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Modernization of Pedagogical Higher Education
by Innovative Teaching Instruments

The concept of the discipline¹

HIGHER EDUCATION INSTITUTION		Borys Grinchenko Kyiv University
Institute (faculty), department or other structural unit for which the discipline is assigned		Pedagogical Institute, Department of Primary Education
DESCRIPTION OF THE EDUCATIONAL DISCIPLINE²		
1	The name of the discipline	Information and technological education: Fundamentals of STEAM education
2	Modular code	
3	Cycle / level of higher education	NFQ of Ukraine - level 7, FQ-EHEA - first cycle, EQF - LLL – 6 first (bachelor's) level
4	Degree of higher education	bachelor
5	Field of knowledge	01 "Education / Pedagogy"
6	Specialty, specialization (if available)	013 "Primary education"
7	The name of the educational program, which includes the discipline.	013.00.01 Primary education
8	Assigned educational qualification	educational qualification: bachelor of primary education <i>professional qualification</i> : 2331 - primary school teacher <i>additional specialization</i> 1) additional specialization: preschool education; <i>professional qualification</i> : 2332 - educator of a preschool institution 2) additional specialization: foreign language; <i>professional qualification</i> : 2331 - foreign language teacher in primary school

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² Letter from the Ministry of Education and Science of Ukraine from 09.07.2018 № 1/9-434 (see attached, the connection will be provided as L2.1.1. what means Letter of Ministry of the Education and Science of Ukraine, Article 2 (The structure of the working program of the discipline), point 2.1.1. general information)



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9	Characteristics of the discipline by form of study	full-time education
10	Discipline status	Normative discipline of the cycle of professional and practical training
11	Prerequisites for studying the discipline	Introduction to the specialty, Pedagogy, Mathematical and natural education, Educational practice
12	Year of preparation, semester.	Year of preparation - 2, semesters 3-4
13	The volume of discipline in ECTS credits and its distribution in hours by forms of organization of the educational process and types of training sessions	3.0 Content modules - 3 Total number of hours: 90, incl. 6 hours of lectures, 22 hours of practical classes, 8 hours of seminars, 6 hours of laboratory classes, 42 hours - independent work of students, 6 hours - modular control
14	Form of final exam	test
15	Study Language	Ukrainian
16	Internet address of the permanent placement of educational content of the discipline	https://elearning.kubg.edu.ua/course/view.php?id=20050
17	Developer (s)	Doctor of Pedagogical Sciences, Professor Nataliia Morze Senior Lecturer of the Department of Computer Science and Mathematics Mariia Boiko

Brief 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 and cognitive learning), blended and inverted learning, making, computing (computation thinking) and 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 in 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.



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Key concepts

STEAM-education, project activities, PBL, integrated learning, cross-cutting lines, problem-based learning, PrBL, inquiry-based learning in education, virtual and remote laboratories, ILS space for research and learning, robotics, blended learning, inverted learning, formative assessment, 3-D printer, maker, group work, pair assessment, GoLab, computing (computation thinking).

The purpose of studying the discipline

The aim is to ensure a high level of formation of methodological competencies of the future primary school teacher 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.

Program competencies that are formed in the process of teaching the discipline

Integral competence (IC)	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 are 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 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



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Expected learning outcomes of the discipline

Learning outcomes ³	Forms and methods of evaluation ⁴
<i>Professional knowledge</i>	PRN 1. Know the content of regulations governing primary education (SA, FA). PRN 3. To know methodical systems of training of pupils of elementary school of educational branches / defined by the State standard of primary education (SA, FA).
<i>Professional skills and abilities</i>	PRN 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 (SA, FA). PRN 7. To design the process of learning the subject in the form of calendar-thematic planning for a particular class, topic (SA, FA). To reproduce the basic knowledge of the theoretical provisions 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 (SA, FA).
<i>Communication</i>	Be able to interact effectively and work in a coordinated 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 (SA, FA).
<i>Autonomy and responsibility</i>	PRN 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 (SA, FA). 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 (SA, FA).

³ National qualifications framework. Annex to the Resolution of the Cabinet of Ministers of Ukraine of November 23, 2011 № 1341 (as amended by the Resolution of the Cabinet of Ministers of Ukraine of June 25, 2020 № 519). Access mode: <https://zakon.rada.gov.ua/laws/show/1341-2011-%D0%BF/paran12#n12>

⁴ Summative assessment (SA1, SA2...); formative assessment (FA1, FA2 ...).



Control of students' academic achievements

Criteria for evaluating learning outcomes

Calculation of rating points by types of current control

№	Type of student activity	Max. number of points per unit	Module 1		Module 2		Module 3	
			Number of units	Max. scores	Number of units	Max. scores	Number of units	Max. scores
1	Seminar	10	3	30	1	10		
2	Practice session	10	1	10	5	50	5	50
3	Laboratory lesson (admission, execution, protection)	10			1	10	2	20
4	Performing tasks for independent work	30	1	30	1	30		
5	Execution of modular control work	25					1	25
Total			-	70	-	100	-	95
Max. scores:			265					
Coefficient calculation:			2,65					

Means of diagnostics of learning outcomes (summative and formative assessment)

Assessment for each content module includes points for the student's current work in practical and laboratory classes, including project implementation and defense, as well as for Individual work.

List of questions for final control

1. Modern educational trends and their impact on the educational process.
2. Introduction of STEAM in the educational process of primary school
3. STEAM approaches in education. Tools for its implementation.
4. Basic methods and technologies of training during the implementation of STEAM approaches.



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	<ol style="list-style-type: none"> 5. Features of STEAM-projects implementation. 6. Robotics as an element of STEAM-education. Organization of classes using robotic kits. 7. Fundamentals of robotics. Use of robotic kits and simulation environments. 8. The concept of computational thinking. Features of implementation in primary school. 9. Augmented and virtual reality. 10. Using 3-D printing to implement STEAM-projects. 11. STEM learning resources in the classroom. 12. Organization of work in the innovation class. 13. Stages of development and implementation of educational STEAM-project. 14. STEAM-project evaluation system. Peering interaction.
Final evaluation and feedback	<p>The final assessment in the form of a test is based on the results of the current work of students during the course and has the following weights:</p> <p>Module 1 - 26%</p> <p>Module 2 - 38%</p> <p>Module 3 - 36%</p> <p>Total: 100 points</p> <p>Ratings and comments will be displayed in the MOODLE rating log.</p> <p>The “MOODLE” Forum resource for questions and answers allows participants to have asynchronous discussions.</p> <p>The messenger of the MOODLE system will allow to realize instant communication with students. The use of corporate mail of each teacher and student provides an additional opportunity for communication</p>
Assessment scale of the HEI	<p>Stem scale rating Rating scale Value of the rating</p> <p>100-90 points A Excellent</p> <p>82-89 points B Very good</p> <p>75-81 points C Good</p> <p>69-74 points D Satisfactory</p> <p>60-68 points E Enough</p> <p>35-59 points FX Unsatisfactory</p> <p>0-34 points F Unsatisfactory</p>



The structure of the discipline

Name of content modules, topics	Total	Distribution of hours between types of tasks					
		Classwork:					self-studies
		Lectures	Seminars	Practical	Laboratory	Individual	
Content module 1. Innovative technologies and approaches in STEAM education							
Topic 1. Modern educational trends. STEAM approaches in education	4	2	2				
Topic 2. Basic methods and technologies of teaching during the implementation of STEAM approaches	24	2					22
Topic 3. STEAM-projects	6		4	2			
Total	34	4	6	2			22
Content module 2. Robotics as an element of STEAM-education							
Topic 4. Fundamentals of robotics	6			6			
Topic 5. Computational thinking	4			4			
Topic 6. Augmented and virtual reality	2		2				
Topic 7. 3-D printing	22				2		20
Total	34			10	4		20
Content module 3. Introduction of STEAM in the educational process of primary school							



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Topic 8. Tools for STEAM approaches in education. STEM learning resources in the classroom. Organization of work in an innovative class	2	2						
Topic 9. Development and implementation of educational STEAM-project	14			10	4			
Modular control	6	6						
Total	22	2	2	10	2			
Preparation and passing of control measures								
Total	90	6	8	22	6			42

Curriculum (content block)

Module / Topic	Topics of seminars / practical / laboratory classes (if available)	Approximate topics of individual and / or group tasks (if available)	Task for self-test work
Content module 1. Introduction. STEAM approaches in education			
Topic 1. Modern educational trends. STEAM approaches in education.	C 1.1. Modern educational trends. STEAM approaches in education	Individual tasks: presentation at the Forum, research of the problem on the topic. Group tasks: Discussion of research (posts of classmates), research of one of educational trends. Creating a mind map.	
Topic 2. Basic methods and technologies of teaching during the implementation of STEAM approaches		Group work: Basic requirements for the use of the project method, the difference between the project method and the instructional approach. Brainstorming: Defining question types for a project	Subscribe in Prometheus for the course "Design-thinking at school" (https://courses.prometheus.org.ua/courses/course-v1:MIT+DTLL101+2018_T3/about)



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			<p>Get trained at a convenient time.</p> <p>Upon completion, take a screenshot of the received certificate, as well as a diagram of learning progress, and send it to the system for the task.</p>
<p>Topic 3. STEAM-projects</p>	<p>C 1.2. STEM projects for primary school</p> <p>P 1.1. Research and cognitive environments</p>	<p>Work in groups: Execution of the project according to the instruction. Placement of project materials in the Google folder. (Execution of the project involves keeping a workbook, photo-fixation of the created products, presentation materials). Filling in the Google table. Individually: ILS study. Check out ILS at Go-labz. Analyze several ILS for elementary school. Choose one ILS. Create a Google document called "ILS Analysis" and fill in the table. Research of virtual and remote laboratories. Explore virtual and remote labs at Go-labz. Analyze several laboratories for primary school. Create instructions for using a virtual or remote lab for a specific</p>	



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		lesson. Place in the created Google document under the table.	
Content module 2. Robotics as an element of STEAM-education			
Topic 4. Fundamentals of robotics	P 2.1. Fundamentals of robotics P 2.2. Methods of studying robotics	Group work: research on the topic. Create a multimedia presentation for children in Powtoon (up to 2 minutes). Discussion and mutual evaluation of works (Topics: Robotics in Ukraine, Top 20 interesting robots, Comparison of resources for the study of robotics, The dangers of robotics, etc.). Work with a robotic set. Creating a description of the project work using the instructions for the work according to the stages for open research. Comparison of Micro: bit and Arduino boards. Acquaintance with ready projects. Individual work: acquaintance with sets for robotics for elementary school students.	
Topic 5. Computational thinking	P 2.3. Computational thinking	Individual work: development of the task to two stages of OM (Problem formulation, Data collection, Data analysis, Data visualization, Decomposition, Abstraction, Algorithms and procedures,	



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		Automation, Modeling, Parallelization). Research the Blockly resource. Explore the Kodetu resource. Create a game with 5 levels of varying difficulty. MakeWorld resource research. Creating one game by analogy. Game publication.	
Topic 6. Augmented and virtual reality	C 2.1. Augmented and virtual reality	Group work: study of the application Quiver - 3D Coloring App Working with the Futurio application. Work with the application Sky Guide AR and SkyView. Explore the capabilities of the application. Working with the Augment application - 3D Augmented Reality. Individual work: creating a comparative table based on the results of the study.	
Topic 7. 3-D printing	L 2.1. 3D printing	Individual work: designing a logo for an educational institution (or a model of an object for a future project) using the Tinkercad service. Group work: find interesting examples of using a 3D printer in various subjects in primary school	Register at https://www.coursera.org/ through a corporate account. Find a 3D Printing Software course (or 3D printing for everyone)



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		and post the results on the link to discuss them.	Get trained at a convenient time. Upon completion, take a screenshot of the received certificate, as well as a diagram of learning progress, and send it to the system for the task.
Content module 3. Introduction of STEAM in the educational process of primary school			
Topic 8. Tools for STEAM approaches in education. STEM learning resources in the classroom. Organization of work in an innovative class		Work in groups: rotation stations of different types. Organization of work students in different areas of rotation. Use of interactive panel, interactive tablet, mobile devices. Formative assessment.	
Topic 9. Development and implementation of educational STEAM-project	P 3.1. Designing tasks for an educational research project P 3.2. Implementation of the STEAM training project L 3.1. Presentation and defense of project results	Work in groups: Identify Key and Thematic issues for the future educational project. Discuss in pairs and plan a learning project. Create your own Curriculum Plan (according to a template). Develop criteria for evaluating project work, methodological materials for the project, a checklist for parents in evaluating the project (example), didactic materials for students:	



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		<p>Workbook, instructions, worksheets, instructions, templates, tests, reflection, etc.</p> <p>Implementation of a project prepared by classmates. Mutual evaluation of projects according to criteria.</p> <p>Creating a board to protect the project, preparing a video to protect the project, posting videos on Youtube.</p>	
Technological and resource support, the use of which provides for the discipline (if necessary)			
Innovative learning technologies	Inverted classroom, blended learning, augmented reality, project-based learning, problem-based learning, Inquiry-Based Learning, MOOC, formative and peer-to-peer assessment.		
Use of digital tools in the learning process	Virtual, remote labs, 3D tools, Google applications, multimedia presentation tool, LMS, Youtube, visualization tools, online boards, tag clouds, mind maps, virtual and remote labs, social networks, wikis, digital scientific communication tools, tools for webinars, screen capture and demonstration tools, mobile applications.		
Logistics	ICR equipment: SMART board, computers, smartphones, robotics kits, VR equipment		
Using the capabilities of the innovation class as part of the educational ecosystem MoPED	The innovative class will provide the organization of student rotations for research training.		
Software (if necessary) and educational and methodical support	<p>Instructions, video lectures, additional literature in the electronic course https://elearning.kubg.edu.ua/course/view.php?id=20050 Browser and open resources, software for robotic kits, software for VR-equipment.</p>		
Recommended sources of information (including electronic resources)	<p>Основа:</p> <p>1. Morze N., Nanaeva T., Omelchenko N. STEM in education. Tutorial. - K .: ACCORD GROUP, 2018. - 116 p.</p>		



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2. Morze N., Varchenko-Trotsenko L., Gladun M., Fundamentals of robotics: a textbook / N. Morze, L. Varchenko-Trotsenko, M. Gladun. - Kamyans-Podilskyi: Buinytskyi., 2016. - 184 p.
3. J. Craig Introduced into robotics. Mechanics and control. Institute of Computer Research Publishing House, 2013. - 564 p.
4. Morze N., Wember V., Sarazhinskaya N. We are smart.- A guide for students. - K.: Scholiar.- 2012. - 112 p.
5. Korshunova OV Informatics with micro: bit. Workbook-summary. Grade 5 ISBN 978-966-983-050-0
6. Morze N., Barna O., Bolshakova I., Wember V. Verification of subject competencies. Informatics, 4th grade. Collection of tasks for assessing student achievement: Textbook. manual (with the stamp of the Ministry of Education and Science of Ukraine "Approved for use in the educational process of secondary schools") / N. Morze, O. Barna, I. Bolshakova, V. Wember. - K.: Orion.- 2015. - 40 p..
7. Morze N., Wember V., Sarazhinskaya N. Steps to computer science: a book for a student of 2nd grade of secondary schools. - / N. Morze, V. Wember, N. Sarazhynska (stamp "Recommended by the Ministry of Education and Science, Youth and Sports of Ukraine") / K.: Scholiar. 2013. - 184 p.

Additional:

8. Litovchenko I., Maksimenko S. Children on the Internet: how to learn safety in the virtual world / - K.: Publishing House: 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-pochatkovoyiosviti>
10. DSanPiN 5.5.2.008-01. [Electronic resource]. - Access to the resource: <https://zakon.rada.gov.ua/go/v0063588-01>
11. Gololobov V. Where robots begin. About the Arduino project for schoolchildren (and not only). - M., 2011
12. Filippov S. Robotics for children and parents. - SPb.: Nauka, 2010 - 195 c. 1.

The system of internal quality assurance of the discipline

Survey of students on the quality of teaching the course, the results of their success.

Feedback from independent internal and external experts on the quality of teaching the discipline.