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MoPED: Modernization of Pedagogical Higher Education by Innovative Teaching Instruments

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HANDBOOK

Course: *Technologies for the development of critical thinking in teaching physics*

For students majoring in "014.08 Secondary Education (Physics)",
degree of higher education: *Master*

Developer:
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Course abstract:

The new Ukrainian school envisages the formation of schoolchildren's key competencies and the ability to think critically. Therefore, it is important that future physics teachers have competence-oriented learning technologies, on their basis schoolchildren can form critical thinking and relevant competencies. Such technologies include STEM-oriented technologies, interactive cooperative learning technologies, cloud technologies and mobile learning. It is important for future physics teachers to have such technologies and be able to implement them in the educational process in educational institutions. A scientific approach is impossible without the ability to think critically. The ability to make hypotheses, distinguish between correlation and causation, the ability to analyze empirical data, etc. is inherent in scientists. Physics as a science of Nature has significant didactic potential for the development of critical thinking. That is why the main goal of this course is the development of critical thinking of future physics teachers who will have modern technologies for teaching the development of critical thinking.

Key concepts:

Learning technology, critical rationalism, critical thinking, mobile learning, STEM, robotics, blended learning, flipped classroom, 21st century skills, key competencies, school physics course.

CONTENT

1. **Description of the course**

1.1. The workload of the course in ECTS credits: 3,0 ECTS credits
Total number of hours: 90, including those for full-time instruction: 14 lecture hours, 16 practical and laboratory hours, 60 hours for consultations and individual work of students.
Extramural training: 10 lecture hours, 4 practical and laboratory hours, 76 hours for consultations and individual work of students.
Status: Elective course.
1.2. Language of training: Ukrainian
1.3. Internet address of the permanent placement of educational content of the course https://drive.google.com/drive/my-drive
1.4. Developer: Serhii Tereshchuk, candidate of pedagogical sciences, associate professor, Department of Physics, Astronomy and Methods of Training.
1.5. The aim of the course: The formation of knowledge and competences of future physics and natural science teachers who can successfully use STEM oriented technologies of studies, mobile learning, blended learning, interactive technologies of cooperative learning for the development of student's skills and abilities of critical thinking in schools.
1.6. Competences forming in the process of learning the course

Integral competences (IC)	The ability to solve complex specialized problems and tasks in the field of higher and secondary specialized education. It provides implementation of innovations in the practice of the educational process and is characterized by uncertainty of conditions and requirements. The ability to solve complex tasks and problems, involving the implementation of research.
General competences (GC)	The ability to search, process and analyze information from various sources.
Professional (special) competencies (P_sC)	P_sC-1. The ability to use systematized theoretical and practical knowledge of physics and methods of teaching physics in the process of students' forming

	critical thinking skills in specialized secondary schools. P_sC-2. The ability to organize and conduct the educational process in physics with elements of STEAM-education in order to develop student's critical thinking in specialized schools. P_sC-3. The ability to use computer programs and mobile applications to organize physics classes focused on the development of students' critical thinking.

1.7. Learning outcomes

1. Knowledge of psychological and educational mechanisms of communication, content and features of application of modern information and educational technologies in professional activity (P_sC-1).
2. Knowledge of the main sources of information, principles and means of its search and processing (GC).
3. Knowledge of basic psychological and educational theories of teaching, innovative technologies of teaching physics aimed at the development of critical thinking, current problems of development and methods of teaching physics, the development of schoolchildren's critical thinking, in particular (P_sC-1).
4. Ability to independently study new issues of physics and methods of teaching physics, technologies for the development of critical thinking from a variety of information sources (GC).
5. Knowledge of ways and methods of searching, processing and analyzing information from various sources, primarily using digital technologies (GC)
6. Ability to adequately and impartially perceive personal characteristics and specific actions of schoolchildren and students, to understand individual and age features of schoolchildren and students (P_sC-1).

1.8. Control of learning outcomes

Methods, means and forms of diagnostics of learning outcomes	Methods of diagnostics of learning outcomes: oral examination on practical and laboratory classes, checking students' written papers (individual research tasks, essays). Means of oral checking of students' academic achievements: technology Plickers

<table>
<tr><td></td><td>(https://get.plickers.com/).
Means of written checking of students' knowledge: Google Forms service, written assignments in Google Classroom.
Forms of evaluation: individual check, frontal examination, consultations, final test (exam).</td></tr>
<tr><td>Final evaluation</td><td>The system of evaluation consists of the following types of educational activities. Two intermediate tests for evaluation of P_sC-1 (30%) і P_sC-2 (15%) accordingly. Final test evaluating P_sC-1 (20%). Report on laboratory experiments conducted P_sC-2 (5%) та P_sC-3 (15%). Work aimed at evaluating general competences (GC) (15%).

There is the following way of obtaining the final mark:

Final mark = P_sC-1 (50%) + P_sC-2 (20%) + P_sC-3 (15%) + GC (15%)

<table>
<tr><th>Competences</th><th>Intermediate evaluation, %</th><th>Final test, %</th><th>Total, %</th></tr>
<tr><td>P_sC-1</td><td>30%</td><td>20%</td><td>50%</td></tr>
<tr><td>P_sC-2</td><td>20%</td><td></td><td>20%</td></tr>
<tr><td>P_sC-3</td><td>15%</td><td></td><td>15%</td></tr>
<tr><td>GC</td><td>15%</td><td></td><td>15%</td></tr>
</table>
</td></tr>
<tr><td>Communication and feedback</td><td>Students will receive information about the results of the evaluation via the G Suite for Education services integrated with the Classroom platform. Classroom will provide information on:
1. The results of tasks (essay, individual research task, tests, literature review).
2. The results of educational projects.
3. The results of tests.
Support and consultation will be provided during meetings and online support via Classroom.</td></tr>
</table>

Scale of evaluation: national and ECTS

The sum of points for all types of educational activities	ECTS points	National/institutional grade
90-100	A	excellent
82 – 89	B	good
75 – 81	C	
69 – 74	D	satisfactory
60 – 68	E	
35 – 59	FX	Fail - some more work required before credit can be awarded
0-34	F	Fail – considerable further work is required

2. **Content and structure of the course**

2.1. **Content Module 1**. **Critical thinking** (40 hours: including 6 hours of lectures, 4 laboratory and practical classes, 30 hours of individual and independent work of the students).

2.1.1. Topic 1. Critical thinking as a philosophical category of critical rationalism.

2.1.2. Objective: to form students' concept of critical thinking and reveal its genetic origins.

Expected outcomes:

1) Knowledge and understanding of philosophical, psychological and pedagogical theories of cognition (P_sC-1).

2) Knowledge and understanding of the differences between empirical-inductive and hypothetical-deductive schemes of cognition and their role in teaching physics in educational institutions (P_sC-1).

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

Table 1. Criteria for evaluating learning outcomes

Evaluation criteria	Quantitative and / or qualitative characteristics
Understanding the basic principles and ideas of critical rationalism.	High level - the student understands well the basic ideas of the theory of critical rationalism and its origins, based on the synthesis of classical rationalism and empiricism. Low level - the student experiences significant difficulties in explaining the basic tenets of Karl Popper's theory of cognition.
Ability to distinguish different schemes of educational process in a school physics course on the basis of analysis of various theories of cognition.	High level - the student independently selects specific examples of studying educational material in the school physics course to explain the empirical-inductive scheme of cognition, guided only by the curriculum in physics and relevant textbooks in physics for specialized secondary education. Intermediate level - the student experiences some difficulties reviewing the necessary methodological literature for the selection of educational material in order to illustrate various schemes of students' cognitive activity. Low level - the student is not able to independently select and review the necessary scientific and methodological literature on this topic.

2.1.4. Digital tools

Tools for work: personal computers, tablet computers, smartphones, laptops, multimedia projectors, multimedia Smart-boards; software: (Windows, Linux (Debian, Ubuntu)); software for working with electronic documents: Google Docs, Presentations, Forms, Drive; LibreOffice Writer, Microsoft Word; for working with mobile applications: Android, iOS, Google Classroom, Plickers (https://www.plickers.com); for working with visualization tools: Google

Presentations, LibreOffice Impress, Classroomscreen service (https://classroomscreen.com/).

2.1.5. Innovative learning technologies: critical thinking development technologies, mobile learning technology, blended learning ("flipped classroom" model).

Innovative classroom spaces: study area and student's personal space area.

2.1.6. Lecture "Critical thinking as a philosophical category of critical rationalism" (Planning):

1. Critical thinking - analysis of existing models.
2. Classical rationalism and empiricism in modern epistemology.
3. Hume's problem. Inductive reasoning. Ideas of N. Taleb.
4. Ideas of positivism in the methodology of teaching physics.
5. Critical rationalism as an alternative to positivism and neopositivism.
6. Didactic aspects of critical rationalism in teaching physics.
7. Conclusions and generalizations.

2.1.7. Tasks for independent student's work

Write an individual research task (revision of literature sources (topics)):

1. Implementation of ideas of inductive and hypothetical-deductive reasoning in the educational process (GC, P_sC-1)
2. Critical rationalism as a conceptual basis for the development of critical thinking in physics lessons in secondary schools (GC).
3. Deductive and inductive approaches in the methodology of teaching physics (GC).

2.1.11. Topic 2 "Tools and strategies for the development of schoolchildren's critical thinking".

2.1.12. Objective: to familiarize students with the tools and strategies for the development of critical thinking.

Expected outcomes:

1. Knowledge of methods, techniques for the development of critical thinking (PsC-1)
2. Ability to use (organize and conduct appropriate classes) methods and techniques for the development of critical thinking in the student body (P_sC-1)
3. Knowledge of digital tools for the development of critical thinking.

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

Table 2. Criteria for evaluating learning outcomes

Evaluation criteria	Quantitative and / or qualitative characteristics
Knowledge and understanding of basic methods and techniques of critical thinking development.	High level — the student understands well the basic methods and techniques of developing critical thinking. Low level — the student experiences significant difficulties in explaining the main ideas embedded in the technology of developing critical thinking.
Ability to organize and use the necessary resources and didactic materials for organizing the educational process of developing high school children's critical thinking.	High level — the student independently selects specific methods, technologies and appropriate resources for organizing the educational process of developing critical thinking. Intermediate level — the student experiences some difficulties in organizing and conducting lessons on developing schoolchildren's critical thinking. Low level — the student is not able to independently select and prepare for a lesson on developing critical thinking.

2.1.14. Digital tools

Tools: personal computers, tablet computers, smartphones, laptops, multimedia projectors, multimedia Smart boards; software: Windows, Linux (Debian, Ubuntu); software for working with electronic documents: Google documents, presentations, forms, disk; LibreOffice Writer, Microsoft Word; for working with mobile applications: Android, Google Classroom, Plickers (https://www.plickers.com); for working with visualization tools: Google presentations, LibreOffice Impress; services: Classroomscreen (https://classroomscreen.com/), Gaasp (https://graasp.eu/), GO LAB (https://www.golabz.eu/).

2.1.15. Innovative learning technologies: mobile learning technology, interactive technologies of cooperative learning.

Innovative classroom spaces: study area and student's personal space area.

2.1.16. Lecture "Strategies for developing schoolchildren's critical thinking"
Planning
1. Critical thinking is higher-order thinking.
2. Laws of logic and critical thinking.
3. Correlation and cause-and-effect relationship.
4. Conclusions and generalizations.

Lecture "Methods and techniques for developing critical thinking".
1. Educational discussion.
2. "Six thinking hats" technique (Edward de Bono method).
3. Interactive methods and techniques.
4. Methods and techniques of "questioning" (Socratic method, 7W method).
5. Method of control and isolation. Piaget's task.
6. Conclusions and generalizations.

2.1.17. Seminar / practical / laboratory lesson
Practical lesson "Six thinking hats" method in the educational project."
Laboratory work "Preparation of a fragment of a physics lesson using methods of developing schoolchildren's critical thinking".
2.1.18. Topics of individual and / or group tasks
1. The ability to ask questions: the Socratic method.
2. 7W method: application at physics lessons.
2.1.19. Tasks for independent work of students.
Completion of an IRT (individual research task) based on a review of literary sources:
1. Methods and techniques for developing schoolchildren's critical thinking.
2. Interactive technologies and development of schoolchildren's critical thinking.
3. Development of schoolchildren's logical thinking at physics lessons.

2.2. Content module 2. Critical thinking based on modern educational technologies (50 hours, including 8 hours of lectures, 12 laboratory and practical classes, 30 hours of individual and independent work of students).

2.2.1. Topic 1. Educational technology as a means of developing critical thinking.

2.2.2. Objective: forming students' abilities and skills using educational technologies for the development of schoolchildren's critical thinking in the course of physics in specialized secondary education.

Expected outcomes:

1). Knowledge and understanding of the technology of critical thinking development (IC, P_sC-1, GC).2)

2). Ability to apply methods of developing schoolchildren's critical thinking in (IC, P_SC-1).

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

Table 3. Criteria for evaluating learning outcomes

Evaluation criteria	Quantitative and / or qualitative characteristics
Knowledge and understanding of the concept of "educational technology".	High level — the student understands the basic features of learning technology, is able to explain the differences between technology and teaching method, understands the differences between the concepts of "pedagogical technology" and "educational technology". Low level — the student experiences significant difficulties in explaining the main features of educational technology, inaccurately explains the differences between the concepts of "teaching method", "methodical technique", and "educational technology".
Ability to prepare a physics lesson project and use the necessary resources and didactic materials to organize the educational process using the technology of developing high school children's critical thinking.	High level — the student independently selects specific materials and resources for applying the technology of developing critical thinking at physics lessons. Intermediate level — the student experiences some difficulties in organizing and conducting lessons on developing schoolchildren's critical thinking. Low level — the student is not able to independently select and prepare for a lesson on developing critical thinking.

2.2.4. Tools: personal computers, tablet computers, smartphones, laptops, multimedia projectors, multimedia Smart boards; software: Windows, Linux (Debian, Ubuntu); software for working with electronic documents: Google

documents, presentations, forms, disk; LibreOffice Writer, Microsoft Word; for working with mobile applications: Android, Google Classroom, Plickers (https://www.plickers.com); for working with visualization tools: Google presentations, LibreOffice Impress, services: Classroomscreen (https://classroomscreen.com/), Gaasp (https://graasp.eu/), GO LAB (https://www.golabz.eu/).

Innovative classroom spaces: study area and student's personal space area.

2.2.5. Innovative learning technologies: mobile learning technology, interactive cooperative learning technologies.

Planning

1. The concept of technology for the development of critical thinking (educational technology, tdct

2. Educational technologies focused on developing critical thinking.

1.1. DCTRW (Development of critical thinking through reading and writing)

1.2. Interactive technologies

1.3. ICT

1.4. Mobile technologies

1.5. STEM-oriented technologies

2. Combining and integrating educational technologies as a means of developing schoolchildren's critical thinking at physics lessons.

2.2.7. Seminar / practical / laboratory lesson

Practical lesson "Educational Technologies"

Laboratory work "Technologies of interactive learning and development of critical thinking".

2.2.8. Topics of individual and / or group tasks

Task 1. Development of a physics lesson using the technology of cooperative learning.

Task 2. Development of demonstration experiments using the technology of developing lyceum students' critical thinking.

2.2.9. Tasks for independent work of students

Preparation of IRT (topics)

2. Organization of a discussion when studying a particular topic in physics (random choice) in specialized secondary education institutions.

2.2.10. Topic 2. Development of critical thinking based on mobile and blended learning.

2.2.11. Objective: to familiarize students with educational technologies (mobile learning and blended learning), the use of which allows them to develop lyceum students' critical thinking.

Expected outcomes:

1. Understanding the concept of "mobile learning technology" in the context of developing critical thinking (PsC-1, PsC-3).

2. Knowledge and understanding of the technology of "blended learning" in the context of developing critical thinking (PsC-1, PsC-3).

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

Table 4. Criteria for evaluating learning outcomes

Evaluation criteria	Quantitative and / or qualitative characteristics
Knowledge and understanding of the concept of "mobile learning technology", "blended learning technology".	High level — the student understands the main features of mobile learning technology, understands the differences between the concepts of "mobile learning" and "blended learning technology". Low level — the student has significant difficulties in explaining the main features of mobile learning technology, inaccurately explains the differences between the concepts of "mobile learning" and "blended learning technology".
Ability to prepare a physics lesson project and use the necessary resources and didactic materials to organize the educational process using technologies for developing high school students' critical thinking based on mobile learning and blended learning.	High level — the student independently selects specific materials and resources for applying the technology of developing critical thinking at physics lessons based on mobile learning and blended learning. Intermediate level — the student experiences some difficulties in organizing and conducting classes on developing schoolchildren critical thinking using mobile and blended learning technologies. Low level — the student is not able to independently select and prepare for a lesson on developing critical thinking..

2.2.13. Tools: personal computers, tablet computers, smartphones, laptops, multimedia projectors, multimedia Smart boards; software: (Windows, Linux (Debian, Ubuntu)); software for working with electronic documents: Google documents, presentations, forms, disk; LibreOffice Writer, Microsoft Word; for working with mobile applications: Android, Google Classroom, Plickers (https://www.plickers.com); for working with visualization tools: Google presentations, LibreOffice Impress, Classroomscreen service (https://classroomscreen.com/), Phet Interactive Simulation (https://phet.colorado.edu/uk/simulations/category/physics)

Innovative classroom spaces: study area and student's personal space area.

2.2.14. Innovative learning technologies: mobile learning technology, interactive cooperative learning technologies.

2.2.15. Lecture "Mobile and blended learning technologies and developing critical thinking at physics lessons"

Planning

1. Mobile learning technology.
2. Blended learning.
3. Development of critical thinking through mobile learning at physics lessons in specialized secondary education institutions.
4. Development of critical thinking through blended learning at physics lessons in specialized secondary education institutions.

Practical lesson 2. "Technology of blended learning at physics lessons"

Laboratory work "Mobile and blended learning technologies and developing critical thinking".

2.2.15. Topics of individual and / or group tasks

Task 1. Development of a physics lesson physics using mobile learning technology for developing critical thinking.

Task 2. Development of a physics lesson using blended learning technology ("flipped classroom" model) for developing critical thinking.

2.2.16. Tasks for independent work of students

Preparation of IRT (topics)

1. Technology of developing schoolchildren's critical thinking by means of mobile applications.
2. Technology of developing critical thinking on the basis of various blended learning models during studying physics.

2.3.1. Topic 3. Development of critical thinking based on STEM education.

2.3.2. Objective: to familiarize students with STEM/STEAM/STREAM learning technologies, the use of which allows them to develop lyceum students' critical thinking.

Expected outcomes:

1. Knowledge and understanding of the concept of STEM / STEAM / STREAM learning (PsC-2).

2. Ability to organize and conduct STEM-oriented physics classes (PsC-2, PsC-3).

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

Table 5. Criteria for evaluating learning outcomes

Evaluation criteria	Quantitative and / or qualitative characteristics
Knowledge and understanding of the concept of "STEM education".	High level — the student understands well the main features of mobile learning technology, understands the differences between the concepts of "mobile learning" and "blended learning technology". Low level — the student has significant difficulties in explaining the main features of mobile learning technology, inaccurately explains the differences between the concepts of "mobile learning" and "blended learning technology".
Ability to prepare a physics lesson project and use the necessary resources and didactic materials to organize a STEM lesson.	High level — the student independently selects specific materials and resources applying the technology of developing critical thinking at physics lessons based on STEM training. Intermediate level — the student experiences some difficulties in organizing and conducting lessons on the development of schoolchildren's critical thinking using STEM training. Low level — the student is not able to independently select and prepare for a lesson on the development of critical thinking.

2.3.4. Tools: personal computers, tablet computers, smartphones, laptops, multimedia projectors, multimedia Smart boards; software: (Windows, Linux (Debian, Ubuntu)); software for working with electronic documents: Google

documents, presentations, forms, disk; LibreOffice Writer, Microsoft Word; for working with mobile applications: Android, Google Classroom, Plickers (https://www.plickers.com); for working with visualization tools: Google presentations, LibreOffice Impress, Classroomscreen service (https://classroomscreen.com/), Phet Interactive Simulation (https://phet.colorado.edu/uk/simulations/category/physics); programming tool: Arduino IDE.

2.3.5. Innovative learning technologies: mobile learning technology, interactive cooperative learning technologies.

2.3.6. Lecture "STEM in studying physics"

Planning

1. STEM education: basic concepts.
2. Integration of physics and computer science within STEM-technologies.
2. Educational Technologies focused on STEM education.
3. Virtualization of physical experiment and STEM training.
4. Use of mobile device sensors at STEM classes.
5. Use of Arduino microcontrollers at STEM physics classes.
6. Use of the Raspberry Pi for physics training projects.
7. Use of LEGO for optional robotics classes (LEGO MINDSTORMS® Education EV3 Core Set)
7. Conclusions and generalizations.

2.3.7. Seminar / practical / laboratory lesson

Practical lesson "Development of critical thinking at robotics lessons".

Laboratory work "Development of critical thinking during completing projects based on Arduino".

2.3.8. Topics of individual and / or group tasks

Task 1. Development of a physics lesson with elements of STEM training.

Task 2. Development of a demonstration experiment (frontal laboratory work) using the mobile application Google Science Journal (arbitrary topic).

Task 3. Preparation of an extracurricular STEM event "Festival of interesting science".

2.3.9. Tasks for independent work of students

Preparation of IRT (topics)

1. STEM / STEAM / STREAM projects and festivals of interesting science.
2. Technology for the development of critical thinking based on STEM education.
3. Creation of educational projects in physics by means of the Raspberry Pi for the development of high school children's critical thinking.

3. **Tasks for final attestation**

3.1. List of questions for final test evaluation.

1. Critical thinking. The analysis of existing models and definitions.
2. Classical rationalism and empiricism in modern gnosiology.
3. Hume's problem. Inductive cognition. Ideas of N. Taleb.
4. Ideas of positivism in the methodics of teaching physics.
5. Critical rationalism is an alternative to positivism and neopositivism.
6. Didactic aspects of critical rationalism in teaching physics.
7. Critical thinking as a category of pedagogical psychology.
8. Laws of logic and critical thinking.
9. Discussions. Correlation and causation.
10. Methods and techniques for developing critical thinking.
11. "Six thinking hats" technique (Edward de Bono's method).
12. Interactive methods and techniques for developing critical thinking.
13. Methods and techniques of "questioning" (Socratic method, 7W method).
14. Method of control and isolation. Piaget's task.
15. Technological nature of the educational space — a historical excursus.
16. Educational technologies — definitions, basic concepts.
17. Educational technologies focused on developingt critical thinking.
18. Combining and integrating educational technologies as a means of developing students' critical thinking at physics lessons.
19. Mobile learning technology. The concept of LMS.
20. Educational technologies. Blended learning.
21. Development of critical thinking through mobile learning at physics lessons in specialized secondary education institutions.
22. Development of critical thinking through blended learning at physics lessons in specialized secondary education institutions.
23. STEM education: basic concepts.
24. Integration of physics and computer science within STEM-technologies.
25. Educational technologies focused on STEM education.
26. Virtualization of physical experiment and STEM training.
27. Use of mobile device sensors at STEM classes. Robotics and the development of critical thinking.
28. Use of Arduino microcontrollers at STEM physics classes.
29. Use of the Raspberry Pi for physics training projects.
30. Methods of organizing science festivals within STEM education.

3.2. Procedure for final attestation

Distribution of points received by students

Intermediate testing and individual work					Total	Exam
Content module 1		Content module 2				
T1	T2	T3	T4	T5	50	50
10	10	10	10	10		

T1, T2 ... T5 — topics of content modules.

3.3. Approximate evaluation of various types of students' educational activities (in points)

Types of activity	*Points*
Completing a laboratory work	*1-5*
Preparing a presentation on a topic	*1-5*
Preparing an essay, review	*1-5*
Developing a creative project	*1-5*
Preparing a project (including group project)	*1-5*
Individual research task	*1-10*
Final test evaluation	*1-15*
Total	*1-50*
Exam	*1-50*
Total	*100*

4. List of recommended reading

1. Vukina N.V., Dementiyevs`ka N.P. Kry`ty`chne my`slennya: yak cz`ogo navchaty`. Naukovo-metody`chny`j posibny`k. - X.: Vy`davny`cha grupa «Osnova»: «Triada+», 2007. - 112 s.
2. Vseukrayins`ky`j festy`val` «Nauka na sceni» (Science on Stage Festival. Book of Abstracts). Tezy` dopovidej uchasny`kiv festy`valyu. Xarkiv 18-19 ly`stopada 2016 roku. Xarkiv 2016, s. 48.
3. Evdokimov V.I., Oleinik T.A., Gorkova S.A., Mikitiuk M.V. Praktikum po razvitiiu kriticheskogo myshleniia. - Kharkov: Tornado, 2002. - 143 s.
4. Zajchenko I.V. Pedagogika. Navchal`ny`j posibny`k dlya studentiv vy`shhy`x pedagogichny`x navchal`ny`x zakladiv, 2-e vy`d. - K., "Osvita Ukrayiny`", "KNT", 2008. - 528 s.
5. Kriticheskoe myshlenie: otchet ob ekspertnom konsensuse v otnoshenii

obrazovatelnogo otsenivaniia i obucheniia (Delfi-doklad) (Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction. Executive Summary) // Dr. Peter A. Facione (Dean of the College of Arts and Sciences, Santa Clara University), perevod E.N. Volkova (1990.: sait. — URL: http://evolkov.net/critic.think/basics/delphi.report.html

6. Lipman M. Kry`ty`chne my`slennya: chy`m vono mozhe buty`? Visny`k program shkil`ny`x obminiv. 2006. # 27. S. 17-23.
7. Makarenko V.M., Tumanczova O.O. Yak opanuvaty` texnologiyu formuvannya kry`ty`chnogo my`slennya. - X.: Vy`d. grupa «Osnova»: «Triada+», 2008. - 96 s. (Seriya: «Pedagogichni innovaciyi. Majsternya»).
8. Osvitni texnologiyi: Navch.-metod.posib. / O.M.Pyexota, A.Z.Kiktenko, O.M. Lyubars`ka ta in.; Za red. O.M.Pyexoty`. - K.: Vy`davny`cztvo A.S.K., 2003. - 255 s.
9. Pometun O.I. Ency`klopediya interakty`vnogo navchannya. - K., 2007. - 144s.
10. Pometun O.I. ta in. Suchasny`j urok: Interakty`vni texnologiyi navchannya: Nauk.-metod. posibny`k / O.I. Pometun, L.V. Py`rozhenko; Za red. O.I. Pometun. - K.: A.S.K., 2004. - 192 s.
11. Pometun O.I., Py`ly`pchatina L.M., Sushhenko I.M., Baranova I.O. Osnovy` kry`ty`chnogo my`slennya: Navchal`ny`j posibny`k dlya uchniv starshy`x klasiv zagal`noosvitn`oyi shkoly`. - Ternopil`: Navchal`na kny`ga — Bogdan, 2010. - 216 s.
12. Popper K. Istina, ratsionalnost i rost nauchnogo znaniia // Predpolozheniia i oproverzheniia. - M.: AST, Ermak, 2004. - 638 s. - S.359-419.
13. Sergij Tereshhuk, Rozvy`tok kry`ty`chnogo my`slennya uchniv na urokax fizy`ky` v starshij shkoli // Fizy`ka ta astronomiya v shkoli – 2008.
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