

NATIONAL RESEARCH UNIVERSITY HIGHER SCHOOL OF ECONOMICS  
THE INSTITUTE OF EDUCATION

As a manuscript

Taras Pashchenko

Using Problem-Based Learning to Develop Critical Thinking in Adults

Summary of the thesis  
for the purpose of obtaining academic degree  
Doctor of Philosophy in Education

Academic supervisor:  
Elena Chernobay  
Prof., Doctor of Sciences (Ped.)

Moscow — 2024

Full name of the applicant	Pashchenko Taras Valerievich
Subject	Using Problem-Based Learning to Develop Critical Thinking in Adults
Organization	National Research University Higher School of Economics, Institute of Education
Supervisor	Chernobay Elena Vladimirovna, Doctor of Pedagogical Sciences, Professor
List of publications	<ol style="list-style-type: none"> <li>1. Girinsky A. A., Lepetyukhina A. O., Pashchenko T. V. The concept of critical thinking: the genesis of the concept and current problems of application in education // World of Psychology. 2023. No. 3 (114) pp. 383–403.</li> <li>2. Pashchenko T.V., Formation of critical thinking in adults using problem-based learning in an online environment // Educational Issues. 2024. №2 (accepted)</li> <li>3. Santos Meneses L. F., Pashchenko T., Mikhailova A. Critical thinking in the context of adult learning through PBL and e-learning: A course framework // Thinking Skills and Creativity. 2023. Vol. 49. Article 101358.</li> <li>4. Sadova A. R., Khil Yu. S., Pashchenko T. V., Tarasova K. V. Measuring critical thinking in adults: methodology and development experience // Modern foreign psychology. 2022. T. 11. No. 4. pp. 105–116.</li> <li>5. Girinsky A. A., Lepetyukhina A. O., Pashchenko T. V. Critical thinking: from the Humboldtian model to the Federal State Educational Standard // Educational Policy. 2022. T. 89. No. 1. pp. 42–52.</li> </ol> <p>Other publications on the topic:</p> <ol style="list-style-type: none"> <li>1. Koreshnikova Yu. N., Frumin I. D., Pashchenko T. V. Organizational and pedagogical conditions for developing critical thinking skills among students of Russian universities // University management: practice and analysis. 2021. T. 25. No. 1. P. 5–17.</li> <li>2. Koreshnikova Yu. N., Frumin I. D., Pashchenko T. V. Barriers to creating pedagogical conditions for the development of critical thinking in Russian universities // Pedagogy. 2020. T. 84. No. 9. pp. 45–54.</li> <li>3. Avdeeva S. M., Gass P. V., Koreshnikova Yu. N.,</li> </ol>

	<p>Kulikova (Ponomareva) A. A., Orel E. A., Pashchenko T. V., Sorokin P. S. Assessment of universal competencies as results of higher education Analytical report for the XXII April international scientific conference on problems of economic and social development / Director: E. Yu. Kardanova. M.: National Research University Higher School of Economics, 2021.</p> <p>4. Pashchenko T.V., Nepryakhin N.Yu. Critical thinking Iron logic for all occasions. M.: Alpina Publishers, 2020.</p>
<p>Conferences where research results were presented</p>	<ol style="list-style-type: none"> <li>1. Report: Developing critical thinking in adults through structured problem solving. XIV International Conference of Higher Education Researchers (IHE Conference), 2023.</li> <li>2. Report: Smart and/or knowledgeable: in search of balance: the place of universal competencies in the content of higher education. XIII International Russian Conference of Higher Education Researchers, 2022.</li> <li>3. Report: Developing critical thinking in adults through structured problem solving. XXIII Yasinsk (April) international scientific conference on problems of economic and social development, 2022.</li> <li>4. Report: Universal competencies in Russian universities. Eighth annual international scientific and practical conference “Education and world cities: the third mission of the university and students”, 2021.</li> <li>5. Report: Designing a course on the development of critical and creative thinking. Edcrunch Tomsk. 2020</li> </ol>

## Table of contents

Introduction	5
Statement of the problem	7
Research objectives	10
Theoretical Framework of the Study	11
Operationalization and Research Methods	16
Results	18
Analysis of historical and philosophical prerequisites for the emergence of components of critical thinking as an educational result.	18
Features of using problem-based learning in an online environment to develop critical thinking in adults	24
Course requirements for the development of critical thinking in adults based on problem-based learning, implemented in an online format	29
Assessing educational outcomes related to adult critical thinking in an online format	35
Assessment of the results of the course for Critical Thinking development	36
Conclusions	39
References	42

# Introduction

Critical thinking (hereinafter referred to as CT) is considered one of the most sought-after competencies among modern employers. Recent reports analyzing labor market trends show that the number of jobs requiring “soft” skills (or “general competencies”), which includes CT, is growing [Hall & Schmutz, 2023; Indrašienė et al., 2021a; OECD, 2022; World Economic Forum, 2020]. According to employers, CM helps to increase the professional self-esteem of employees, helps to cope with difficult situations and find innovative solutions [Jiang et al. 2018]. In addition, CM creates the prerequisites for the employee’s constant self-development in the interests of organizational change [Yuan et al. 2021], helps employees constructively respond to the challenges of a changing environment and seek better solutions for themselves, clients and the organization [Indrašienė et al. 2019]. Recognition of the importance of CT can be evidenced by its inclusion as an intended educational outcome in documents defining policy in the field of higher education in different countries. For example, the UK Quality Code for Higher Education recognizes the development of QM as one of the core principles of learning and teaching, “which increases the overall employability of students and promotes entrepreneurial behavior” [Quality Assurance Agency, 2018, p. 6]. In the United States, the National Academies of Sciences, Engineering, and Medicine assigns similar importance to CT in its monitoring of higher education in STEM [National Academies of Sciences, 2017]. In addition, in the current version of the Russian Federal State Educational Standards of Higher Education, universal competencies are included in the expected learning outcomes, among which KM [Federal State Educational Standard of Higher Education] also appears. Among the universal competencies in these documents, CM occupies a special place, since it determines how well a person copes with complex work and everyday tasks based on information analysis, reasoning, evaluating arguments, decision making, etc. [Koreshnikova et al. 2020, Zahner , 2022]. Therefore, developed CT skills are considered necessary for higher education students to achieve success not only academically, but also in personal and professional spheres [Butler, 2012].

Despite these facts, at the moment it cannot be said that universities pay adequate attention to the development of universal competencies (in particular CT) of students [Huber & Kuncel, 2016; Indrašienė et al., 2021b; OECD, 2022; Zahner, 2022, Koreshnikova et al., 2020; 2021]. For example, a recent study shows that the level of development of universal

competencies among Chinese, Indian and Russian students is low and does not grow during their studies [Loyalka et al., 2021]. These results are confirmed by the opinion of employers who note the insufficient level of development of universal competencies of graduates entering the labor market [Gruzdev et al., 2018; Indrašienė et al., 2021a; OECD, 2022; Zahner, 2022]. Thus, it can be argued that there is a gap between the stated importance of developing CT as a universal competence and the learning outcomes achieved.

This gap leads to an increase in educational services aimed at developing universal competencies of employees (with higher education), including CM. A significant number of such courses are also offered in online formats on various platforms. For example, “Open Education”, Stepik, edX, Coursera, LinkedIn Learning offer open courses on the development of CT. In addition, a number of CM programs are implemented by universities (Higher School of Economics, UrFU, Tyumen State University, Tomsk State University, National Research Nuclear University MEPhI) and additional education organizations (School of Critical Thinking, Synchronization). In addition to university students, these courses are intended for working adults, falling into the context of continuing education, which is the reason for their implementation in various online formats (MOOCs, webinars, text courses using LMS), since this allows working adult students to combine work and study [Bowen, 2015].

According to a number of authors [Berg, Simonson, 2023], a fundamental feature of learning in online formats, or online learning, is the use of the Internet as a medium for communication, interaction and involvement. Online learning offers a flexible and adaptive approach to education that goes beyond traditional face-to-face learning, allowing students to learn anywhere and anytime [Blaschke & Bedenlier, 2020]. Online learning and distance education are becoming increasingly common in higher education institutions in the 21st century. [ibid].

Despite the potential benefits of using online formats, existing CT courses often look like lecture-based classic university courses, overloaded with passive learning. Many authors discuss the limitations of the online format, especially for the development of competencies related to communication, reasoning, and argumentation [Cortázar et al., 2021; Lorencová et al., 2019; Saadé et al., 2012; Şendağ & Odabaşı, 2009; Viberg et al., 2020 and others]. However, many studies have shown that to develop CT, active learning strategies should be used, including, but not limited to, problem-based learning (PBL), group discussions and

authentic learning [Abrami et al., 2015; Bezanilla et al. , 2019; Lorencova et al., 2019; Payan-Carreira et al., 2019; Theall, 2003]. It turns out that the most common adult education formats are not entirely adequate to the task of developing such complex competence as CT.

Thus, the relevance of this study arises from: 1. The existence of a need for the development of CM in adults associated with the demands of the labor market and society; 2. Inconsistencies between the actual educational results of programs within formal education and this request; 3. The need for scientifically based creation of educational products aimed at the development of CT within the framework of non-formal (continuous) education, including using online learning tools.

## Statement of the problem

Current scientific discussions about the formation of CT as an educational result can be grouped around three groups of issues.

The first group of questions is related to the conceptualization of CT as an educational outcome: How is CT understood?” or “What educational outcomes are components of CT?” as part of a separate study or educational product. This issue is related to the theoretical foundations for the development of pedagogical interventions and assessment tools. In existing studies [Tarasova, Orel, 2022], at least three approaches to understanding CM can be distinguished: psychological [Rubinstein, 2002; Teplov, 1946; Zeigarnik, 1986], philosophical [Paul, Elder, 2011; Ennis, 2015; Hitchcock, 2020; Lai, 2011], educational (pedagogical) [McPeck, 2016; Dewey, 1910, 1933; Glaser, 1942; Weinstein (1990); Willingham, 2020]. Of particular interest within the framework of the conceptual analysis of CM is the question of its historical and philosophical premises. Studying the genesis of CM as a concept and its components can help clarify modern ideas about CM as an educational result, as well as the dissemination of promising educational practices.

The second question: “What practices (pedagogical tools) contribute to the formation of students’ CT (are effective)?” It has been the subject of many empirical studies, including meta-analyses [Abrami, 2008; 2015]. Among the many tools, PBL, discussion-based learning, and tutor support are considered the most effective. The development of CT within formal education is a fairly well-researched area in terms of theoretical assumptions, methods and their effectiveness (for example, [Scott et al., 2004]). However, when it comes to the

development of CT outside the framework of traditional education (in the context of online learning, in adult education), this topic remains insufficiently studied [Dwyer & Walsh, 2020; Indrašienė et al., 2021a]. In addition, according to [Awan et al. 2018] and [JC Trullàs et al. 2022], the use of online tools within problem-based learning is also insufficiently studied.

The third question: “How to integrate effective practices into the educational process to achieve planned educational results?” (KM development strategies). This issue began to be discussed in the late 1980s, and it still remains relevant. Ennis (1989) identified 4 strategies for teaching CT within formal education: the general strategy involves teaching the “general” principles of critical thinking without the use of specific content; the infusion strategy involves the inclusion of elements of critical thinking in subject courses; the immersion strategy involves teaching a subject with the expectation that elements of critical thinking will develop naturally. way, and mixed implies the simultaneous use of several mentioned approaches [Ennis, 1989]. A meta-analysis [Abrami et al., 2008] showed that among four strategies for developing critical thinking, mixed strategies most contribute to the achievement of educational outcomes associated with critical thinking. At the same time, the immersion strategy is the least effective (in this understanding of effectiveness), and the general and infusion strategies demonstrate average effectiveness.

Despite a significant number of studies devoted to these issues within formal education and allowing us to judge the effectiveness of individual strategies and pedagogical tools in basic or higher education, the question is whether these strategies will maintain their effect when transferred to non-formal adult education, and even more so in online format requires additional research.

Issues of development and formation of thinking have a rich history in the Russian (Soviet) psychological and pedagogical tradition. In the works of L. S. Vygotsky, A. N. Leontyev, P. Ya. Galperin, D. B. Elkonin and V. V. Davydov. In classic Soviet works, the term “critical thinking” was not used or was rarely used. Soviet psychologists used concepts close to the modern understanding of critical thinking: creative thinking [Galperin, 2008], scientific thinking [Elkonin, Davydov, 1962], dialectical thinking [Ilyenkov, 1995]. An important feature of this tradition is the study of the development of thinking primarily in childhood, and approaches to the formation of thinking in general education.

This characteristic of thinking as criticality was discussed in the works of B.V. Zeigarnik, S.L. Rubinstein and B.M. Teplov. Criticality is considered as a skill that can be



developed (S. I. Veksler, L. I. Bozhovich), and as the ability to analyze and evaluate thought processes and their results (N. A. Menchinskaya, A. B. Brushlinsky). According to A. M. Matyushkin, critical thinking is one of the final stages of thinking, the purpose of which is to check and evaluate the results of previous mental actions. [Kharlampyeva, 2003].

Since the beginning of the 2000s, one can note a growing interest in the problems of developing critical thinking among Russian researchers. G.V. Sorina, based on the ideas of D. Dewey, argues that critical thinking is closely related to the ability to analyze one's thought processes. She describes critical thinking as practically oriented, similar to applied logic [Sorina, 2003]. T. A. Olkhova and V. N. Eliseeva consider critical thinking as a complex phenomenon that includes not only intellectual abilities and skills, but also awareness of one's own thinking, the presence of certain attitudes and the willingness to use these skills [Olkhova, Eliseeva, 2013, p. 48]. Among the well-known methodological developments in the pedagogical community, the technology aimed at use in general education "Development of critical thinking through reading and writing" deserves special mention. In this approach, CM is understood as "the process of correlating external information with a person's existing knowledge, making decisions about what can be accepted, what needs to be supplemented, and what needs to be rejected. At the same time, sometimes you have to adjust your own beliefs or even abandon them if they contradict new knowledge" [Zair-Bek, Mushtavinskaya, 2011].

Thus, despite the significant number of works in Russian and the conceptual similarity of the author's positions, it can be seen that in the Soviet tradition, the development of the child's thinking and the formation of thinking within the framework of general education were studied primarily. In turn, the formation of critical thinking in adults requires separate research.

# Research objectives

The **object** of this study is adult education as an activity aimed at developing knowledge, skills, dispositions and values in students over 18 years of age and, as a rule, outside formal education.

The subject of the study is the use of problem-based learning to develop critical thinking in adults in an online format.

**The purpose of the study** is to study the characteristics and methods of developing critical thinking of adults within the framework of non-formal education.

To achieve this goal it is necessary to complete the following **tasks** :

1. Study and justify the historical and philosophical foundations of the concept of critical thinking and its individual components as educational results;
2. Determine the features of the formation of adult CM in the context of non-formal education;
3. Consider the characteristics of problem-based learning that promote and hinder the development of adult CT within non-formal education;
4. To study the features of the organization of online learning that promote and limit the development of CM in adults;
5. Develop a list of course requirements for the development of CM in adults based on PBL for implementation in an online format;
6. Develop and validate a tool for assessing CM in adults;
7. Based on the list of requirements, develop a course for the development of CM in adults using PBL in an online format;
8. Evaluate the effectiveness of the proposed methodological solution.

**The study asked the following research questions:**

1. What are the historical and philosophical bases for identifying the key components of CT for teaching adults: skills of working with sources of information, independent reasoning, application of methods of rational cognition in solving practical problems?

2. What are the key features of using problem-based learning in an online environment to develop CM in adults?
3. What are the specifics of the course model for the development of CM in adults based on PBL, implemented in an online format?
4. Does a course designed based on problem-based learning and delivered using online learning in the context of non-formal adult education contribute to the development of CT?

The study aims to test the following **hypothesis**:

A course based on problem-based learning and delivered using online formats can promote the development of critical thinking in adults if a number of requirements for course design, interaction between the teacher and students, and the qualifications of the teacher are met during the course development and implementation process.

## Theoretical Framework of the Study

In this work, CM is considered as a universal competence [Dobryakova et al., 2020]. This approach was chosen because most empirical research and applied developments rely on it. This approach primarily involves considering CT as a complex construct, including a certain set of knowledge, skills and dispositions (activity attitudes). The versatility of CM lies in the fact that this competency can be used in various contexts and allows one to successfully solve problems in various fields. Thus, CM is understood as a set of knowledge, skills and dispositions that allow rational analysis and evaluation of information for reasoned decision-making [Koreshnikova, Frumin, Pashchenko, 2020]. Examples of knowledge as components of CT include criteria for the reliability of sources, types of cognitive distortions, basic methods of correct reasoning, criteria for convincing arguments, types of argumentative tricks. CT skills include the skills of information analysis, logical reasoning, and argumentation. The list of CM dispositions may include objectivity, curiosity, openness to new things, reflexivity, etc. [Facione, 1990; Ennis, 2015; Orel, Tarasova, 2022].

Problem-based learning (PBL) is an integrated pedagogical approach that involves the systematic use of problems (such as ill-structured problems) and a variety of activities aimed at developing skills or learning objectives, such as problem solving or other CT and technical skills and knowledge [Barrows & Tamblyn, 1980; Kek & Huijser, 2011; Kong et al., 2014; Trullàs et al., 2022]. Despite the variety of definitions, according to [Şendağ, Odabaşı, 2009],

different authors agree that PBL can be understood in terms of three principles: 1. To begin learning, there must be a problem; 2. PBL is not an isolated teaching technique, but a holistic approach that involves the interaction of several approaches and teaching methods; 3. PBL is almost always student-centered.

Although there is sometimes disagreement about the number of phase names for PBL (e.g., Silva et al., 2018), there seems to be agreement that PBL includes at least three phases: a problem analysis phase, consisting of group discussion/problem identification work and formulating educational problems/questions; self-learning phase, consisting of independent search and processing of information; and a reporting phase consisting of synthesis [Loyens et al., 2020; Yew & Goh, 2016]. This echoes Garrison's (1991) conceptual model of the development of critical thinking in adult learners, in which problem solving is central to the “critical thinking/learning cycle” (p. 293). In this model, Garrison identifies five stages: problem identification, problem definition, exploration, applicability, and integration. It is worth noting that a significant part of PBL models more or less corresponds to Dewey’s steps of reflexive action, namely: feeling a difficulty, detecting and defining a difficulty, putting forward a plan to resolve the difficulty, formulating the consequences of the proposed solution, concluding about the correctness or incorrectness of the solution [Dewey, 2021 ]. It is important to note that problem-based (or problem-based) learning was also developed in the Soviet pedagogical tradition. After the Stalinist traditionalization of education, as a result of which promising pedagogical ideas (D. Dewey, B.E. Raikov) were banned, interest in PBL and other innovative forms of education returned to pedagogical theoretical and practical discussions only in the early 1960s. [Klarin, 2016]. But, as in the case of research on the development of thinking, schoolchildren remain the object of application of new pedagogical forms. At the same time, as noted by M.V. Clarin “In general, process-oriented problem-based learning corresponds to the global trend of didactic searches. However, in Soviet/Russian pedagogy there are innovative problem-oriented didactic developments that have no precedents in world practice” [Klarin, 2016, p. 392]. Among them, the author includes organizational-activity pedagogy, training based on the gradual formation of mental actions, developmental training, thought-activity pedagogy, the School of Dialogue of Cultures, TRIZ pedagogy, etc. The potential of the mentioned developments for the formation of critical thinking in adults has yet to be researched and assessed.

In current discussions about organizational forms of learning, three forms of learning are distinguished: formal, informal and non-formal [Johnson, Majewska, 2022]. Formal

education is understood as “an institutionalized, chronologically distributed and hierarchically structured... system extending from primary to higher education” [Coombs, Ahmed, 1974, p. 8]. Informal learning “is not tied to a specific place or institution, nor is it limited by any hierarchy” [Moldovan, Bocoş-Binţinţan, 2015, p. 341]. Informal learning is understood as lying between formal and informal, combining the features of the first and second: “any organized, systematic educational activity carried out outside the formal system for the purpose of providing selected types of learning to specific subgroups of the population” [Coombs & Ahmed, 1974, p. 8]. In this study, we will consider adult learning primarily as informal learning. The terms “adult learning,” “continuing education,” and “lifelong learning” will sometimes be used interchangeably, although some researchers share these concepts [Rubenson, 2010; Korshunov et al., 2019].

Researchers identify three main theories of adult learning: andragogy, self-directed learning, and transformative learning [Merriam, 2018].

Andragogy in the version of M. Knowles aims to determine the features of adult learning that will help make the process, technologies and learning tools suitable for adult learners.

Knowles [Knowles, 1984] formulates the following key principles of andragogy:

1. As a person grows older, the self-concept changes from that of a dependent personality to a self-directed personality.
2. An adult accumulates experience, which is a rich resource for learning.
3. An adult’s readiness to learn is closely related to the tasks of developing his social role.
4. As we grow older, our time perspective changes from future application of knowledge to immediate application. Thus, an adult in learning is more focused on problems (tasks) than on subject knowledge.
5. Adults are primarily driven by intrinsic motivation rather than extrinsic motivators.
6. Adults need to know the reason for learning something (as cited in Merriam, 2018).

These principles are the hallmarks of an adult learner. Focusing on them should make adult learning more effective.

Another influential theory of adult learning is *the theory of self-directed learning*. This theory can be considered a development of Knowles's first principle of andragogy, according to which a person becomes more independent with age. According to Garrison's model [Garrison, 1997], SDL involves three interrelated components: self-management, self-monitoring and motivation. Self-management involves setting learning goals and

managing learning resources and supports. Self-control in this approach is understood as a process in which the student accepts responsibility for achieving educational results. By exercising self-control over the learning process, the student ensures that new knowledge is integrated into existing knowledge and that this integration contributes to a meaningful understanding of the new knowledge [Garrison 1997, p. 24]. Motivation, in turn, is associated with both participation in learning and persistence in completing tasks. SDL assumes that a student can independently choose appropriate learning tools, independently control the achievement of educational results, and independently be responsible for their own motivation. The task of the teacher remains to provide the necessary training materials, facilitate group or individual work, conduct assessments and provide feedback.

*The theory of transformative learning* (TL) is based on the assumption that learning in adulthood is not limited to adding new knowledge to the student's "piggy bank", but is associated with a change in perspective (picture of the world, paradigm). This process begins with a disorienting dilemma—a predicament that cannot be adequately resolved from the learner's existing perspective. This experience leads to the need to critically evaluate one's own knowledge and beliefs, recognize the need to change them, and move on to creating a broader perspective, which, in turn, will help resolve the existing contradiction (Mezirow, 2000).

Of the three listed theories, andragogy is the most suitable for this study. This choice is determined by the pragmatics of the study. Self-directed learning allows for many degrees of freedom for the learner, but the technical and economic limitations of the platform do not allow for a choice of learning tools and methods. At the same time, the student, of course, independently decides to participate in the course (motivation), chooses a convenient pace for studying materials and completing assignments in an online format (self-management), although the sequence and duration of studying the modules are fixed, and also independently controls the achievement of educational results. Therefore, SDL can only be used to a limited extent as a theoretical framework for this study.

The goal of the course being developed is to develop students' critical thinking. If we view critical thinking as the application of scientific rationality to everyday problem solving, transformative learning theory can provide a theoretical framework for this study. But the main result of learning, according to TL, is a change in the student's worldview and perspective. Educational results related to worldview (values, attitudes) are beyond the scope

of this study due to their conceptual uncertainty, complexity of formation and assessment. Therefore, using TL as a theoretical framework does not seem appropriate.

The idea of student independence and the idea of personality transformation are reflected in the principles of andragogy by M. Knowles, which allows it to be used as a theoretical framework for this study.

# Operationalization and Research Methods

The study can be divided into five stages:

1. Analysis of the historical and philosophical prerequisites for the emergence of CM components as an educational result. A review of key primary and secondary sources was conducted to determine the genesis of the components of CT within the Western philosophical tradition and discussions of liberal education in 19th-century German philosophy, and American pragmatism.
2. An analysis of existing research on teaching CT to adults through problem-based learning using online learning tools. A review of current research was conducted to identify the characteristics of the development of CM in adults within the framework of non-formal education, the advantages and disadvantages of using problem-based learning and online learning as a means of developing CM in adults.
3. Development of a course aimed at developing CM in adults. The following were developed: a matrix of educational results, a general structure of the course, an online trainer for self-study, and a system of workshops. The course was designed using the constructive alignment methodology [Biggs, 2014]. This approach involves the coordinated development of educational results, means of assessing the achievement of educational results, as well as educational activities aimed at achieving educational results.
4. Development and validation of an adult CT assessment tool. The following were developed: a theoretical framework of the instrument, two variants of tasks, cognitive laboratories and validation of tasks were conducted.

When forming the theoretical framework, critical thinking was considered as a composite latent construct, which subsequently determined the methodology for creating the evidence-centered design (ECD) tool, a method of evidence-based argumentation.

In order to verify the compliance of the observed behavior with the characteristics included in the conceptual framework of the tool, a qualitative study was conducted - a cognitive laboratory (interview with a representative of the target group to identify problem areas), as well as a pilot study (N = 104 people).



The study sample (version of the test, modified on the basis of cognitive laboratories and testing) consisted of 117 people: 67% women (n = 78) and 33% men (n = 39), aged from 18 to 71 years. The average age of participants was 38 years (SD-12). The sample was collected through Internet mailing using the snowball method. The Alchemer tool was used to compile the survey. Validation considered evidence of the construct, criterion, convergent, and content validity of the instrument.

#### 5. Intervention (course), data collection and analysis.

The study design was based on an intervention model with pretest and posttest without a control group. The intervention took place between the pretest and posttest and took 8 weeks (about 60 instructional hours). The sample consisted of 468 course participants (F = 44%). 184 (39%) of them completed the pretest and posttest. The mean age of participants was 33 years (SD = 6). Participants were trained in cohorts of 20 to 60 participants, recruited once a month for 18 months. Before starting the course, participants were asked to fill out questionnaires with questions about demographic characteristics, work area, and position. Participants' questionnaires, pre-test results (n = 468) and post-test results (n = 184) were used for analysis.

# Results

## Analysis of historical and philosophical prerequisites for the emergence of components of critical thinking as an educational result.

It was shown how the key components of CT arise within the framework of the Western philosophical tradition, discussions about liberal education in German philosophy of the 19th century. and American pragmatism.

*The results of the analysis are presented in the articles:*

- *Girinsky A. A., Lepetyukhina A. O., Pashchenko T. V. Critical thinking: from the Humboldtian model to the Federal State Educational Standard // Educational Policy. 2022. T. 89. No. 1. P. 42–52.*
- *Girinsky A. A., Lepetyukhina A. O., Pashchenko T. V. The concept of critical thinking: the genesis of the concept and current problems of application in education // World of Psychology. 2023.*

The conventional definition of the concept of critical thinking is still a matter of debate: at least 20 different definitions can be found in the literature [Koresnikova et al., 2021; Tarasova, Orel, 2022]. This is largely due to the fact that CM is an interdisciplinary object of study. Philosophers, sociologists, psychologists, and educational researchers write about critical thinking, its theoretical foundations, development practices, and approaches to assessment [Bobrova, 2017]. Despite the fact that discussions about the need for purposeful formation of critical thinking usually date back to the beginning of the 20th century. [Hitchcock, 2021], it can be assumed that individual components of critical thinking acquire their own significance long before the formation of its understanding as a holistic educational result and coincide with the formation of a rational Western European attitude as a whole.

Ennis gives the following definitions of CM as examples:

- “The ability to think critically...involves three things: (1) an attitude of thoughtful consideration of problems and subjects that are within the range of my experience, (2) knowledge of the methods of logical analysis and reasoning, and (3) some ability to apply these methods.”

- “Critical thinking is the intellectually disciplined process of actively and skillfully comprehending, applying, analyzing, synthesizing, and/or evaluating information obtained and produced through observation, experience, reflection, reasoning, or communication as a guide to understanding and action.”
- “Intelligent, reflective thinking focused on deciding what to believe or how to act” [Ennis, 2016: 8].

Analyzing the definitions, Ennis concludes that, on the one hand, they will inevitably be different, since they are given in certain contexts, but, on the other hand, the differences in the definitions are not fundamental.

From the above definitions, the following essential components of CM can be identified:

- discipline and impartiality of thinking;
- skill of working with information and sources;
- the ability to use methods of rational cognition (including reasoning) in solving practical problems.

Techniques of rational (critical) thinking can be found already in antiquity - the time of the birth of Western rationality [Weber, 2013: 7–9]. The most notable element of ancient culture, which modern authors continue to turn to, is the teaching of Socrates. The rationality of Socrates' thinking is revealed in his *method*, which consists of two components: irony and maieutics. “I know that I know nothing” is an expression that expresses Socrates' idea of irony. The philosopher, recognizing his own ignorance, calls on the interlocutor to dialogue, takes upon himself the right to consistently and disciplinedly ask questions, clarifying the interlocutor's beliefs and their conceptual foundations. As a result, the interlocutor begins to doubt the truth of his own judgments, and he himself, led by Socrates, begins to create new knowledge.

The essential characteristics of the Socratic method (posing questions, doubting the truth of one's own judgments and ideas) coincide with individual components of modern scientific and critical thinking. Having undergone a historical and ideological transformation, the Socratic method is still relevant and important for application in the process of education

and cognition (Zare, Mukundan 2015; Boa et al., 2018). Moreover, when studying the history of QM, the Socratic method is traditionally the starting point for the formation of this concept (Hitchcock, 2018).

In modern times, scientific competition for new discoveries gives rise to scientists' distrust of each other and the desire to refute and criticize a scientific opponent, gaining primacy in the discovery of scientific truth [Gaidenko, 2011]. In this phenomenon one can see a kind of reincarnation of the Socratic method, but on new methodological grounds.

Thanks to the works of Descartes, the principle of rational thinking was developed and brought to its logical limit, and in the Age of Enlightenment it received its most detailed definition. The most significant in this regard is the work of Descartes in 1637, "Discourse on Method," in which he describes his own experience of learning and knowledge and comes to the need to reassess these processes. As Descartes becomes educated and immersed in science, he realizes that he is exposed to conflicting opinions and unproven positions that form part of knowledge and science. For this reason, he decides to conduct his own research: "For these reasons, I could not choose anyone whose opinions I should prefer to the opinions of others, and I found myself, as it were, forced to become my own leader" [Descartes 1989: 259].

In Descartes' thoughts it is clearly visible how the principle of rigor and clarity of reasoning is implicitly complemented by the principle of distrust of the past, of information and sources of knowledge that were authoritative in past times. We can say that Descartes offers a kind of revision of the culture that preceded him and thereby builds new value foundations of thinking. He offers new grounds: the place of authority and tradition in the structure of knowledge should be taken by rational thinking, the source of which is the thinking subject himself. This principle will later find development in the main directions of Western philosophy (Kant's critical philosophy, German idealism, etc.).

At the end of the 18th century, discussions about rationality cease to be exclusively scientific and methodological and become a significant part of discussions about the "mission of the university." The result of the discussion between F. Schelling, I. G. Fichte, F. Schleiermacher, and W. Humboldt was the liberal model of education [Kurennaya, 2020]. In this discussion, one can also discover the components of critical thinking used today at different levels of education - in real practice in schools and universities. These are the skills of disciplined thinking, analyzing information and selecting authoritative sources, making

independent judgment and reasoning. It is within the framework of the liberal model of education that the concept appears that the main task is not to impart to the student a certain set of knowledge, but to teach him the basic methods and tools of self-development and self-education, with the help of which he can independently improve throughout the rest of his life. Philosophers focus special attention on the need for critical thinking for subsequent rational decision-making, on the importance of using certain mechanisms of scientific thinking to solve everyday life problems.

Teaching thinking, according to the liberal philosophy of education, is an independent value. The task of education is not the creation of a specialist, but the formation of a person with developed abilities for humanitarian, primarily, thinking, since it is this that allows a person to navigate the complex world of modernity with its constantly changing and conflicting social, political and cultural trends. The responsible and independent thinker is the ideal of a liberal education, and critical thinking is one of the fundamental elements of this concept.

Fichte in his “Deduced Plan” points to the special role of the teacher. It should consist of accompanying the student on the path of his learning, asking him questions and encouraging him to independently search for answers to these questions, while guiding him on the right path if he makes a mistake and selecting material for classes in such a way that it corresponds to student's capabilities [Fichte, 1817, p. 13]. Fichte calls for a return to the Socratic form of dialogue between student and teacher: it is this that seems to him most suitable for teaching independent thinking.

In this discussion, the purpose of education is no longer seen to be to convey ready-made and indisputable knowledge, but to apply it to an issue of interest, to teach one to think and know independently. This idea clearly correlates with the characteristic of critical thinking, according to which critical thinking does not consist in knowledge of some facts or provisions, but in the ability to work with information and come to independent conclusions [Facione, 1990].

The ideas voiced in the German philosophy of liberal education formed the basis of the discussion about the goals and mission of education in the 19th and 20th centuries. For example, John Stuart Mill in his work “On Liberty” (1859) and in “Autobiography” (1873) repeatedly points out the importance of the ideas of German thinkers, especially W. von Humboldt.

The ideas of liberal education are the conceptual basis for the formation of the concept of critical thinking in pedagogical discourse. An important link here is the reception of the ideas of free education, carried out by the liberal theorist J. S. Mill. He explicitly shows the connection of his reasoning with the theories of Humboldt. One of the founders of modern pedagogy, J. Dewey, in turn, was familiar with Mill's works. This contextual connection allows us to explain how critical thinking becomes an important component of modern pedagogy through reception from the "German philosophy of the university." In his "Speech on University Education, delivered at St. Andrew's University," Mill will call the university "the place of free thinking" [Mill, 2010, p. 59–60], and its main task is to teach the search for truth instead of the authoritative transmission of knowledge [ibid.]. These ideas resonate with Humboldt's ideas about the tasks of the university. The same work will introduce new ideas that relate positively to Mill's theory of utilitarianism, namely the idea that education should also serve the purpose of "making each of us practically useful to other people" [Mill, 2010, p. 55].

Mill's ideas about society and education would influence Dewey's pedagogy: he makes numerous references to Mill, including in *How We Think* [Dewey, 2021]. In turn, "How We Think" is considered the first pedagogical work that points out the need to develop critical thinking in all students. Thus, it is possible to trace the continuity of ideas about the components of CT as educational results from German thinkers to Mill, and then to Dewey's pedagogy.

An important stage in the development of CM components in educational discussions is American pragmatism. It was the ideas of pragmatism that had a decisive influence on the formation of Dewey's pedagogical ideas, focusing on the applied nature of thinking skills [Mironova, 2011]. Explaining his idea of the principles of the work of thinking in the article "How to Make Our Ideas Clear," one of the central thinkers of American pragmatism, Charles Pierce, states that, according to pragmatism, "thinking consists in a living, inferential transformation of symbols, the meaning of which lies in making conditioned general decisions to act" (Pearce 2000: 281). Thus, on the one hand, the significance of logic as a theory of reasoning ("the transformation of symbols based on inference") is affirmed, on the other hand, the applied nature of thinking. This practicality, the connection of thinking to solving problems, to action can be considered one of the postulates of pragmatism as a philosophical, rational, and subsequently pedagogical tradition.

Dewey coins the term “critical thinking” as “the active, persistent, and careful consideration of any belief or putative form of knowledge in the light of the reasons that support it and the further conclusions to which it tends” [Hitchcock, 2018: 6]. In the light of the ideas of pragmatism, as well as the examples that Dewey considers further, it becomes clear that the “further conclusions” to which thinking strives are of a purely practical nature. This is confirmed by the quote from J. St. Mill, to which Dewey refers. “Drawing conclusions has been called the greatest work of life. Every day, every hour, every minute, each of us is presented with the need to be confident in facts which he has not directly observed, and this need arises not from a general desire to increase the mass of our information, but from the significance of these facts for our interests and occupations” [Dewey 2021: 22] . In this quote we again encounter the opposition between the speculative and the practical, which is given greater significance. Summarizing Dewey's approach, we can conclude that critical thinking is the application of the scientific (rational) method to solving real (professional or everyday) problems. Education should be aimed at developing skills in using this method.

After Dewey, discussions of critical thinking move into the realm of educational policy. The authors of a significant part of the works of the second half of the 20th - beginning of the 21st centuries. [Ennis, 2018] focus not so much on the philosophical foundations of critical thinking, but on the reforms of school and higher education necessary to develop students' critical thinking. A separate branch of research concerns the assessment of the level of critical thinking, including the validation of assessment tools and effective practices that can be identified using quantitative methods [Liu et al., 2014]. Moreover, these discussions are actually free from explicit philosophical reflection: their authors solve (quite successfully) specific pedagogical problems without expending intellectual effort on studying the fundamental aspects of such developments.

Thus, it was possible to establish that the components of CT as a competence are not an original invention of theorists and practitioners of education in the 20th century. Indeed, one can trace the emergence of discussions about the importance of CT skills and dispositions in the history of thought since classical antiquity. A distinctive feature of discussions about CM already in the twentieth century. One can consider the idea of the need to develop CM skills and attitudes for every educated person, and not just for representatives of the intellectual elite (philosophers, scientists, enlightened “administrators”). As a result, CT components

become a familiar part of national educational standards in the status of meta-subject or universal results.



## Features of using problem-based learning in an online environment to develop critical thinking in adults

*The results of the analysis are presented in the article Santos Meneses LF, Pashchenko T., Mikhailova A., Critical thinking in the context of adult learning through PBL and e-learning: A course framework // Thinking Skills and Creativity. 2023*

There is a significant number of studies on the development of critical thinking in formal education (including several meta-analyses, for example [Abrami et al., 2008, 2015]). The results of these studies allow us to judge the effectiveness of individual strategies and pedagogical tools aimed at developing CT in basic or higher education. One of the most studied approaches that has proven its effectiveness in formal education is problem-based learning (PBL) [Abrami et al., 2015; Bezanilla et al. , 2019; Lorencova et al., 2019; Payan-Carreira et al., 2019; Theall, 2003]. At the same time, an increasing number of educational products are sold using online formats [Bowen, 2015]. Modern theories of adult learning agree that adult learners have a number of characteristics that must be taken into account when developing and implementing educational products [Knowles, 1984; Garrison, 1997; Mezirow, 2000].

Thus, the question arises about the features of using problem-based learning in an online environment for the formation of CM in adults. Will strategies that are effective in formal education lead to the development of adult CT in non-formal education?

Research shows that adults tend to be more motivated to learn than older students (e.g., Dwyer & Walsh, 2020; Illeris, 2010; Kuhn, 2008, pp. 28–29). However, adult motivation may be more extrinsic than intrinsic (e.g., Diep et al., 2016, p. 6; Illeris, 2010, p. 39; Merriam, 2010, p. 13). Green (2015) argues that the CT curriculum in the context of non-formal adult education should help to maintain students' intrinsic motivation. Intrinsic adult motivation can be stimulated by emphasizing the importance of CT for an adult meaningful life—a life that goes beyond financial or utilitarian goals—and by discouraging extrinsic rewards such as grades. Green argues that this, in turn, can inspire students to continue to develop independent CT throughout their lives, which is in fact required for full CT development [Green, 2015]. Using problems or cases relevant to the lives or work of adults in PBL can make the process more meaningful and engaging.

Review has shown that the use of semi-structured tasks from real-world contexts is particularly important for the development of adult CT using PBL (Garrison, 1991; Kallio, 2020; King & Kitchener, 1994, 2004; K. Ku et al., 2014a; Kuhn, 1991). Since the main characteristic of semi-structured problems is the variety of possible answers, this helps the development of multiperspective thinking, stimulating openness, skepticism, non-absolutist thinking, the desire to seek truth, as well as other thinking skills and dispositions in students [Kallio, 2020].

Among the success factors for using PBL, previous studies mainly point to dynamic and formative facilitation by the teacher, as well as well-structured organization of small group work (Kong et al., 2014; Seibert, 2021; Şendağ & Odabaşı, 2009; Trullàs et al., 2022; Yuan et al., 2008). Table 1 provides an expanded list of factors.

*Table 1. Features of problem-based learning that contributed to the development of students' CT*

Yuan et al. (2008)	Şendağ & Odabaşı (2009)	*Kong et al.'s (2014)	Seibert (2021)	*Trullàs et al. (2022)
<ul style="list-style-type: none"> <li>— Questions to clarify the problem;</li> <li>- brainstorm;</li> <li>— students allocate their time themselves and can further reflect on the solution;</li> <li>— group discussion;</li> <li>— careful planning;</li> <li>— assessment and reflection;</li> <li>— work in small groups;</li> <li>— teacher facilitation;</li> <li>– limited amount of lecture training</li> </ul>	<ul style="list-style-type: none"> <li>— Facilitation by the teacher;</li> <li>— the teacher encourages students to think more deeply by asking leading questions and not giving ready-made answers/solutions;</li> <li>— the teacher encourages students to independently search for information;</li> <li>— use of semi-structured tasks</li> </ul>	<ul style="list-style-type: none"> <li>— Work in small groups;</li> <li>— providing and receiving mutual feedback;</li> <li>— teacher facilitation</li> </ul>	<ul style="list-style-type: none"> <li>— The teacher provides feedback;</li> <li>— the teacher supports group communication, group dynamics, search and collection of information, data analysis, use of acceptable sources</li> </ul>	<ul style="list-style-type: none"> <li>— Work in small groups;</li> <li>— use of realistic cases and scenarios;</li> <li>— professional management of group dynamics;</li> <li>— institutional support for teacher/tutor training</li> </ul>

Although a recent report has shown that lecture-based learning can support the development of CT among university students [OECD, 2022], a significant number of studies demonstrate that active learning promotes CT development to a greater extent than passive learning (e.g. [Abrami et al., 2015] ). At the same time, using a set of active learning strategies within one CT course seems to be more effective than using any one approach [Ennis, 2016]. PBL can include various practices [Rossi et al., 2021; Şendağ & Odabaşı, 2009; Yuan et al., 2008]. For example, discussion, research, self-study [Yuan et al., 2008],

etc. Thus, PBL provides ample opportunities for active learning, contributing to the development of CT.

However, the use of VET is associated with certain difficulties and may be less effective due to a number of factors. A summary of these factors is presented in Table 2.

*Table 2. Features of problem-based learning that made it difficult for students to develop CT*

Azer (2001)	Hung (2006) and Kek & Huijsers (2011)	Caplow et al. (1997); Klunklin et al. (2011)	Yuan et al. (2008)	*Kong et al.'s (2014)	Styawan & Arty (2021)	* Trullàs et al. (2022)
Poor communication skills of group work participants, lack of mutual support, distractions during group work, stress, late completion of tasks	Lack of systematicity in developing learning problems/cases and applying the PBL model	Students perceive the PBL model as stressful, time-consuming and overwhelming	— Poorly developed dispositions for students' independent work; — students perceive the PBL model as stressful, time-consuming and overloading; — insufficient support from the teacher when working with information	Brief interventions using PBL	— Lack of scientific literacy among students; — lack of subject knowledge; — weak independent learning habits; - lack of teacher support	3 Methodological complexity of PBL; — insufficiently clear communication of methodology, learning objectives, approaches to assessment; — poor organization of PBL classes; — lack of methodological experience of tutors; — poor standardization of the application of the methodology by tutors; — negative perception of the methodology by tutors; — lack of administrative support; — overload of tutors; — lack of material resources for conducting classes; — insufficient training of tutors in guided self-learning

Thus, despite the demonstrated advantages of using PBL for the development of CM in adults, this approach is difficult to use and requires compliance with a number of requirements for course design, forms of work, and teacher qualifications (a full list of requirements is formulated in the next section).

In addition to intrinsic motivation, an important feature of adult learning is the need for flexibility in the learning process. Flexibility suggests that adult learning is best delivered without restrictions of time and place, using a variety of formats to better suit individual learning styles and allow learning to fit into work and home circumstances and provide

different types of stimuli [e.g., Dwyer & Walsh, 2020] . Research shows [e.g., Chou et al., 2019; Rossi et al., 2021] that the use of online learning formats can provide such opportunities.

An important advantage of using online formats for teaching CT is that modern digital technologies allow you to participate in the learning process at any time from anywhere. This implies the possibility of conducting remote classes in real time, which allows the use of synchronous learning formats along with asynchronous ones, active and passive learning, independent learning and group work [Brookfield, 2020; Dwyer & Walsh, 2020; Şendağ & Odabaşı, 2009; Todd et al., 2019]. In addition, multimedia and other digital tools can enhance user/learner motivation by presenting content in forms other than traditional lectures or reading physical sources. This is due to the ability to present digital content in the form of audio, video and/or interactive text and images, which can be particularly important for adult self-learning.

As noted earlier, an important condition for the development of CT is the use of active learning formats. Online learning is well suited for this purpose as online learning practices are often based on constructivist (Şendağ & Odabaşı, 2009) and active learning approaches (Clark, 2005; Dwyer & Walsh, 2020; Rossi et al., 2021). For example, through the use of PBL (McLinden et al., 2006; Şendağ & Odabaşı, 2009), multimedia exercises (Clark, 2005) or collaborative/group work, case studies, learning through inquiry (Rossi et al., 2021).

The use of online tools greatly facilitates the search and study of sources, which is especially relevant in the context of the development of CT, since information analysis skills are one of the key components of CT [Ennis, 2016]. Currently, access to sources is almost instantaneous, as opposed to obtaining physical books or other materials, making CT learning in online formats potentially more productive [Author, 2021]. At the same time, the issue of assessing information remains critically important, since information found on the Internet is usually unreliable [Santos, 2021]. Evaluating information and data involves the process of searching and selecting multiple sources of information and assessing their relevance, completeness and usefulness. Successful assessment of information requires the use of critical thinking and may include the ability to check the credibility of news sources, the ability to comprehend and identify the necessary data to solve a specific problem [OECD, 2018]. Therefore, searching for information on the Internet for educational purposes should be done with caution and with the help of a CT teacher. Thus, the Internet as a learning tool

represents both a challenge and an opportunity because, although risky, it is a stimulus for the development of students' CT skills and dispositions.

The benefits of online learning for developing adult CM are presented in Table 3.

*Table 3. Benefits of online learning on adult CT development and individual effects*

Study	Brookfield (2020); Chou et al. (2019); Tan (2017); Todd et al. (2019); Kuhn (2018)	McGrew et al. (2019); Rossi et al., (2021)	Meirbekov et al. (2022)	Brookfield (2020); Chou et al. (2019); Meirbekov et al. (2022); McLinden et al. (2006); OECD (2021); Rossi et al., (2021); Saade et al. (2012); Todd et al. (2019)	McLinden et al. (2006); Rossi et al. (2021)
<b>Advantage</b>	— Synchronous and asynchronous online discussions;  - freely pose complex questions and discuss different points of view (Brookfield, 2020), especially in asynchronous (Todd et al., 2019) and anonymous discussion formats (Brookfield, 2020; Todd et al., 2019)	— Easy-to-use tools and applications;  - real/authentic materials for analysis (McGrew et al., 2019)	Easy-to-use tools and apps	Various forms of web interactivity (for example, chat, forum, electronic file exchange, audio/video forms, etc.)	Synchronous and asynchronous group work
<b>Effect</b>	— Reflection skills have developed more strongly than when using personal dialogue (Kuhn, 2018);  — the breadth and depth of students' thinking has increased (Todd et al., 2019);  — increasing the inclusion of introverted students (Tan, 2017)	— Increasing student engagement;  — increasing student motivation	Discussions and group work are facilitated by visualizing information, comments and ideas in graphical applications or mind maps	Engagement (Saadé et al., 2012)	Engagement and motivation

Along with evidence of the positive impact of online formats for teaching CT, it is necessary to note the limitations of using these tools for educational purposes. Among the “contraindications” of using online learning for developing CM in adults are:

- Potential social isolation and health problems (e.g., depression, fatigue, sedentary lifestyle) with excessive or inappropriate Internet use [Heller, 2022, pp. 53-54].
- Limitation of practical (face-to-face) learning activities and the relationship between theory and practice [Cortázar et al., 2021].
- Limited competence of teachers in effectively working with new technologies (digital tools, media, etc.) - insufficient training [Lorencová et al., 2019; Saadé et al., 2012; Şendağ & Odabaşı, 2009; Viberg et al., 2020].
- Limited readiness of teachers and students to work with new technologies (digital tools, media, etc.) [Lorencová et al., 2019].
- Complexity. Independent workload for students and difficulty for teachers with adapting/adding new materials/tools and planning lessons [Rossi et al., 2021].
- The inability of students to analyze or summarize a large amount of information on the Internet [Jou et al., 2016].
- Students’ difficulties in assessing the reliability of information on the Internet [Molerov et al., 2020; Author, 2021].
- Insufficient time to conduct an online intervention [Chou et al., 2019; Rossi et al., 2021].

Despite its limitations and possible contraindications, online learning can be very effective in developing students' CT. Especially if barriers are addressed, as previous studies have shown [e.g., Chou et al., 2019]. This requires teacher training [Şendağ & Odabaşı, 2009; Viberg et al., 2020], careful course design [Saadé et al., 2012], well-planned teaching [Chou et al., 2019; Todd et al., 2019], tutor support [Chou et al., 2019], detailed and regular feedback [Cortázar et al., 2021].

Analysis of studies on the use of PBL and online learning made it possible to identify the advantages and disadvantages of using these approaches to develop the CM of adults. Based on the results of the analysis, a list of requirements for the course aimed at developing CM in adults was developed.

## Course requirements for the development of critical thinking in adults based on problem-based learning, implemented in an online format

*The list of course requirements is presented in the articles:*

*Santos Meneses L.F., Pashchenko T., Mikhailova A., Critical thinking in the context of adult learning through PBL and e-learning: A course framework // Thinking Skills and Creativity. 2023.*

*Pashchenko T. Formation of critical thinking in adults using problem-based learning in an online environment // Educational Issues, 2024 (in press).*

The analysis of existing research carried out at the previous stage to determine the features of the use of problem-based learning in the online environment and the formation of critical thinking in adults allowed us to identify a number of requirements, following which helps to increase the effectiveness of the use of problem-based learning using online tools for the development of CM in adults. We classified the requirements into four categories: *requirements for course design, requirements for teaching and interaction with students, requirements for teacher qualifications, requirements for a digital platform.* Within each category, we have identified *general requirements* that can be applied to courses on the formation of universal competencies as comprehensive educational results and *specific requirements* for CT. The list of requirements is presented in Table 4.

*Table 4. Course requirements for the development of critical thinking in adults based on problem-based learning, implemented in an online format*

Category	Are common	Specific
<b>1. Course design requirements</b>	1.1 The course must be long enough (at least 8 weeks, 6 hours of group work weekly);	1.7 Activities related to problem-based learning should be central to the course;
	1.2 The course must allow synchronous interaction between students and the teacher, including individual communication if necessary;	1.8 Course assignments should be constructed using semi-structured problems related to students' real-life experience or context known to them;
	1.3 Lecture formats should be used as little as possible;	
	1.4 Course assignments should encourage both independent work of students and work in mini-groups, group discussions, brainstorming;	
	1.5 Intrinsic motivation of students must be supported, including by demonstrating the significance of educational results;	

	1.6 For assessment, you need to use both learning analytics and performance-based tasks.	
<b>2. Requirements for teaching and interaction with students</b>	2.1 Educational results, conditions for taking the course, rules of interaction, assessment, deadlines for completing assignments must be known to students;	2.5 The teacher should pose open questions, not give ready-made solutions, encourage the search for information, research, stimulating independent thinking of students;
	2.2 The size of mini-groups and formats of group work should provide the opportunity to provide personal feedback;	2.6 Student responses and comments based on evidence and argument should be encouraged;
	2.3 Group sessions should be well organized and effectively managed by the teacher;	
	2.4 Predominantly formative tools should be used to provide feedback.	
<b>3. Requirements for teacher qualifications</b>	3.1 The teacher must be able to manage group dynamics, facilitate various forms of group work;	3.3 The teacher must have a sufficiently high level of development of critical thinking skills and dispositions;
	3.2 The teacher must be able to give and receive feedback and encourage students to provide mutual feedback.	3.4 The teacher should be intimately familiar with problem-based learning as an approach;
<b>4. Requirements for the digital platform</b>	4.1 Digital tools should be accessible for quick learning by listeners without special technical skills;	4.5 The platform must allow the possibility of individual and group, synchronous and asynchronous communication (including anonymous);
	4.2 The platform must support information visualization tools, including the creation of mental maps;	4.6 Students must have access to authentic data and sources of information;
	4.3 The platform must record and provide information on the progress of students in achieving educational results;	
	4.4 The platform should record the educational behavior of students and perform educational analytics.	

This list of requirements is likely not a minimum: many of the requirements included may not only relate to courses aimed at developing adult CT using PBL in online formats, but also, to an even greater extent, reflect the features of active learning as an approach [ Bonwell, Eison, 1991]. At the same time, this list reflects the orientation of the course to support intrinsic motivation and ensure flexibility in learning, which are features of adult learning, according to preliminary research.

The development and implementation of a course for the development of CM allowed us to empirically confirm the applicability and effectiveness of the identified requirements. Moreover, the positive dynamics of the knowledge and skills of course students (see Result 5)



allow us to evaluate this list of requirements as *sufficient* to achieve the planned educational results (knowledge and skills related to CM). However, the available data does not allow us to assess which of the requirements are *necessary*. More research using experimental designs is needed to identify a minimum set of requirements.

Thus, the analysis and data obtained allow us to conclude that the proposed requirements are sufficient for a course aimed at developing CM in adults, although they may not be necessary.

Based on the above list of requirements, the “Critical Thinking” course was developed, implemented on the Yandex Workshop platform <sup>1</sup>.

The design of the course was preceded by the development of a system of educational results in the form of a competency matrix built on the basis of the “Universal Competencies and New Literacy” framework [Dobryakova et al. 2020]. This framework assumes three groups of universal competencies: “thinking”, “interacting with others” and “interacting with oneself”. Competence is considered as “an integrated set of knowledge, skills and activity attitudes that are mobilized in a certain context to solve a specific problem” [ibid., p. 38]. Thus, critical thinking as a universal competence can be represented in the form of finite lists of knowledge, skills and attitudes. Analysis of the literature made it possible to generate such lists and compare behavioral indicators relevant to the target audience of the course to each component. Next, from these lists, we selected those components that, according to the developers’ hypothesis, could be developed and assessed based on the results of the course. At the same time, attitudes and dispositions of critical thinking were deliberately excluded from the list of planned educational outcomes, since the developers did not have access to a tool for their assessment, and the project did not involve the original development of such a tool. At the same time, a number of studies show a positive relationship between the levels of development of critical thinking skills and attitudes [Facione et al, 1994; Yang et al, 2008], and a careful assumption can be made that the development of skills and attitudes occurs together.

The educational results of the course were *knowledge* :

- criteria for the reliability of sources,
- types of cognitive distortions,

---

<sup>1</sup> Навыки критического мышления для менеджеров. URL: <https://practicum.yandex.ru/thinking/>  
Дата обращения 17.11.2023

- basic methods of correct reasoning,
- types of logical errors,
- criteria for convincing arguments,
- types of argumentative tricks.

And *skills* :

- distinguish between fact and opinion,
- evaluate the reliability of the information source,
- reason deductively and inductively,
- think hypothetically
- evaluate reasoning
- create arguments
- analyze arguments
- recognize tricks in arguments,
- choose the most appropriate solution option, taking into account conditions and resources,
- evaluate the applicability of a solution in different contexts.

The course consists of four modules, each of which focuses on thinking tools used at specific stages of the problem-solving process:

- analysis of the context to clarify the problem (7 lessons, 5 workshops);
- generating multiple solutions (4 lessons, 5 workshops);
- choosing the best solution (8 lessons, 5 workshops);
- convincing stakeholders of the optimality of the selected solution (6 lessons, 5 workshops).

This design allows students to get acquainted with the basic tools of critical (and, partly, creative) thinking: tools for analyzing information and clarifying the problem (48 critical questions 5W + H, cognitive distortions, the basics of fact-checking, etc.), tools for generating solutions (for example, method 6 lateral thinking hats De Bono, SCAMPER, etc.), formal logic (for example, SMART hypotheses, hypothetico-deductive method, probabilistic reasoning) and argumentation (for example, Argumentation RAS + SExI, argumentative tricks, etc.).

Each module is designed for two weeks of training and includes two forms of work:

1. An online simulator containing theoretical material and practical tasks for independent completion, divided into lessons. Studying one lesson is designed for 60–120 minutes.

To ensure the internal coherence of the course and support student motivation, the theory and assignments in the online textbook are connected by a common story. In it, the participant is assigned the role of a member of a team developing an environmental startup. This story does not affect the theoretical foundations of the course, but helps participants keep their attention on the material, and also immerses them in the context of solving semi-structured problems.

2. Workshops are interactive group classes with a teacher, carried out synchronously via video communication using interactive whiteboards. One workshop lasts approximately 90 minutes and includes individual and group assignments aimed at achieving a deeper understanding of the material and developing skills in using the tools presented in the simulator. The general scenario of workshops consists of referring to previously studied material, solving problems (individually and in mini-groups), and reflection.

Before each workshop, participants take a short survey to test and update the theoretical and practical knowledge acquired in previous simulator lessons.

During the final workshop of each module and the final workshop of the course, participants in groups solve a case in the form of a semi-structured problem from a general professional context, demonstrating skills in using the tools they have learned. In this way, workshops help participants immerse themselves in the process of group problem solving using the thinking tools they have learned.

Throughout the entire training, a team works with students to support the students' educational activities. Each cohort of participants is assigned a curator whose tasks include helping with organizing the learning process (reminders about assignment deadlines, assistance with technical problems at workshops, informing about news, sending out tasks for independent work before workshops, answering students' organizational questions, collecting feedback communications after workshops, upon completion of modules and upon completion of the entire course). Interaction with the curator is aimed at creating a sense of continuity in the learning process and supporting the internal motivation of participants.

In total, the course takes approximately 60 hours of high-involvement independent and group work over eight weeks.

Immediately before the start of training and after completion of the course, participants are tested (using a developed tool) to determine the level of formation of CM components.

## Assessing educational outcomes related to adult critical thinking in an online format

*The results of the development and validation of an instrument for assessing CM in adults are presented in the article by Sadova A. R., Khil Yu. S., Pashchenko T. V., Tarasova K. V. Measuring critical thinking in adults: methodology and development experience // Modern foreign psychology. 2022. T. 11. No. 4. pp. 105–116.*

To evaluate course outcomes, a measurement tool was developed based on evidence-centered design. This approach allows us to consider test results as manifestations of the expression of certain personality characteristics and makes it possible to measure complex constructs, which include critical thinking [Uglanova, Brun, Vasin, 2018].

The theoretical framework of the test includes two types of indicators - knowledge and skills, distributed into three groups:

- work with information (it includes such indicators as “Names the criteria for the reliability of sources”, “Evaluates the degree of reliability of information sources”, “Determines the insufficiency of information for a conclusion”, etc.);
- logical reasoning (“Describes the types of logical errors in deductive, inductive and probabilistic reasoning”, “Demonstrates signs of correct and convincing reasoning”, “Correctly uses deductive, plausible, probabilistic reasoning”, etc.);
- argumentation (“Names the criteria for convincing arguments”, “Finds convincing arguments to support a position”, “Finds counterarguments to refute a position”, “Finds a thesis, arguments, illustrations in the text”, etc.) [Sadova et al., 2022].

The test was developed in two versions for use before starting and after completing the course and contains tasks to assess knowledge and skills that are the educational outcomes of the course. Each version of the test consists of three blocks of tasks, two of which are performance-based assessment type tasks, and the third is classic tasks with a choice of one

or more answer options. The tasks of the first and second blocks are organized around stimulating texts on general professional topics with questions for their analysis.

Each version of the test consists of three blocks of tasks, two of which are performance-based assessment type tasks, and the third is classic tasks with a choice of one or more answer options. The tasks of the first and second blocks are organized around stimulating texts on general professional topics with questions for their analysis. For example, in the first block (6 questions) to one of the stimulus texts, consisting of 12 statements on the topic “Women Leaders,” the following task was asked: “Find statements that support the position that women demonstrate better results in leadership positions, than men. Indicate the numbers of suitable statements” (indicator: “Finds convincing arguments to support a position”). The second block (8 questions) is built around the stimulus text “Four-day working week” (15 statements). For example, “Find a statement that justifies the thesis by citing the fact that the majority holds the view presented. Indicate the number of the appropriate statement” (indicator: “Recognizes psychological and logical tricks”). The third block consists of five classic format tasks with a choice of one or more answer options, as well as one matching task.

The test is presented in computer form and consists of tasks aimed at identifying the observed behavior of the subject that is relevant to the CM components. The validity of the developed instrument, including its compliance with theoretical expectations of factor structure, was supported by evidence of construct, criterion, convergent, and content validity.

## Assessment of the results of the course for Critical Thinking development

*The results of course development and assessment of learning outcomes are presented in the article Pashchenko T. Formation of critical thinking in adults using problem-based learning in an online environment // Educational Issues, 2024 (in press).*

Analysis of the pre-test and post-test results was carried out using the Wilcoxon T-test. The average results for three components of the test: working with information, logic and argumentation for respondents who passed both tests are presented in Table 5.

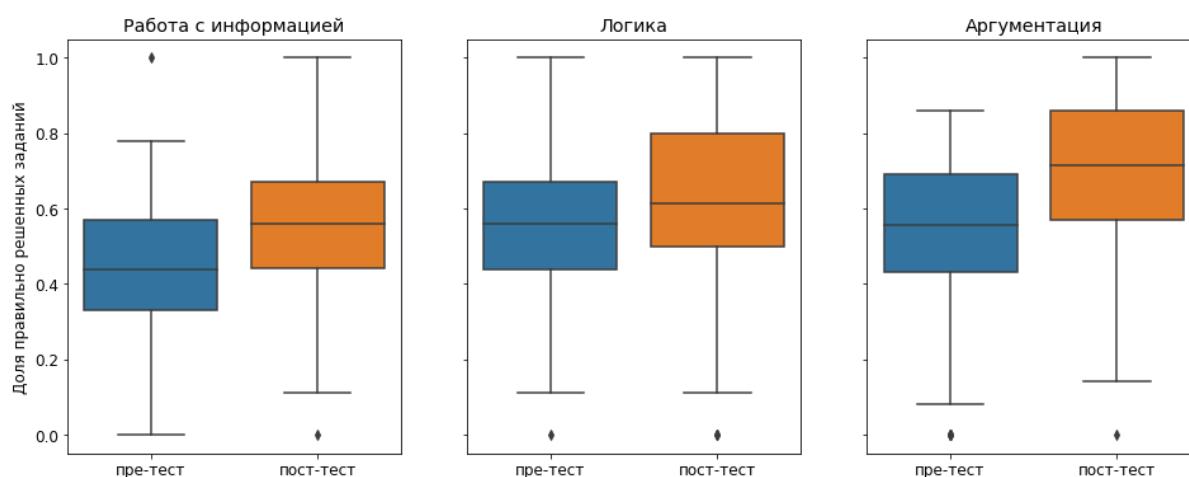
*Table 5. Mean pretest and posttest scores by component (n = 184)*

	t1	t1_STD	t2	t2_STD	$\Delta$
Working with information	0.47	0.19	0.59	0.20	0.12*
Logics	0.54	0.18	0.64	0.23	0.1*
Argumentation	0.52	0.20	0.69	0.23	0.17*

\*p < 0.01

The average percentage of correctly completed pretest tasks for all respondents was 0.47 (working with information), 0.55 (logic) and 0.52 (argumentation). The average percentage of correctly completed post-test items for all respondents was 0.59 (working with information), 0.64 (logic) and 0.69 (argumentation). Thus, it is possible to record an improvement in the average results for all components by 0.12, 0.09 and 0.17, respectively. These differences are statistically significant at the  $p < 0.01$  level. The distribution of results is presented in Figure 1.

Figure 1. Distribution of pretest and posttest scores ( $n = 184$ )



Additional analyzes were conducted to assess possible bias in the results by gender and age. Analysis using the Mann-Whitney test did not reveal significant differences between men and women in changes in test scores after completing the course (Table 6).

Table 6. Difference between pretest and posttest scores by gender.

	Men	Women	P-value
Working with information	0.12	0.14	0.57
Logic	0.10	0.10	0.95
Argumentation	0.19	0.16	0.82

At the same time, correlation analysis (Spearman's correlation coefficient) did not reveal a significant relationship between age and changes in test results. The correlation coefficients between age and the increase in correctly solved tasks were  $-0.005$  (working with information),  $0.035$  (logic),  $0.103$  (argumentation). Thus, we can conclude that the difference in the results of the pretest and posttest is not associated with gender and age differences of respondents.

Analysis of test results showed that respondents, on average, demonstrated higher test results after completing the course. This may indicate that learning in the course is related to the development of their knowledge and critical thinking skills. At the same time, the results of the three components of critical thinking embedded in the theoretical framework of the study - working with information, logic and argumentation - change unevenly. Performance on argumentation tasks improves the most, while logic tasks show the least progress. At the same time, the difference between logic and argumentation in the pretest is insignificant. This may indicate that the concept and design of the course, work formats and duration of the modules contribute to varying degrees to the formation of knowledge and the development of skills in information analysis, logic and argumentation. Testing this hypothesis requires additional research.

# Conclusions

Key scientific findings and conclusions submitted for defense

1. Despite the emergence of CM as a subject of pedagogical discussions in the first half of the 20th century, ideas about the key components of CM as educational results (discipline and impartiality of thinking, skills in working with information and sources, the use of methods of rational cognition in solving problems) arise and develop within the framework of tradition Western rationality, discussions about liberal education in German philosophy of the 19th century. and American pragmatism.
2. Important features of the development of critical thinking in adults are the importance of internal motivation and the flexibility of the learning process. To maintain motivation, PBL can be used based on contexts relevant to the student's experience, and online formats can be used to ensure flexibility. The use of these approaches has a number of features that affect the achievement of planned educational results.
3. An analysis of the features of the development of CM in adults, the use of PBL, and the use of online learning formats made it possible to identify a list of requirements for a course aimed at developing CM in adults based on PBL using online formats. This list includes requirements for course design, requirements for interaction with students, requirements for teacher qualifications, requirements for technical features of the platform, among which we can highlight both general ones for the development of universal competencies and those specific to CM.
4. Developed based on the evidence-centered design methodology, the adult CT assessment tool demonstrated acceptable psychometric properties. It can be used to assess knowledge and skills related to CM for research and applied purposes.
5. A course aimed at developing CM in adults, built on the basis of PBL using online formats, contributes to the achievement of planned educational results.

Taking into account the provisions submitted for defense and the results obtained, the research hypothesis can be considered confirmed.

Theoretical significance and scientific novelty of the study

In this study:



1. An interpretation of the genesis of the components of critical thinking within the framework of new European rationality, the philosophy of liberal education, and American pragmatism is proposed. It is shown how the skills and attitudes associated with CT arise within the framework of ancient philosophy, are formed within the framework of modern philosophy, penetrate into discussions about the mission of the university in German philosophy of the 19th century, and gain relevance in connection with ideas about the practical application of thinking in American philosophy and pedagogy at the turn of the 19th–20th centuries.
2. Features of the formation of adult CT within the framework of informal learning using problem-based learning using online formats have been identified: support for internal motivation and flexibility of learning. Intrinsic motivation of adults can be supported if, throughout the course, attention is focused on the learning goals and their benefits for the student (for example, the contribution of CT to improving life, increasing resilience, the quality of decisions made, etc.), using task contexts that are relevant to professional and everyday tasks (for example, semi-structured tasks from a general professional context). Flexibility of learning suggests that adult CT learning in the context of non-formal education is best done without strict time and space restrictions and using a variety of learning modalities to better suit adults' learning styles and lives, as well as to provide different types of stimuli.
3. Based on a synthesis of approaches to adult learning, the development of critical thinking, the use of problem-based learning and the use of online formats, course requirements for the development of CM in adults were determined. The list of requirements includes requirements for course design (for example, the structure of modules, minimum duration, content features, formats of group and independent work, etc.), requirements for interaction with students (role of the teacher, communication of educational results, formative assessment, etc.), requirements to the qualifications of the teacher (level of computer science, proficiency in PBL, facilitation skills, etc.), requirements for the technical features of the platform (for example, the possibility of synchronous and asynchronous communication). Both general requirements for universal competencies and specific requirements for CM are identified.

The practical significance of the studyA

1. A tool for measuring critical thinking in adults has been developed and validated based on evidence-centered design methodology;
2. A course on the development of cognitive skills in adults based on problem-based learning using online formats has been developed and tested.
3. The resulting list of course requirements can be used to design courses for other complex educational outcomes.

## References

1. Ado, P. What is ancient philosophy / P. Ado. - Moscow: Publishing House of Humanitarian Literature, 1999. - 320 p.
2. Akimova, T. A. The essence of critical thinking: from Socrates to our time / T. A. Akimova // Kazakhstan Science Journal. - 2019. - T. 2, No. 5 (6). — P. 31 – 45.
3. Arnautova, Yu. G. “Historicism”, “the problem of historicism”, “the crisis of historicism”: the phenomenon of historicism and the concept of historicism in the German sciences of the spirit of the 19th - early 20th centuries. / Yu. G. Arnautova // New past. - 2019. - No. 4. - P. 86 – 110.
4. Bobrova, A. S. Critical thinking. The problem of definition / A. S. Bobrova // RATIO.ru. — 2017. — No. 1 (18). — P. 26 – 36.
5. Weber, M. Preliminary remarks / Selected: the Protestant ethic and the spirit of capitalism. – Moscow, St. Petersburg: “Center for Humanitarian Initiatives”, 2013. – P. 7 – 9.
6. Voevoda, E.V. Critical thinking as a cultural phenomenon / E.V. Voevoda // Language and communication in the context of culture = Language and communication through culture: collection. Art. by mother 7th Int. scientific-practical Conf., May 21–22, 2012 - Ryazan, 2012. - pp. 120 – 146.
7. Volkov, E. N. (2015). Critical thinking tests: an introductory review / E.N. Volkov // Psychological diagnostics. – 2015. – T.3, No. 5. – P. 5 – 23.
8. Gaidenko P.P., History of modern European philosophy in its connection with science. — 3rd ed. - Moscow: Librocom, 2011. - 456 p.
9. Humboldt, W. von On the external and internal organization of higher educational institutions in Berlin. / V. Humboldt // Emergency reserve – 2002 – No. 2. pp. 5 – 10.
10. Descartes, R. Reasoning about the method / R. Descartes // Works: in 2 volumes - Moscow, 1989. - T. 1. - 654 p. — P. 250–296.
11. James, V. What is pragmatism / V. James // Pragmatism. - St. Petersburg, 1910. - pp. 32–55.
12. Dmitrochenko, T. V. Consideration of the category “critical thinking” in the history of foreign philosophical and psychological-pedagogical thought / T. V. Dmitrochenko // New pedagogical research: collection. Art. international scientific-practical conf. — Penza, 2020. — pp. 151–155.
13. Dobryakova, M. S., Frumin, I. D., Barannikov, K. A., Remorenko I. M., Ziil N., Moss J., Hautamäki J. Universal competencies and new literacy: from slogans to reality / M S. Dobryakova, I. D. Frumin, K. A. Barannikov [and others]. – Moscow: Publishing house. House of the Higher School of Economics, 2020. – 472 p.
14. Droyzen, I. G. History: lectures on the encyclopedia and methodology of history / I. Droyzen. - St. Petersburg: Vladimir Dal, 2004. - 581 p.
15. Dewey, D. Psychology and pedagogy of thinking / D. Dewey. — Moscow: Yurayt, 2021. — 166 p.

16. Development of critical thinking in the classroom: a manual for general education teachers. institutions / S. I. Zair-Bek, I. V. Mushtavinskaya. — 2nd ed., revised. - M.: Education, 2011. - 223 p.
17. Zeigarnik, B.V. Pathopsychology / B.V. Zeigarnik. – Moscow: Moscow University Publishing House, 1986. – 287 p.
18. Measuring critical thinking in adults: methodology and development experience / A. R. Sadova, Yu. S. Khil, T. V. Pashchenko, K. V. Tarasova // Modern foreign psychology. - 2022. - T. 11, No. 4. - P. 105-116.
19. Ilyenkov, E.V. School should teach to think / E.V. Ilyenkov // Reader on educational psychology / under scientific. ed. A. I. Krasilo, A. P. Novgorodtseva. - Moscow, 1995. - 416 p. pp. 284-312.
20. Clarin, M. V. Innovative teaching models: A study of world experience / M. V. Clarin. – Moscow: LLC Publishing House “Luch”, 2016. – 632 p. – ISBN 978-5-88915-093-0. – EDN XCULWV.
21. Kozlov, S.L. Implantation / S.L. Kozlov – Moscow: NLO, 2020. – 576 p.
22. Koreshnikova, Yu. N., Frumin, I. D. Professional competencies of a teacher as a factor in the development of students’ critical thinking / Yu. N. Koreshnikova, I. D. Frumin // Psychological Science and Education. - 2020. - No. 25(6). — P. 88-103.
23. Koreshnikova, Yu. N., Frumin, I. D., Pashchenko, T. V. Barriers to creating pedagogical conditions for the development of critical thinking in Russian universities / Yu. N. Koreshnikova, I. D. Frumin, T. V. Pashchenko // Pedagogy. — 2020. — No. 9. — pp. 45–54.
24. Koreshnikova, Yu. N., Frumin, I. D., Pashchenko, T. V. Organizational and pedagogical conditions for the formation of critical thinking skills among students of Russian universities. / Yu. N. Koreshnikova, I. D. Frumin, T.V. Pashchenko // University management: practice and analysis – 2021. – No. 25(1). – P. 5 – 17.
25. Kumskov, V.V. Pedagogical ideas of D. Dewey and Soviet education of the 1920s / V.V. Kumskov // Yaroslavl Pedagogical Bulletin - 2011. - No. 3. – P. 7 – 11.
26. Kurennoy, V. A. Institutional theory of modernity: Johann Gustav Droysen / V. A. Kurennoy // Logos. — 2020. — No. 6. — P. 41–96.
27. Kurennoy, V. A. Science in the modern world / V. A. Kurennoy // Otechestvennye zapiski. - 2003. - No. 1. - Access mode: URL: <https://strana-oz.ru/2003/1/nauka-v-sovremennom-mire> (access date: 08/17/2023).
28. Kurennoy, V. A. Philosophy of liberal education: contexts. / V. A. Kurennoy // Issues of education. – 2020. – No. 2. – P. 8 – 36.
29. Kurennoy, V. A. Philosophy of liberal education: principles. / V. A. Kurennoy // Issues of education. – 2020. – No. 1. – P. 8 – 39.
30. Mill J. On Freedom / Transl. from English A. Friedman // Science and life. – 1993. – No. 11. – P. 10-15; No. 12. – pp. 21-26.
31. Mill, J. St. Autobiography. The story of my life and beliefs / J. St. Mill – Moscow: RIPOL classic. – 2018. – 384 p.
32. Mill, J. St. Speech about university education / J. St. Mill // Newest education: its true goals and requirements. – St. Petersburg: Russian book trade. – 2010. – P. 5 – 71.

33. Mironova, O. A. John Dewey's pragmatism as the leading philosophy of education of the 21st century. / O. A. Mironova // Problems and prospects for the development of education in Russia – 2011. – No. 7. – P. 11 – 15.
34. Olkhova T. A., Eliseev V. N. Critical thinking as the basis for the development of information and cognitive independence // Higher education today. 2013. No. 9. pp. 46–51.
35. Assessment of universal competencies as results of higher education: analytical report for the XXII April International Scientific Conference on Problems of Economic and Society Development / S. M. Avdeeva, P. V. Gass, E. Yu. Kardanova [and others]. - Moscow, 2021. - Access mode: URL: <https://conf.hse.ru/mirror/pubs/share/462013609.pdf> (access date: 08/17/2023).
36. Pierce, Ch. S. How to make our ideas clear / Ch. Pierce. — Moscow: Logos. – 2000. – 448 p.
37. Order of the Ministry of Education and Science of the Russian Federation dated January 10, 2018 N 8 "On approval of the federal state educational standard of higher education - bachelor's degree in the field of study 01.03.01 Mathematics" (with amendments and additions) Revision as amended N 1456 dated 11/26/2020: introduced effective 11/26/2020.
38. Rubinstein, S. L. Fundamentals of general psychology / S. L. Rubinstein. – St. Petersburg: Peter – 2002. – 720 p.
39. Sadova, A.R., Khil, Yu.S., Pashchenko, T.V., Tarasova, K.V. (2010) Measuring critical thinking in adults: methodology and development experience / A. R. Sadova, Yu. S. Khil, T. V. Pashchenko, K. V. Tarasova // Modern foreign psychology - 2022. - T. 11, No. 4. - P. 105-116.
40. Smirnova, I. V. The concept of critical thinking in modern pedagogical science / I. V. Smirnova // Modern problems of science and education. - 2015. - No. 5. - Access mode: URL: <https://science-education.ru/ru/article/view?id=22783> (date of access: 08.17.2023).
41. Sokuler, Z. A. Knowledge and power: science in modern society / Z. A. Sokuler. – St. Petersburg: RKhGI. – 2001. – 240 p.
42. Sorina G.V. Critical thinking: history and modern status // Bulletin of Moscow University. Ser. 7, Philosophy. 2003. No. 6. P. 99–111.
43. Sorina, G.V. Critical thinking: status in modern social space and in the education system / G.V. Sorina // Modern education: vectors of development, the role of social and humanitarian knowledge in teacher training: material. V International conf. — Moscow, 2020. — pp. 138–145.
44. Tarasova, K. V., Orel, E. A. (2022) Measuring students' critical thinking in an open online environment: conceptual framework and typology of tasks / K. V. Tarasova, E. A. Orel // Issues of Education. – 2022 – No. 3. – P. 187 – 212.
45. Teplov, B. Psychology / B. Teplov - Moscow: Uchpedgiz, 1953. - 121 p.
46. Uglanova, I. L., Brun, I. V., Vasin, G. M. “Evidence-Centered Design” methodology for measuring complex psychological constructs / I. L. Uglanova, I. V. Brun, G. M. Vasin // Modern foreign psychology. – 2018. – No. 7(3). – P. 18 – 27.

47. Uglanova, I. L., Orel, E. A., Brun, I. V. Measuring creativity and critical thinking in elementary school / I. L. Uglanova, E. A. Orel, I. V. Brun // Psychological Journal . – 2020. – No. 41(6). – P. 96 – 107.
48. Willingham, D. Why don't students like school? A cognitive psychologist answers questions about how the mind functions and what this means for schoolwork / D. Willingham. – Moscow: Publishing house. House of National Research University Higher School of Economics, 2020. – 288 p.
49. Universal competencies and new literacy: from slogans to reality / M. S. Dobryakova, I. D. Frumin, K. A. Barannikov [etc.]. - Moscow: Publishing house. House of the Higher School of Economics, 2020. - 472 p.
50. FSES VO. Portal of Federal State Educational Standards of Higher Education: official. website. URL: <https://fgosvo.ru/fgosvo/index/24> (access date 06/24/2022)
51. Kharlampyeva T.V. Formation of critical thinking of university students as a means of protecting them from negative information influences in professional activity: dis. ...cand. ped. Sci. South-Ur. state Univ., 2009. 203 p.
52. Sheler, M. Problems of the sociology of knowledge / M. Sheler. - Moscow: Institute of General Humanitarian Research, 2011. - 320 p.
53. Schelling F. V. J. Lectures on the method of university education / F. V. J. Schelling. – St. Petersburg: Mir, 2009. – 352 p.
54. Schleiermacher F. Unexpected thoughts about the spirit of German universities / F. Schleiermacher. – Moscow: Kanon-Plus, 2018. – 207 p.
55. Ab Kadir, MA What Teacher Knowledge Matters in Effectively Developing Critical Thinkers in the 21st Century Curriculum? Thinking Skills and Creativity. 2017. No. 23. pp. 79 – 90.
56. Abrami, PC, Bernard, R.M., Borokhovski, E., Wade, A., Surkes, M.A., Tamim, R., Zhang, D. Instructional interventions affecting critical thinking skills and dispositions: A stage 1 meta-analysis Review of educational research . 2008. No. 78(4). pp. 1102-1134.
57. Abrami, P., Bernard, R., Borokhovski, E., Waddington, D., Wade, A., Persson, T. Strategies for teaching students to think critically: A meta-analysis. Review of Educational Research. 2015. No. 85(2). pp. 275–314.
58. Akoglu, H. User's guide to correlation coefficients. Turkish journal of emergency medicine. 2018. №18(3). Pp. 91 – 93.
59. Alsaleh, N. J. Teaching Critical Thinking Skills: Literature Review. Turkish Online Journal of Educational Technology-TOJET. 2020. №19(1). Pp. 21 – 39.
60. American Educational Research Association. Standards for educational and psychological testing. Educational Research Association. 2018.
61. Anderson, M. B. Education for medicine. International Encyclopedia of Education. Elsevier Ltd. 2018. Pp. 19 – 24.
62. Assessment of critical thinking: Next generation performance assessment. International Journal of Testing. 2019. №19(4). Pp. 337-362.
63. Awan, Z. A., Awan, A. A., Alshawwa, L., Tekian, A., Park, Y. S. (2018). Assisting the integration of social media in problem-based learning sessions in the Faculty of

- Medicine at King Abdulaziz University. Issue sup1: 2018 Saudi Supplement on Medical Education, 40. 2018. Vol.40. Pp. S37 – S42.
64. Azer, S. A. Problem based learning: challenges, barriers and outcome issues. Saudi Medical Journal. 2001. №22(5). Pp. 389 – 397.
  65. Baker, K. Critical thinking and lifelong learning. Information Literacy and Cultural Heritage. 2013. Pp. 95 – 116.
  66. Bandyopadhyay, S., Szostek, J. Thinking critically about critical thinking: Assessing critical thinking of business students using multiple measures. Journal of Education for Business. 2019. №94(4). Pp. 259 – 270.
  67. Barker, K., Wendel, T. E-learning: Studying Canada’s virtual secondary schools. Society for the Advancement of Excellence in Education. 2001.
  68. Barnes, D. Active Learning. Leeds University TVEI Support Project. 1989. P. 19.
  69. Barrows, H. S. Essentials of problem-based learning. Journal of Dental Education. 1998. №62(9). Pp. 630 – 633.
  70. Barrows, H. S., Tamblyn, R. M. Problem-based learning: An approach to medical education. Vol. 1. Springer Publishing Company, 1980.
  71. Berg, G. A., Simonson, M. Distance learning. Encyclopedia Britannica. 2023. URL: <https://www.britannica.com/topic/distance-learning>.
  72. Bezanilla, M. J., Fernández-Nogueira, D., Poblete, M., Galindo-Domínguez, H. Methodologies for teaching-learning critical thinking in higher education: The teacher’s view. Thinking Skills and Creativity. 2019. №33. Pp. 12 – 24.
  73. Biggs, J., Tang, C. Applying constructive alignment to outcomes-based teaching and learning. In Training material for “quality teaching for learning in higher education” workshop for master trainers. Ministry of Higher Education, Kuala Lumpur. 2010. Vol. 53, No. 9. Pp. 23 – 25.
  74. Blair, J. A., Allen, D., Bailin, S., Barnett, A., Battersby, M., Dai, Y., ... Bowell, T. Studies in Critical Thinking: 2nd Edition. Windsor Studies in Argumentation. 2021. DOI: 10.22329/wsia.08.2019.
  75. Blaschke, L. M., Bedenlier, S. Online Learning. In Oxford Research Encyclopedia of Education. Oxford University Press, 2020.
  76. Boa, E. A. The development and validation of the Blended Socratic Method of Teaching (BSMT) : An instructional model to enhance critical thinking skills of undergraduate business students. Kasetsart Journal of Social Sciences. 2018. Vol. 39, №1. Pp. 81–89.
  77. Bonwell, C.; Eison, J. Active Learning: Creating Excitement in the Classroom AEHE-ERIC. Higher Education Report. №1. Washington, D.C.: Jossey-Bass, 1991.
  78. Bowen, W. G. Frontmatter. In Higher Education in the Digital Age. Princeton University Press, 2015.
  79. Brabeck, M. M. The relationship between critical thinking skills and development of reflective judgment among adolescent and adult women. 89th Annual Convention of the American Psychological Association 1981. Pp. 24 – 26.
  80. Brookfield, S. Adult cognition as a dimension of lifelong learning. In Lifelong Learning. 2019.

81. Brookfield, S. Teaching for Critical Thinking. *International Journal of Adult Education and Technology*. 2020. №11(3). Pp. 1 – 21.
82. Bruine de Bruin, W., Parker, A. M., Fischhoff, B. Individual differences in adult decision-making competence. *Journal of personality and social psychology*. 2007. №92(5). P. 938.
83. Butler, H. A. Halpern Critical Thinking Assessment predicts real-world outcomes of critical thinking. *Applied Cognitive Psychology*. 2012. №26(5). Pp. 721–729.
84. Calma, A., Cotronei-Baird, V. Assessing critical thinking in business education: Key issues and practical solutions. *The International Journal of Management Education*. 2021. №19(3). Pp. 721 – 729.
85. Caplow, J., Donaldson, J., Kardash, C., Hosokawa, M. Learning in a problem-based medical curriculum: students' conceptions. *Med. Educ*. 1997. №31. Pp. 440–447.
86. Chan, Z. C. Y. A systematic review on critical thinking in medical education. *International Journal of Adolescent Medicine and Health*. Vol.30, Issue 1. 2018. Pp. 127 – 134. DOI:10.1515/ijamh-2015-0117.
87. Chen W. H., Lenderking W., Jin Y., Wyrwich K. W., Gelhorn H., Revicki D. A. Is Rasch model analysis applicable in small sample size pilot studies for assessing item characteristics? An example using PROMIS pain behavior item bank data. *Qual Life Res*. 2014. DOI:23:485-493.
88. Chou, T., Wu, J., Tsai, C. Research Trends and Features of Critical Thinking Studies in E-Learning Environments: A Review. *Journal of Educational Computing Research*. 2019. №57(4). Pp. 1038–1077.
89. Clark, R. C. Multimedia learning in e-courses. R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning*. 2005. Pp. 589–615.
90. Class Central. (n.d.). MOOCWatch. The Report by Class Central. URL: <https://www.classcentral.com/report/category/moocwatch/> (Retrieved March 24, 2023)
91. Cortázar, C., Nussbaum, M., Harcha, J., Alvares, D., Felipe, L., Goñi, J., & Cabezas, V. Computers in Human Behavior Promoting critical thinking in an online, project-based course. *Computers in Human Behavior*. 2021.
92. Council of the European Union. Council Recommendation on Key Competences for Lifelong Learning. 2018.
93. Dawson, T. L. Metacognition and learning in adulthood. Developmental Testing Service, LLC. 2008.
94. de Bono, E. *Six Thinking Hats: An Essential Approach to Business Management*. Little, Brown, & Company. 1985. ISBN 0-316-17791-1
95. de Oliveira, L. B., Díaz, L. J. R., Carbogim, F. da C., Rodrigues, A. R. B., Püschel, V. A. de A.. Effectiveness of teaching strategies on the development of critical thinking in undergraduate nursing students: A meta-analysis. *Revista da Escola de Enfermagem*. 2016. Vol. 50, I.2.
96. Dewey J. *How We Think*. Boston: D. C. Heath & Co. 1910.
97. Dewey, J. *How we think: A restatement of the relations of reflective thinking to the educative process*. Heath. 1933.



98. Diep, N. A., Cocquyt, C., Zhu, C., Vanwing, T. Predicting adult learners' online participation: Effects of altruism, performance expectancy, and social capital. *Computers and Education*. 2016. №101. Pp. 84–101.
99. Dondi, M., Klier, J., Panier, F., Schubert, J. Defining the skills citizens will need in the future world of work. McKinsey & Company. 2001.
100. Dwyer, C. P., Hogan, M. J., Stewart, I. An integrated critical thinking framework for the 21st century. *Thinking Skills and Creativity*. 2014. №12. Pp. 43–52.
101. Dwyer, C. P., Hogan, M. J., Stewart, I. The effects of argument mapping-infused critical thinking instruction on reflective judgement performance. *Thinking Skills and Creativity*. 2015. №16. Pp. 11–26.
102. Dwyer, C. P., Walsh, A. An exploratory quantitative case study of critical thinking development through adult distance learning. *Educational Technology Research and Development*. 2020. №68(1). Pp. 17–35.
103. Eftekhari, M., Sotoudehnama, E., Marandi, S. S. Computer-aided argument mapping in an EFL setting: does technology precede traditional paper and pencil approach in developing critical thinking? *Educational Technology Research and Development*. 2016. №64(2). Pp 50 – 62. DOI:10.1007/s11423-016-9431-z.
104. Elder, L., Paul, R. *The Thinker's Guide to The Human Mind*. Foundation for Critical Thinking. 2015.
105. Ennis R. H. Critical thinking and subject specificity: Clarification and needed research. *Educational Researcher*. 1989. №18(3). Pp. 4–10.
106. Ennis R. H. Definition: A Three-Dimensional Analysis with Bearing on Key Concepts. O SSA Conference Archive. 2016.
107. Ennis, R. *Critical Thinking Across the Curriculum : A Vision*. Topoi. 2018. Vol. 37, № 1. Pp. 165–184.
108. Ennis, R. H. Critical thinking and subject specificity: Clarification and needed research. *Educational researcher*. 1989. №18(3). Pp. 4–10.
109. Ennis, R. H. Critical thinking: A streamlined conception. In *The Palgrave handbook of critical thinking in higher education*. Palgrave Macmillan, New York. 2015. Pp. 31–47.
110. Facione, PA *Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction*. The California Academic Press. 1990. pp. 1–19.
111. Facione, P., Facione, NC *Holistic critical thinking scoring rubric*. 1994.
112. Facione, P., Gittens, CA *Think Critically* (3rd ed.). Pearson Education. 2016.
113. Fichte JG *Deduced plan of a higher educational institution to be built in Berlin, which would be properly connected to an academy of sciences*. 1971.
114. Fischer, KW, Bidell, TR *Dynamic development of action, thought, and emotion*. W. Damon & RM Lerner (Eds.), *Handbook of child psychology: Theoretical models of human development*. 2006. pp. 313–399.
115. Garrison, D. R. Critical thinking and adult education: A conceptual model for developing critical thinking in adult learners. *International Journal of Lifelong Education*. 1991. №10(4). Pp. 287–303.

116. Garrison, D. R., Kanuka, H. Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education*. 2004. №7(2). Pp. 95–105.
117. Glaser, E. *An Experiment in the Development of Critical Thinking*. New York : Teachers College, Columbia University, 1941.
118. Gogtay, N., Giedd, J. N., Lusk, L., Hayashi, K. M., Greenstein, D., Vaituzis, A. C., Nugent, T. F., Herman, D. H., Clasen, L. S., Toga, A. W., Rapoport, J. L., & Thompson, P. M. Dynamic mapping of human cortical development during childhood through early adulthood. *Proceedings of the National Academy of Sciences of the United States of America*. 2004. №101(21).
119. Green, P. *Teaching Critical Thinking for Lifelong Learning*. In *The Palgrave Handbook of Critical Thinking in Higher Education*. 2015.
120. Grossmann, I. *Wisdom in Context. Perspectives on Psychological Science*. 2017. №12(2). Pp. 233–257.
121. Gruzdev, M. V, Kuznetsova, I. V, Tarkhanova, I. Y., Kazakova, E. I. University Graduates' Soft Skills: The Employers' Opinion. *European Journal of Contemporary Education*. 2018. №7(4). Pp. 690–698.
122. Haghparast, M., Nasaruddin, F. H., & Abdullah, N. *Cultivating Critical Thinking Through E-learning Environment and Tools: A Review*. *Procedia - Social and Behavioral Sciences*. 2014. №129. Pp. 527–535.
123. Hall, S., Schmautzer, D. *The skills revolution and the future of learning and earning*. McKinsey & Company. 2023.
124. Halpern, D. F. Teaching critical thinking for transfer across domains: Disposition, skills, structure training, and metacognitive monitoring. *American psychologist*. 1998. №53(4). P. 449.
125. Halpern, D. F. *Thought and Knowledge: An Introduction to Critical Thinking*. Taylor & Francis. 2014.
126. Heard, J., Scoular, C., Duckworth, D., Ramalingam, D., & Teo, I. *Critical Thinking: Skill Development Framework*. The Australian Council for Educational Research (ACER), June, 1–26. 2020.
127. Heller, R. F. *The Distributed University for Sustainable Higher Education*. The Distributed University for Sustainable Higher Education. Springer Singapore. 2022.
128. Heller, R. F., Chilolo, E., Elliott, J., Johnson, B., Lipman, D., Ononeze, V., Richards, J. Do tutors make a difference in online learning? A comparative study in two Open Online Courses. *Open Praxis*. 2019. №11(3). Pp. 230 – 241.
129. Hitchcock, D. *Critical Thinking*. The Stanford Encyclopedia of Philosophy. The Stanford Encyclopedia of Philosophy. Ed. by Edward N. Zalta. 2020. URL: <https://plato.stanford.edu/archives/fall2020/entries/critical-thinking/> (date of the application: 17.08.2023).
130. Huber, C. R., Kuncel, N. R. Does College Teach Critical Thinking ? A Meta-Analysis. *Review of Educational Research*. 2016. №86(2). Pp. 431–468.
131. Hung, W. The 3C3R Model: A Conceptual Framework for Designing Problems in PBL. *Interdisciplinary Journal of Problem-Based Learning*. 2006. №1(1). Pp. 5–22.

132. Illeris, K. Characteristics of Adult Learning. *International Encyclopedia of Education*. 2010. Pp. 36–41.
133. Indrašienė, V., Jegelevičienė, V., Merfeldaitė, O., Penkauskienė, D., Pivorienė, J., Railienė, A., ... Valavičienė, N. What Critical Thinking and for What?. *Social Welfare Interdisciplinary Approach*. 2019. №9(1). Pp 24 – 38. DOI:10.21277/sw.v1i9.460.
134. Indrašienė, V., Jegelevičienė, V., Merfeldaitė, O., Penkauskienė, D., Pivorienė, J., Railienė, A., Sadauskas, J., Valavičienė, N. Critical Thinking in Higher Education and Labor Market. In *Critical Thinking in Higher Education and Labor Market*. Peter Lang. 2021.
135. Indrašienė, V., Jegelevičienė, V., Merfeldaitė, O., Penkauskienė, D., Pivorienė, J., Railienė, A., Sadauskas, J., Valavičienė, N. The Value of Critical Thinking in Higher Education and the Labor Market: The Voice of Stakeholders. *Social Sciences*. 2021. №10(8). P. 286.
136. Jiang, J., Gao, A., Yang, B. Employees' critical thinking, leaders' inspirational motivation, and voice behavior. *Journal of Personnel Psychology*. 2018. №17. Pp. 33-41.
137. Jonassen, D. H. Toward a design theory of problem solving. *Educational Technology Research and Development*. 2000. №48. Pp. 63–85.
138. Johnson, M., Majewska, D., Formal, non-formal, and informal learning: What are they, and how can we research them? 2022. Cambridge University Press & Assessment Research Report.
139. Jou, M., Lin, Y. T., Wu, D. W. Effect of a blended learning environment on student critical thinking and knowledge transformation. 2016. №24(6). Pp. 1131–1147.
140. Kallio, E. K. Development of Adult Thinking: Interdisciplinary Perspectives on Cognitive Development and Adult Learning. In E. K. Kallio (Ed.), *Development of Adult Thinking: Interdisciplinary Perspectives on Cognitive Development and Adult Learning*. Taylor and Francis. 2020.
141. Kay, C. S., Slovic, P. The Generic Conspiracist Beliefs Scale–5: A short-form measure of conspiracist ideation. 2022. DOI:10.31234/osf.io/2uvr9
142. Keegan, D. *Foundations of distance education*. Routledge. 1996.
143. Kek, M. Y. C. A., Huijser, H. The power of problem-based learning in developing critical thinking skills: Preparing students for tomorrow's digital futures in today's classrooms. *Higher Education Research and Development*. 2011. №30(3). Pp. 329–341.
144. King, P. M., Kitchener, K. S. *Developing Reflective Judgment: understanding and promoting intellectual growth and critical thinking in adolescents and adults*. 1994.
145. King, P. M., Kitchener, K. S. Reflective Judgment: Theory and Research on the Development of Epistemic Assumptions Through Adulthood. *Educational Psychologist*. 2004. №39(1). Pp. 5 – 18. DOI:10.1207/s15326985ep3901\_2.
146. Klunklin, A., Subpaibongid, P., Keitlertnapha, P., Viseskul, N., Turale, S. Thai nursing students' adaption to problem-based learning: A qualitative study. *Nurse Education in Practice*. 2011. №11(6). Pp. 370–374.

147. Knowles, M. S. *The Modern Practice of Adult Education: From Pedagogy to Andragogy*. Cambridge Books. 1980.
148. Kong, L. N., Qin, B., Zhou, Y. qing, Mou, S. yu, Gao, H. M. The effectiveness of problem-based learning on development of nursing students' critical thinking: A systematic review and meta-analysis. *International Journal of Nursing Studies*. 2014. №51(3). Pp. 458–469.
149. KPMG. *The future of higher education in a disruptive world*. 2020.
150. Ku, K. Y. L. Assessing students' critical thinking performance: Urging for measurements using multi-response format. *Thinking Skills and Creativity*. 2009. №2. Pp. 70–76.
151. Ku, K., Lai, E., Hau, K. Epistemological beliefs and the effect of authority on argument-counterargument integration: An experiment. *Thinking Skills and Creativity*. 2014. №13. Pp. 67–79.
152. Ku, Kelly Y.L., Ho, I. T., Hau, K. T., Lai, E. C. M. Integrating direct and inquiry-based instruction in the teaching of critical thinking: an intervention study. *Instructional Science*. 2013. №42(2). Pp. 251–269.
153. Kuhn, D. A Developmental Model of Critical Thinking. *Educational Researcher*. 1999. №28(2). Pp. 16–46.
154. Kuhn, D. A Role for Reasoning in a Dialogic Approach to Critical Thinking. *Topoi*. 2018. №37(1). Pp. 121–128.
155. Kuhn, D. *Education for Thinking*. Harvard University Press. 2008.
156. Kuhn, D. *The skills of argument*. Cambridge University Press. 1991.
157. Lai, E. R. Critical thinking: A literature review. *Pearson's Research Reports*. 2011. №6(1). Pp. 40-41.
158. Leighton, J. P. *Using think-aloud interviews and cognitive labs in educational research*. Oxford University Press. 2017.
159. Lin, C. F., Lu, M. S., Chung, C. C., Yang, C. M. A comparison of problem-based learning and conventional teaching in nursing ethics education. *Nursing Ethics*. 2010. №17(3). Pp. 373–382.
160. Linacre, J. M. Optimizing rating scale category effectiveness. *Journal of applied measurement*. 2002. № 3(1). Pp. 85–106.
161. Liu, O., Frankel, L., Roohr, K. *Assessing Critical Thinking in Higher Education: Current State and Directions for Next-Generation Assessment*. ETS Research Report Series. 2014. Pp. 1–23.
162. Liu, Y., Páztor, A. Effects of problem-based learning instructional intervention on critical thinking in higher education: A meta-analysis. *Thinking Skills and Creativity*. 2022. № 45. Pp. 2 – 21.
163. Lorencová , H. , Jarošová , E. , Avgitidou , S. , Dimitriadou , C. Critical thinking practices in teacher education programs: a systematic review . *Studies in Higher Education*. 2019. No44(5). Pp. 844–859.
164. Loyalka , P. , Liu , OL , Li , G. , Kardanova , E. , Chirikov , I. , Hu , S. , Yu , N. , Ma , L. , Guo , F. , Beteille , T. , Tognatta , N. , Gu , L. , Ling , G. , Federiakin , D. , Wang , H. , Khanna , S. , Bhuradia , A. , Shi , Z. , & Li , Y. Skill levels and gains in

- university STEM education in China, India, Russia and the United States. *The Nature of Human Behaviour*. 2021. No5(7). Pp. 892–904.
165. Loyens, S.M.M., Wijnia, L., Duker, S., & Rikers, R.M.J.P. Problem-Based Learning. *Oxford Research Encyclopedia of Education*. 2020.
166. Makhene, A. Argumentation: A methodology for facilitating critical thinking. *International Journal of Nursing Education Scholarship*. 2017. No14(1). Pp. 48 – 53. DOI: 10.1515/ijnes-2016-0030.
161. Marchand, H. Some reflections on post-formal thought. *The Genetic Epistemologist*. URL: <https://www.dareassociation.org/documents/Some Reflections on Postformal Thought.html> (Retrieved March 14, 2023)
162. Masters, G. N. A Rasch model for partial credit scoring. *Psychometrika*. 1982. No47(2). Pp. 149–174. DOI:10.1007/BF02296272
163. McLinden, M., McCall, S., Hinton, D., Weston, A., Douglas, G. Developing online problem-based resources for the Professional development of teachers of children with visual impairment. *Open Learning*. 2006. No21(3). Pp. 237–251.
164. McPeck, J. *Critical thinking and education*. St. Martin's Press. 1981.
165. McPeck, J. E. *Critical thinking and education*. Routledge. 2016.
166. Mehmet, Ş. A. H. I. N. Critical thinking and transformative learning. *Journal of Innovation in Psychology, Education and Didactics*. 2018. No22(1). 103-114.
167. Meirbekov, A., Maslova, I., & Gallyamova, Z. Digital education tools for critical thinking development. *Thinking Skills and Creativity*. 2022. No44. Pp. 10 – 23.
168. Merriam, S. B. Adult education–adult learning, instruction and program planning. In *International Encyclopedia of Education*. 2010. Pp. 12–17.
169. Miner-Romanoff, K., Rae, A., & Zakrzewski, C. E. A holistic and multifaceted model for ill-structured experiential problem-based learning: Enhancing student critical thinking and communication skills. *Journal of Problem Based Learning in Higher Education*. 2019. No7(1). Pp. 70–96.
170. Mislevy R. J. *Sociocognitive Foundations of Educational Measurement*. Routledge. 2018.
171. Mislevy, R. J., Almond, R. G., & Lukas, J. F. A brief introduction to evidence-centered design. *ETS Research Report Series*. 2003. I29. DOI:10.1002/j.2333-8504.2003.tb01908.x
172. Molerov, D., Zlatkin-Troitschanskaia, O., Nagel, M. T., Brückner, S., Schmidt, S., & Shavelson, R. J. Assessing University Students' Critical Online Reasoning Ability: A Conceptual and Assessment Framework With Preliminary Evidence. *Frontiers in Education*. 2020. No5. Pp. 1–29.
173. Morgado P., Sousa N., Cerqueira J. J. The impact of stress in decision making in the context of uncertainty. *Journal of Neuroscience Research*. 2015. Vol. 93. No. 6. Pp. 839-847
174. National Academies of Sciences, E. Indicators for Monitoring Undergraduate STEM Education. In *Indicators for Monitoring Undergraduate STEM Education*. The National Academies Press. 2017.
175. Navarro Hernández, N., & Zamora S., J. The opinion of teachers about tutorial problem based learning. *Medical Magazine of Chile*. 2014. No142(8). pp. 989–997.

176. OECD. 21st-Century Readers: Developing Literacy Skills in a Digital World. PISA, OECD Publishing. 2021.
177. OECD. Does Higher Education Teach Students to Think Critically? (D. Van Damme & D. Zahner (eds.)). OECD Publishing. 2022.
178. Olivares, SL, & Heredia, Y. Development of critical thinking in problem-based learning environments in higher education students. *Mexican Journal of Educational Research*. 2012. №17(54). pp. 759–778.
179. Oliveri, ME, & Mislevy, RJ Introduction to “Challenges and Opportunities in the Design of 'Next-Generation Assessments of 21st Century Skills’”. 2019. Special Issue. Taylor & Francis.
180. Paul, R. A Brief History of the Idea of Critical Thinking. The Foundation for Critical Thinking. 1997. URL: <https://www.criticalthinking.org/pages/a-brief-history-of-the-idea-of-critical-thinking/> (date of the application: 17.08.2023).
181. Paul, R., & Elder, L. Critical thinking: Competency standards essential for the cultivation of intellectual skills, part 3. *Journal of Developmental Education*. 2011. №35(2). P. 34.
182. Paul, R., & Elder, L. *Critical Thinking: Tools for taking Charge of Your Learning and Your Life*. Pearson Education. 2012.
183. Payan-carreira, R., Cruz, G., & Papathanasiou, I. V. The effectiveness of critical thinking instructional strategies in health professions education : a systematic review. *Studies in Higher Education*. 2019. №0(5). Pp. 1–15.
184. Penkauskienė, D., Railienė, A., & Cruz, G. How is critical thinking valued by the labour market? Employer perspectives from different European countries. *Studies in Higher Education*. 2019. №44(5). Pp. 804–815.
185. Perry, W. G. *Forms of intellectual and ethical development in the college years: A scheme*. Holt, Rinehart and Winston. 1970.
186. Piaget, J. *The Origins of Intelligence in Children* (first publ. in 1936). International Universities Press. 1952.
187. PISA 2021 ICT FRAMEWORK. OECD. 2018
188. Plummer, K. J., Kebritchi, M., Leary, H. M., & Halverson, D. M. Enhancing Critical Thinking Skills through Decision-Based Learning. *Innovative Higher Education*. 2022. Pp. 1-24. DOI:10.1007/s10755-022-09595-9.
189. Quality Assurance Agency. *UK quality code – Advice and guidance*. 2018.
190. Rosenfeld, R. A. Anxiety and learning. *Teaching sociology*. 1978. Pp. 151–166.
191. Rossi, I., de Lima, J., Sabatke, B., Ferreira, M., Ramirez, G., Ramirez, M. Active learning tools improve the learning outcomes, scientific attitude, and critical thinking in higher education: Experiences in an online course during the COVID-19 pandemic. *Biochemistry and Molecular Biology Education*. 2021. №49. Pp. 888–903.
192. Rotter, J. B. Internal versus external control of reinforcement: A case history of a variable. *American Psychologist*. 1990. №45(4). Pp. 489–493.
193. Rubenson, K. Adult Education Overview. *International Encyclopedia of Education*. 2010. Pp. 1–11.

194. Saadé, R. G., Morin, D., Thomas, J. D. E. Critical thinking in E-learning environments. *Computers in Human Behavior*. 2012. №28(5). Pp. 1608–1617.
195. Schwartz, R. W., Donnelly, M. B., Nash, P. P., Young, B. Developing students' cognitive skills in a problem-based sur... : *Academic Medicine*. *Academic Medicine*. 1992. №67(10). Pp.135 – 148. DOI:10.4085/1402135.
196. Scott, G., Leritz, L. E., & Mumford, M. D. Types of creativity training: Approaches and their effectiveness. *The Journal of Creative Behavior*. 2004. №38(3). Pp. 149–179.
197. Scriven, M. The Foundation for Critical Thinking. 8th Annual International Conference on Critical Thinking and Education Reform. The Foundation for Critical Thinking. 1987. URL: [www.criticalthinking.org/pages/defining-critical-thinking/766](http://www.criticalthinking.org/pages/defining-critical-thinking/766) (date of the application: 17.08.2023).
198. Seibert, S. A. Problem-based learning: A strategy to foster generation Z's critical thinking and perseverance. *Teaching and Learning in Nursing*. 2021. №16(1). Pp 85–88.
199. Şendağ, S., Odabaşı, H. Effects of an online problem based learning course on content knowledge acquisition and critical thinking skills. *Computers and Education*. 2009. №53(1). Pp 132–141.
200. Senge, P. Learning organizations. In *Knowledge management in education: enhancing learning & education*. Taylor & Francis. 2013.
201. Shaw, A., Liu, O. L., Gu, L., Kardanova, E., Chirikov, I., Li, G., Hu, S., Yu, N., Ma, L., Guo, F., Su, Q., Shi, J., Shi, H., Loyalka, P. Thinking critically about critical thinking: validating the Russian HEIghten® critical thinking assessment. *Studies in Higher Education*. 2020. №45(9). Pp. 1933–1948. DOI:10.1080/03075079.2019.1672640
202. Silva, A. B. Da, Bispo, A. C. K. de A., Rodriguez, D. G., Vasquez, F. I. F. Problem-based learning: A proposal for structuring PBL and its implications for learning among students in an undergraduate management degree program. *Revista de Gestao*. 2018. №25(2). Pp. 160–177.
203. Skurvydas A. et al. Do physical activity, BMI, and wellbeing affect logical thinking? *International journal of environmental research and public health*. 2022. Vol. 19. №. 11. C. 6631.
204. Smith Jr, E. V. Detecting and evaluating the impact of multidimensionality using item fit statistics and principal component analysis of residuals. *Journal of applied measurement*. 2002. №3(2). Pp. 205–231.
205. Sobocan, J., Giancarlo-Gittens, C. A., Groarke, L., Johnson, R. H., Ennis, R. H., Hare, W., ... Murphy, S. *Critical thinking education and assessment: 2nd ed.* Windsor Studies in Argumentation. 2022. DOI:10.22329/wsia.12.2022
206. Steinmayr, R., Weidinger, A. F., Schwinger, M., & Spinath, B. The importance of students' motivation for their academic achievement—replicating and extending previous findings. *Frontiers in psychology*. 2019. №10. P. 1730.
207. Sternberg, R. J. Personal wisdom in the balance. In M. Ferrari & N. M. Weststrate (Eds.), *The Scientific Study of Personal Wisdom: From Contemplative Traditions to Neuroscience*. Springer Netherlands. 2013. Pp. 53–74.

208. Styawan, A., Arty, I. S. Inquiry-based learning and problem-based learning : which one has better effect on students critical thinking skills profile of thermochemistry? *Journal of Physics: Conference Series*. 2021. №1806(1). Pp. 1 – 21. DOI:10.1016/j.tsc.2022.101069.
209. Sujová, E., Čierna, H., Simanová, L., Gejdoš, P., Štefková, J. Soft Skills Integration into Business Processes Based on the Requirements of Employers—Approach for Sustainable Education. *Sustainability*. 2021. №13(24). Pp 2 – 15. DOI:10.3390/su132413807
210. The future of Jobs Report 2020. World Economic Forum. Geneva, 2020. URL: <https://www.weforum.org/reports/the-future-of-jobs-report-2020/> (date of the application: 17.08.2023).
211. Theall, M. Higher Education. In *Encyclopedia of Education*. Macmillan. 2003. Pp. 2493–2498.
212. Todd, C. L., Ravi, K., & McCray, K. Cultivating critical thinking skills in online course environments: Instructional techniques and strategies. *International Journal of Online Pedagogy and Course Design*. 2019. №9(1). Pp. 19–37.
213. Trullàs, J. C., Blay, C., Sarri, E., & Pujol, R. Effectiveness of problem-based learning methodology in undergraduate medical education: a scoping review. *BMC Medical Education*. 2022. №22(1). Pp 1 – 12.
214. Van Laar, E., Van Deursen, A. J., Van Dijk, J. A., & De Haan, J. The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in human behavior*. 2017. №72. Pp. 577–588. DOI: 10.1016/j.chb.2017.03.010
215. Wedemeyer, C. A. *Learning at the back door : Reflections on non-traditional learning in the lifespan*. University of Wisconsin Press. 1981.
216. Weinstein, M. Towards a Research Agenda for Informal Logic and Critical Thinking. *Informal Logic*. 1990. №12(3). Pp. 121–143.
217. West, R. F., Toplak, M. E., Stanovich, K. E. Heuristics and biases as measures of critical thinking: associations with cognitive ability and thinking dispositions. *Journal of Educational Psychology*. 2009. №100(4). P. 930. DOI:10.1037/a0012842
218. World Economic Forum. *The Future of Jobs Report 2020*. 2020. I-October.
219. Yew, E. H. J., & Goh, K. Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*. 2016. №2(2). Pp. 75–79.
220. Yuan, H., Kunaviktikul, W., & Klunklin, A. Improvement of nursing students ' critical thinking skills through problem-based learning in the People ' s Republic of China : A quasi-experimental study. *Nursing and Health Sciences*. 2008. №10. Pp. 70–76.
221. Yuan, Y. H., Liu, C. H., & Kuang, S. S. An innovative and interactive teaching model for cultivating talent's digital literacy in decision making, sustainability, and computational thinking. *Sustainability*. 2021. №13(9). Pp 1 – 13. DOI:10.3390/su13095117.
222. Zahner. Assessing academic and career skills for CTE student success. 2022. URL: <https://www.acteonline.org/tech-essential-skills/>.



223. Zare, P. The use of Socratic method as a teaching/learning tool to develop students' critical thinking : A review of literature. *Language in India*. 2015. Vol. 15, №6. Pp. 256–265.

