, creates projects in the environment microbit.org. *Low level* - the student has a general idea about microplates. |
|---|---|---|---|

**2.2.1.3.** Digital tools.

E-learning course (ENC) on the Moodle platform, online documents, tools for working with video, online programming environment, environment for creating multimedia presentations (Powtooon), forums in LMS Moodle for communication and formative assessment, tools for research and search , tools for working with hardware.

**2.2.1.4**. Innovative learning technologies.

Project training; problem-based learning; IBL; technologies for the formation of computer and computational thinking; gamification; robotics; make-up; integrated learning; group work; selection of teaching methods and digital tools; peer interaction of students, in particular peer evaluation; use of e-learning environments; technologies of media literacy formation.

**2.2.1.5.** Practical lesson №2.

**Topic:** Fundamentals of robotics

**Aims:** to get acquainted with the concept of robotics, to explore the areas of application of robotics, to form skills in the selection of robotic kits, to consider the purpose of component designers.

**Plan:**

1. Research on the given topic. Preparing a multimedia presentation for children in Powtooon.

2. Acquaintance with sets for robotics for elementary school students.

3. Creating a description of project work using a robotic kit.

**2.2.1.6.** Practical lesson №3.

**Topic:** Methods of studying robotics

**Aims:** to get acquainted with the method of studying robotics to encourage students in the coding process and for the development of engineering and maker movement in education.

**Plan:**

1. Acquaintance with microplates

2. Project development.

### 2.2.2. Topic 5. Computational thinking
#### 2.2.2.1. Aims and expected learning outcomes.

**Aims:** to get acquainted with the concept of computational thinking, with the basics of algorithmization and programming; to analyze the components of computational thinking, to form skills of selection of tasks for the formation of computational thinking, to explore the resources for conducting classes in computational thinking; to form a system of fundamental knowledge on the basics of programming and the use of environments of algorithm performers to acquaint children with the basics of programming; demonstrate special algorithm development environments for training designers.

**Expected results:**

**1) formation of competencies:**

**GC 12.** Ability to use modern means of information and computer technology to solve communicative problems in professional activities

**PC 1.** Ability to apply knowledge, skills and abilities from the cycle of professional and scientific disciplines, which is the basis for building the content of educational areas of the State Standard of Primary Education

**PC 4.** Ability to solve standard and problem methodological problems during the training of students in educational areas defined by the State Standard of Primary Education.

**2) program learning outcomes:**

PLO 3. To know methodical systems of training of pupils of elementary school of educational branches / defined by the State standard of primary education.

PLO 7. To design the process of learning the subject in the form of calendar-thematic planning for a particular class, topic.

PLO 8. To model the process of teaching primary school students a certain subject: to develop lesson plans, methods of working on certain types of tasks.

**2.2.2.2.** Criteria and forms of evaluation of learning outcomes on the topic.

Forms of assessment of learning outcomes:

- formative assessment using forums in LMS Moodle and Internet resources;

- peer evaluation of the results of the practical lesson according to the criteria provided by the teacher;

- final assessment by the teacher based on the results of the tasks.

The total maximum score for the topic is 20 points, in particular:

| Type of task | Maximum points | Evaluation criteria | Quantitative and / or qualitative characteristics |
|---|---|---|---|
| Practical lesson №4 | 20 | Ability to develop | *High level* - the student develops exercises and uses digital resources to |

| | | exercises and use digital resources to form computational thinking, create games with different levels of complexity in the resources of Kodetu, MakeWorld. | form computational thinking, creates games with different levels of complexity in the resources of Kodetu, MakeWorld. *Intermediate level* - the student partially uses digital resources to form computational thinking, creates games with different levels of complexity in the resources of Kodetu, MakeWorld. *Low level* - the student has a general idea of computational thinking. |
|---|---|---|---|

**2.2.2.3.** Digital tools.

Programming environments (Kodetu, MakeWorld resources), e-learning course (ENC) on the Moodle platform, forums in LMS Moodle for communication and formative assessment, e-mail, online documents, applications on mobile learning devices.

**2.2.2.4.** Innovative learning technologies.

Technologies for the formation of computational thinking; gamification; robotics; integrated learning; storytelling; group work; selection of teaching methods and digital tools; peer interaction of students, in particular peer evaluation; use of e-learning environments.

**2.2.2.5.** Practical lesson 4.

**Topic:** Computational thinking

**Aims:** to get acquainted with the concept of computational thinking, to analyze the components of computational thinking, to form skills for selecting tasks for the formation of computational thinking, to explore the resources for conducting classes in computational thinking.

**Plan:**
1. Elaboration of the presentation.
2. Development of tasks for the stages of OM.
3. Research Blockly resource.
4. Study of the Kodetu resource.
5. Research the MakeWorld resource.

## 2.2.3. Topic 6. Augmented and virtual reality

**2.2.3.1**. Aims and expected learning outcomes.

**Aim:** formation of students' stable interest in robotics, design, engineering, technology, computer science, physics; to acquaint students with the concept of virtual and augmented reality, to form skills of working with augmented reality and ways to use it in the educational process; formation of the ability to be creative in

solving the problem; development of abilities to independently acquire knowledge and skills in the application of fundamental knowledge in modern production, the latest technologies, in innovation and invention, design, basics of robotics, solving important life problems.

**Expected results:**

**1) formation of competencies:**

**GC 12.** Ability to use modern means of information and computer technology to solve communicative problems in professional activities

**PC 1.** Ability to apply knowledge, skills and abilities from the cycle of professional and scientific disciplines, which is the basis for building the content of educational areas of the State Standard of Primary Education

**PC 4.** Ability to solve standard and problem methodological problems during the training of students in educational areas defined by the State Standard of Primary Education.

**2) program learning outcomes:**

PLO 3. To know methodical systems of training of pupils of elementary school of educational branches / defined by the State standard of primary education.

PLO 7. To design the process of learning the subject in the form of calendar-thematic planning for a particular class, topic.

PLO 8. To model the process of teaching primary school students a certain subject: to develop lesson plans, methods of working on certain types of tasks.

**2.2.3.2.** Criteria and forms of evaluation of learning outcomes on the topic.

Forms of assessment of learning outcomes:

- *formative assessment* using forums in LMS Moodle and Internet resources;

- *peer evaluation* of the results of the seminar according to the criteria provided by the teacher;

- *final assessment* by the teacher based on the results of the tasks.

The total maximum score for the topic is 10 points, in particular:

| Type of the task | Maximum points | Evaluation criteria | Quantitative and / or qualitative characteristics |
|---|---|---|---|
| Seminar №3 | 10 | Ability to use applications to work with augmented reality and selects them according to educational purpose. | *High level* - the student uses applications to work with augmented reality and selects them according to the educational purpose. *Intermediate level* - the student partially uses applications to work with augmented reality and selects them according to the educational purpose. |

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| | | | *Low level* - the student has a general idea of augmented and virtual reality. |
|---|---|---|---|

**2.2.3.3.** Digital tools.

Hardware tools, augmented reality mobile applications, virtual reality kit, e-learning course (ENC) on the Moodle platform, forums in LMS Moodle for communication and formative assessment.

**2.2.3.4.** Innovative learning technologies.

Virtual, mixed, augmented reality; integrated learning; group work; selection of teaching methods and digital tools; peer interaction of students, in particular peer evaluation; use of mobile learning environments; technologies of media literacy formation.

**2.2.3.5.** Seminar №3.

**Topic:** Augmented and virtual reality

**Aims:** to get acquainted with the concept of virtual and augmented reality, to form skills of working with augmented reality and ways to use it in the educational process.

**Plan:**

1. Acquaintance with virtual and augmented reality.
2. Working with applications.
3. Creating a comparison chart.

### 2.2.4. Topic 7. 3-D printing

#### 2.2.4.1. Aims and expected learning outcomes.

**Aims:** formation of students' stable interest in robotics, design, engineering, technology, computer science, physics; to acquaint students with the concept of virtual and augmented reality, to get acquainted with the concept of 3D-printing, 3D-printer, modeling, prototyping, the structure of the 3D printer; algorithm and features of sending the model for printing; principles of 3D modeling in Tinkercad; preparation of 3D model for printing; to develop spatial imagination, understanding of tendencies of development of modern production.

**Expected results:**

**1) formation of competencies:**

**GC 12.** Ability to use modern means of information and computer technology to solve communicative problems in professional activities

**PC 1.** Ability to apply knowledge, skills and abilities from the cycle of professional and scientific disciplines, which is the basis for building the content of educational areas of the State Standard of Primary Education

**PC 4.** Ability to solve standard and problem methodological problems during the training of students in educational areas defined by the State Standard of Primary Education.

**2) program learning outcomes:**

PLO 3. To know methodical systems of training of pupils of elementary school of educational branches / defined by the State standard of primary education.

PLO 7. To design the process of learning the subject in the form of calendar-thematic planning for a particular class, topic.

PLO 8. To model the process of teaching primary school students a certain subject: to develop lesson plans, methods of working on certain types of tasks.

**2.2.4.2.** Criteria and forms of evaluation of learning outcomes on the topic.

Forms of assessment of learning outcomes:

- formative assessment using forums in LMS Moodle and Internet resources;

- peer evaluation of the results of the seminar according to the criteria provided by the teacher;

- final assessment by the teacher based on the results of the tasks.

The total maximum score for the topic is 10 points, in particular:

| Type of task | Maximum points | Evaluation criteria | Quantitative and / or qualitative characteristics |
|---|---|---|---|
| Laboratory class №1 | 10 | Ability to distinguish between the concepts of 3D printing, 3D printer, modeling, prototyping. Ability to navigate in the structure of the 3D printer, send the model for printing. Ability to create a 3D model in Tinkercad, understanding the development trends of modern production using 3D printing. | *High level* - the student distinguishes the concepts of 3D printing, 3D printer, modeling, prototyping, is guided in the structure of the 3D printer, is able to send the model for printing; is able to create a 3D model in the program Tinkercad, understands the trends of modern production using 3D printing. *Intermediate level* - the student partially distinguishes the concept of 3D-printing, 3D-printer, modeling, prototyping, is guided in the structure of the 3D printer, is able to send the model for printing; is able to create a 3D model in the program Tinkercad, understands the trends of modern production using 3D printing. *Low level* - the student has a general idea of 3D printing. |

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| Individual work №7-12 | 30 | Ability to create 3D objects in design environments, prepare a 3D model for printing; configure the printer, work with different file formats. | *High level* - availability of a certificate of completion of the relevant MOOC, course progress in the range from 90% to 100% *Intermediate level* - availability of a certificate of completion of the relevant MOOC, course progress in the range from 75% to 89% *Low level* - availability of a certificate of completion of the relevant MOOC, course progress in the range from 61% to 74% |
|---|---|---|---|

**2.2.4.3.** Digital tools.

Environments for creating 3D models, tools for working with hardware, services for file conversion, online boards, electronic training course (ENC) on the Moodle platform, forums in LMS Moodle for communication and formative assessment.

**2.2.4.4.** Innovative learning technologies.

3d printing; integrated learning; group work; selection of teaching methods and digital tools; peer interaction of students, in particular peer evaluation.

**2.2.4.5.** Laboratory work №1.

**Topic:** 3D printing

**Aims:** to get acquainted with the concept of 3D printing, 3D printer, modeling, prototyping, the structure of the 3D printer; algorithm and features of sending the model for printing; principles of 3D modeling in Tinkercad; preparation of 3D model for printing; to develop spatial imagination, understanding of tendencies of development of modern production.

**Plan:**

1. Introduction to 3D printing.

2. Work in an environment to create 3D models.

3. Selection of examples of using a 3D printer for various subjects in primary school.

**2.2.4.6.** Tasks for Individual work of students.

Individual work №7-12.

**Topic:** 3D printing.

**Aims:** to form the ability to create 3D objects in design environments, to prepare a 3D model for printing; configure the printer, work with different file formats.

**Plan:**

Take the 3D Printing Software course at https://www.coursera.org and obtain a certificate.

**2.3. Content module 3. Introduction of STEAM in the educational process of primary school**

**2.3.1. Topic 8. Tools for STEAM approaches in education. STEM learning resources in the classroom. Organization of work in an innovative classroom**

**2.3.1.1. Aims and expected learning outcomes.**

**Aims:** to acquaint students with tools for STEAM approaches in education, methods of teaching elementary school students in innovative classrooms, to consider rotational zones, to develop the ability to be creative in creating tasks and organizing students' educational activities, to develop skills to apply knowledge and skills in basic knowledge, modern production, the latest technologies, innovation and invention, solving important life problems.

**Expected results:**

**1) formation of competencies:**

**GC 12.** Ability to use modern means of information and computer technology to solve communicative problems in professional activities

**PC 1.** Ability to apply knowledge, skills and abilities from the cycle of professional and scientific disciplines, which is the basis for building the content of educational areas of the State Standard of Primary Education

**PC 4.** Ability to solve standard and problem methodological problems during the training of students in educational areas defined by the State Standard of Primary Education.

**2) program learning outcomes:**

PLO 3. To know methodical systems of training of pupils of elementary school of educational branches / defined by the State standard of primary education.

PLO 7. To design the process of learning the subject in the form of calendar-thematic planning for a particular class, topic.

PLO 8. To model the process of teaching primary school students a certain subject: to develop lesson plans, methods of working on certain types of tasks.

**2.3.1.2.** Criteria and forms of evaluation of learning outcomes on the topic.

Forms of assessment of learning outcomes:

- formative assessment using Internet resources;

- peer evaluation of the results of the discussion during the lecture.

**2.3.1.3.** Digital tools.

E-learning course (ENC) on the Moodle platform, training videos, tools for communication and formative assessment (Mentimeister, Answergarden), cloud service for web-conferences.

**2.3.1.4.** Innovative learning technologies.

Work on inverted class technology; organization of group work; peer interaction of students; storytelling; use of e-learning environments; technologies of media literacy formation; integrated learning.

**2.3.1.5.** Lecture.

**Topic:** Tools for STEAM approaches in education. STEM learning resources in the classroom. Organization of work in an innovative classroom.

**Aims:** to acquaint students with tools for STEAM approaches in education, methods of teaching elementary school students in innovative classrooms, to consider rotational zones, to develop the ability to be creative in creating tasks and organizing students' educational activities, to develop skills to apply knowledge and skills in basic knowledge, modern production, the latest technologies, innovation and invention, solving important life problems

**Lecture plan:**

1. The relationship between STEAM practices

2. Approaches to the organization of STEAM projects.

3. Scientific approach: skills of scientific processes, research cycle,

4. Human-oriented approach.

5. Features of the organization of work on STEAM projects (innovation class, rotation zones, equipment).


**2.3.2. Topic 9. Development and implementation of educational STEAM-project**

**2.3.2.1. Aims and expected learning outcomes.**

**Aim:** to consider the features of designing tasks for an educational research project. To acquaint students with the directions of effective use of project technology, the main stages of work in the project. Prepare topics and project structures for research weeks.

**Expected results:**

**1) formation of competencies**:

**GC 12.** Ability to use modern means of information and computer technology to solve communicative problems in professional activities

**PC 1.** Ability to apply knowledge, skills and abilities from the cycle of professional and scientific disciplines, which is the basis for building the content of educational areas of the State Standard of Primary Education

**PC 4.** Ability to solve standard and problem methodological problems during the training of students in educational areas defined by the State Standard of Primary Education.

**2) program learning outcomes:**

PLO 3. To know methodical systems of training of pupils of elementary school of educational branches / defined by the State standard of primary education.

PLO 7. To design the process of learning the subject in the form of calendar-thematic planning for a particular class, topic.

PLO 8. To model the process of teaching primary school students a certain subject: to develop lesson plans, methods of working on certain types of tasks.

**2.3.2.2.** Criteria and forms of evaluation of learning outcomes on the topic.

Forms of assessment of learning outcomes:

- formative assessment using forums in LMS Moodle and Internet resources;

- peer evaluation of the results of practical classes and laboratory work according to the criteria provided by the teacher;

- final assessment by the teacher based on the results of the tasks.

The total maximum score for the topic is 70 points, in particular:

| Type of task | Maximum points | Evaluation criteria | Quantitative and / or qualitative characteristics |
|---|---|---|---|
| Practical lesson №5 | 30 | Ability to analyze existing developments of STEAM-projects, determine the stages of project activities, components and pedagogical methods and techniques of the project. Ability to select tasks and resources for the project, create a plan, methodological and didactic materials, analyze the project plan according to the project evaluation criteria. | *High level* - the student is able to analyze existing developments of STEAM-projects, determines the stages of project activities, components and pedagogical methods and techniques of the project, selects tasks and resources for the project, creates a plan, methodological and didactic materials, analyzes the project plan according to project evaluation criteria. *Intermediate level* - the student is able to partially analyze existing STEAM-project developments, determine the stages of project activities, components and pedagogical methods and techniques of the project, select tasks and resources for the project, create a plan, methodological and didactic materials, analyze the project plan according to project evaluation criteria. *Low level* - the student has a general idea of the project activity. |

| Practical lesson №6 | 20 | Ability to analyze the development of STEAM-projects, to perform an objective peer evaluation of works according to the criteria, to provide a justification for these assessments. | *High level* - the student is able to analyze the development of STEAM-projects, performs an objective peer review of works according to the criteria, provides a justification for these assessments. *Intermediate level* - the student partially analyzes the development of STEAM-projects, performs an objective peer evaluation of works according to the criteria, provides a justification for these assessments. *Low level* - the student has a general idea of project activities and peer review. |
|---|---|---|---|
| Laboratory work №2 | 20 | Ability to analyze the stages of project activities, to carry out self-assessment of the work performed, to navigate in the components of the presentation board and develop it, the ability to prepare a video presentation. | *High level* - the student is able to analyze the stages of project activities, self-evaluates the work done, understands the components of the presentation board and develops it, prepares a video presentation. *Intermediate level* - the student partially analyzes the stages of project activities, performs self-assessment of the work performed, understands the components of the presentation board and develops it, prepares a video presentation. *Low level* - the student has a general idea of the presentation of the STEAM-project. |

**2.3.2.3.** Digital tools.

Moodle e-learning course, Google Docs, online formative assessment services (including LearningApps, AnswerGarden, Kahoot, Mentimeter, etc.), virtual and remote labs, programming environments, virtual and remote reality applications, creation environments 3D models, video editors, video hosting, forums in LMS Moodle for communication and formative evaluation, tools for project activities.

**2.3.2.4.** Innovative learning technologies.

Project activity (PBL), portfolio, group work, problem-based learning, IBL, selection of methods and digital learning tools, peer-to-peer interaction of students, including peer-to-peer assessment, use of e-learning environments, media literacy technologies, gamification, making, storytelling, integrated learning.

**2.3.2.5.** Practical lesson 5.

**Topic:** Designing tasks for an educational research project

**Aims:** to get acquainted with the requirements for project design, developed projects, analyze the stages of project activities and develop your own STEM-project for primary school students.

**Plan:**

1. Pairing.

2. Acquaintance with the template of the plan of the educational project and with an example of the ready plan.

3. Creating a curriculum plan.

4. Development of methodical materials for the project

5. Develop didactic materials for students.

**2.3.2.6.** Practical lesson 6.

**Topic:** Implementation of the STEAM training project

**Aims:** to analyze the existing developments of STEAM-projects, to investigate the stages of project activities, to determine the components and pedagogical methods and techniques, to implement the project and carry out peer evaluation according to the criteria, to provide justification for these assessments.

**Plan:**

1. Execution of project tasks of a classmate.

2. Implementation of mutual evaluation of prepared projects according to the criteria.

**2.3.2.7.** Laboratory work 2.

**Topic:** Presentation and defense of project results

**Aims:** to analyze the stages of project activities, to develop a critical attitude to the results of work, product presentation skills, self-assessment of work performed, to consider examples of project protection by primary school students, to create a board and video presentation.

**Plan:**

1. Creating a board to protect the project.

2. Preparation of video and placement on video hosting.

**2.3.2.8.** Modular control.

**Aims:** to consolidate knowledge and skills in the discipline, to form skills of self-reflection and analysis of achieving their own goals, to learn to edit video and work on video hosting.

**Plan:**

1. Preparation of questions on the discipline.
2. Exchange questions with classmates.
3. Preparation of answers.
4. Shooting and editing video. Hosting on video hosting.

## 3. Tasks for final certification
**3.1.** The procedure for final certification.

The final assessment in the form of a test is carried out according to the assessment of the obtained learning outcomes of students during the course and has the following weights:

Module 1 - 70 points (1 ECTS credit)
Module 2 - 100 points (1 ECTS credit)
Module 3 - 95 points (1 ECTS credit)
Total: 265 points. Coefficient: 2.65

## 4. List of recommended reading (including electronic resources).
**Literature:**

1. Morse N., Nanaeva T., Omelchenko N. STEM in education. Textbook. - Kyiv: ACCORD GROUP, 2018. – page 116.

2. Morse N., Varchenko-Trotsenko L., Gladun M., Fundamentals of Robotics: Textbook / Morse N., Varchenko-Trotsenko L., Gladun M., - Kamyanets-Podilsky: Buynytsky O., 2016. - page 184.

3. STEM-education: problems and prospects: annotated catalog / edited by Patrikeeva O., Lozova O., Gorbenko S. - Kyiv 2020. - page 30.

4. Morse N., Vember V., Sarazhinskaya N. We are smart - A Textbook for students. - Kyiv- 2012. - page 112.

**Additional:**

5. D. Craig Introduced into robotics. Mechanics and control. Institute of Computer Research Publishing House, 2013. - 564 p.

6. Gololobov V. Where robots begin. About the Arduino project for schoolchildren (and not only). - M., 2011

7. Filippov S. Robotics for children and parents. - Science, 2010 - 195 p.

8. Litovchenko I., Maksimenko S. Children on the Internet: how to learn security in the virtual world / - K.: Publisher: LLC Publishing House "Avanpost-Prim", 2010. - 49 p.

**Information resources:**

9. State standard of primary general education. [Electronic resource]. - Access to the resource: https://www.kmu.gov.ua/ua/npas/pro-zatverdzhennya-derzhavnogo-standartu-pochatkovoyi-osviti

10. Gavrilyuk M., Velgach A., STEM-education, as one of the components of consolidation of knowledge in primary school, Section: STEM-education: ways of implementation, current issues and prospects, [Electronic resource]. - Access to the resource:
http://dspace.tnpu.edu.ua/bitstream/123456789/15347/1/7_Havryliuk_Velhach.pdf

11. Matvienko Y. Application of augmented reality technology in education. [Electronic resource]. - Access to the resource: https://u.nu/6p7o.

12. Poida S. Formation and development of spatial imagination of students by creating and using 3D models. Scientific works №2 (27), - 2018. Series "Informatics, cybernetics and computer engineering". - P. 80-86.