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Human Capital Multidisciplinary Research Center

Can Schools Teach Thinking?

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Human in the Era of Technological Transformations

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Introduction

In 1964, Soviet philosopher Ewald Ilyenkov published an article entitled “Schools Should Teach Thinking.” Most people agree with this statement. In this paper, we decided to look into how exactly a school can teach thinking. The research project “Mechanisms and Factors for Key Skills and Competencies Formation”, implemented by the Laboratory of Education Content Design of the Institute of Education of the National Research University Higher School of Economics, is aimed at studying the means that education uses to form critical and creative thinking, interaction with others and self-regulation. The project participants identified the best practices in the formation of universal competencies, including in the digital environment, and described the challenges and conditions for their successful implementation in educational institutions. This digest will describe how and under what conditions it is possible to form creative and critical thinking in education (primarily in schools).

Critical and creative thinking are high-order thinking skills. According to surveys, employers consider critical thinking and creativity to be the most important skills for their employees (Dobryakova, Frumin, 2020). Purposeful thinking formation begins in school and is closely related to learning activities. Critical and creative thinking are constructs that are quite overlapping.

Creativity (creative thinking) is a competence that allows to produce ideas, solutions, products that are both original, new and relevant to the context in which they are produced (Sternberg & Lubart, 1999). Among the qualities (dispositions) of a creative individual are curiosity, persistence in achieving a goal, imagination, compatibility with others, and organization (Lucas, Claxton, & Spencer, 2013). Critical thinking, in turn, is a competence to evaluate judgments, seek alternative explanations and solutions, and develop a balanced and independent point of view (Facione, 1990). A person with a high level of critical thinking is characterized by attentiveness, a propensity to explore, self-confidence, courage, lack of prejudice, and a willingness to refrain from judgment and seek the truth (Ennis, 1996; Hitchcock, 2018).

Critical and creative thinking complement each other, helping at different stages of solving non-standard tasks and problems. While critical thinking plays a major role in analyzing information and evaluating the resulting solution, creative thinking is required to generate interesting ideas, search for relationships between concepts.

This digest will briefly answer a few questions about critical and creative thinking formation in schools:

1. What cognitive abilities serve as the basis for higher-order thinking skills and what this means for the educational realities of education?
2. What are the characteristics of a learning environment that fosters critical thinking and creativity?
3. How the tasks of teaching subject matter content and developing higher-order thinking skills can interact in education and how to best balance these tasks?
4. What are the best practices for fostering creative and critical thinking in education?

Outcomes

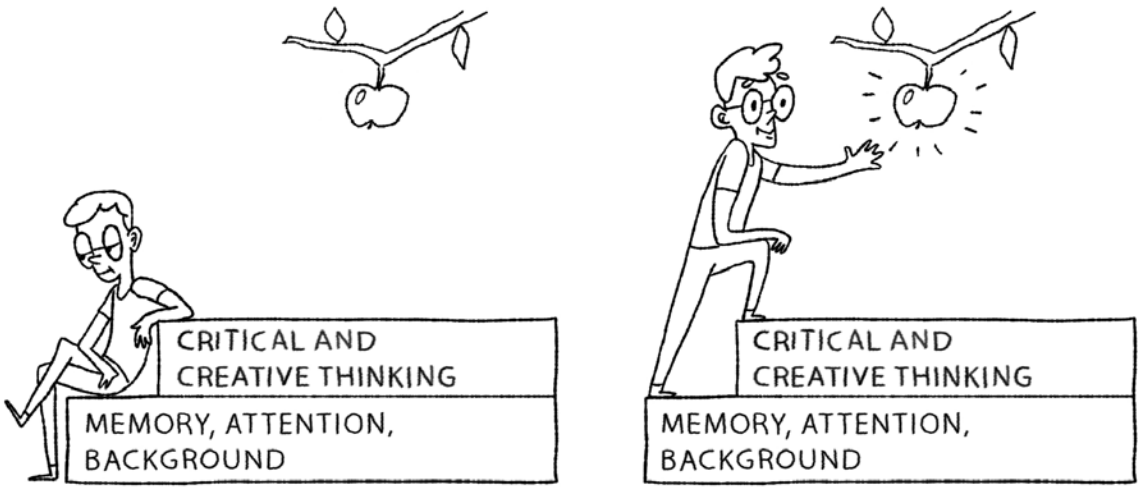
Cognitive framework for building critical thinking and creativity

Before we talk about ways to develop critical and creative thinking in education, let us understand how to develop these types of thinking effectively. According to research, executive functions (memory and attention) are important for creativity (Beaty et al, 2014). Researchers suggest that the higher the level of a person's working memory, the more original ideas they are able to generate - a person with a high level of working memory can simultaneously hold several significantly different ideas in their mind, evaluate them and reject the most trivial ones (Lee, Therriault, 2013). The role of memory and attention is also high in tasks that require critical thinking (Shehab, Nussbaum, 2015). The process of critically evaluating the strengths and weaknesses of arguments involves a person holding many disparate pieces of information in working memory. This requires considerable mental effort.

Does this mean that if memory and attention are underdeveloped we cannot give students tasks that require creative and critical thinking? Researchers refrain from giving a definite answer to this question (Cowan, 2014). There is not enough evidence suggesting that isolated memory training could eventually lead to improved results in critical thinking and creativity. It should be kept in mind that students' low working memory level may be a reason for failure in such tasks.

Basic knowledge is quite important in performing cognitive processes related to critical and creative thinking (Kousoulas, 2010). An approach in which instruction focuses only on metacognitive skills without considering knowledge is often criticized (Carson, 2007). However, acquiring knowledge separately from learning how to use it is also ineffective. Most researchers agree that these types of learning need to be combined.

Figure 1. Executive functions and background knowledge as a basis for the development of creative and critical thinking.



Researchers consider executive functions (memory and attention) and background knowledge to be a necessary basis for the development of critical and creative thinking. However, it does not follow that it is necessary to teach memorizing information first, and only with those who are already good at it can we move on to the development of thinking. Acquiring new knowledge and memorizing facts should be combined with tasks that require higher-order thinking skills.

A learning environment that fosters critical and creative thinking

Before talking about the implementation of specific practices, it makes sense to describe the characteristics of a learning environment that enables the development of higher-order thinking skills.

Creativity is fostered in a learning environment where there is mutual respect, teachers can have open dialog with students and share ideas, and learning is collaborative (Davies et al., 2013). In such an environment, self-regulated learning is encouraged, with a flexible balance between structured activities (students act solely within the teacher's instructions) and freedom (students act according to their own desires and goals).

Important for fostering critical thinking are (Cheng, Wan, 2017) personal relevance (lesson material is relevant to students' everyday experiences), uncertainty (students recognize that every viewpoint is contingent on something), a skeptical voice (students may question what the teacher says), teacher-student shared control of the lesson, opportunities for students to communicate, and opportunities for different viewpoints to coexist in the classroom.

In both cases, it is essential to seek horizontality in teacher-student communication - it both facilitates a meaningful exchange of ideas and the safe expression of doubts about one's point of view.

Figure 2. Striking a balance between structure and freedom is an important characteristic of a learning environment that fosters the development of creative and critical thinking.

Research also provides information on the physical environment and extracurricular connections that promote creative thinking (Davies et al., 2013, de Bruin, Harris, 2017). It is important to utilize both the physical space of the institution and class time in a flexible manner. This is necessary for full immersion in learning activities that require launching of idea work. It is also important to provide access to a variety of learning resources, from creative materials to interactive whiteboards.

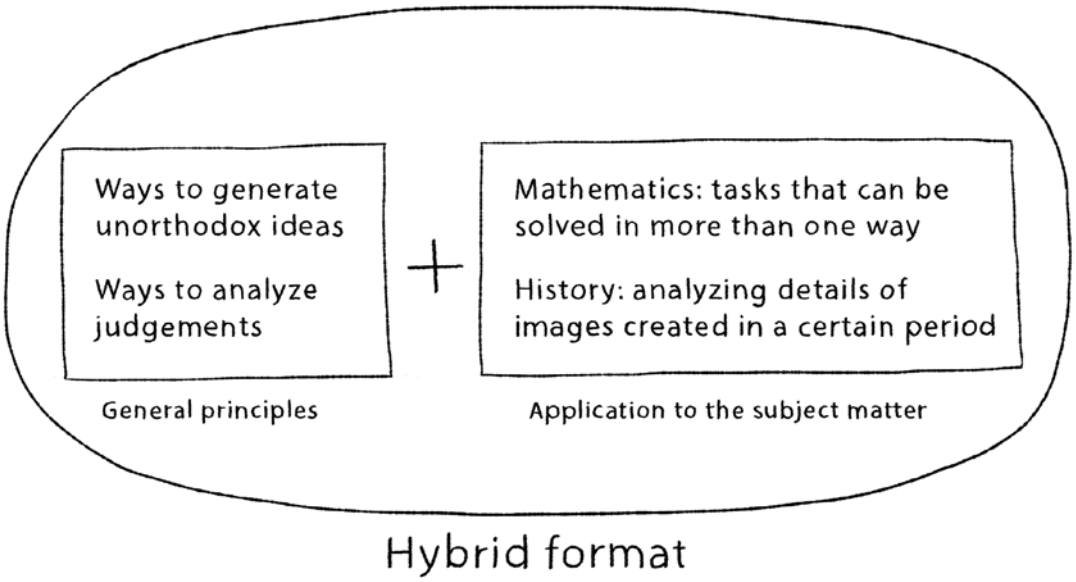
Also useful are links with external organizations: cultural institutions, business representatives, charitable foundations. Separate sessions held in these organizations or inviting experts from them to schools help teachers and experts to exchange ideas, while students get used to facing real-world challenges and try to address them. Researchers (de Bruin, Harris, 2017) have modeled a school environment that builds 21st century skills - it takes into account the need for links between the school and the local community, cooperation between them, going beyond the school space. In this way, students can train themselves to deal with issues they will later encounter in the real world.

Teaching specific subjects and developing higher order thinking skills

Both creativity and critical thinking researchers agree that a hybrid format of instruction is the best strategy for targeting these competencies. In this format, students are simultaneously introduced to general ways of developing critical and creative thinking and are shown how these ways can be applied to subject material.

In discussing how subject matter and critical thinking are combined, Ennis (1989, Ennis, 2018) identifies three possible approaches. The first is a separate critical thinking or informal logic course that teaches students explicitly different critical thinking strategies. In this case, the transfer of critical thinking strategies to the subject area becomes problematic. The second approach is to teach critical thinking within a specific subject area. This

Figure 3. Combination of subject content teaching and development of creativity and critical thinking.



approach can be divided into explicit instruction of critical thinking strategies in the subject material and implicit instruction. In this approach, the transfer of critical thinking skills to everyday domains is problematic. The third approach (advocated by Ennis himself) is a hybrid approach. This approach assumes a general critical thinking course and separate teaching elements that promote critical thinking based on subject matter. A review of a large body of research (Abrami et al, 2008) shows that the hybrid approach is most effective in developing critical thinking. The approach where critical thinking is developed solely through subject matter is less effective.

There is much debate among creativity researchers as to whether this competency can be considered domain-general or universal. To address this issue, a hierarchical model has been proposed that includes both general creativity and domain-specific creativity (Baer, 2010). The authors of the model concluded that creativity is based on some common factors which later begin to differ depending on the field of activity.

Consider examples of combining the challenges of teaching subject matter and developing higher-order thinking skills.

Example 1: creativity in math lessons

After conducting a series of interviews with experts, researchers (Hadar, Tirosh, 2019) propose the following classification of math tasks that require fostering creativity:

- Tasks that require an alternative solution even though one solution is already known;
- Tasks that may have more than one solution;
- Tasks that need to be solved in more than one way and then have all the solutions explained;
- Tasks that require applying mathematical knowledge outside of mathematics;
- Tasks that require recognizing a mathematical principle and applying it again (e.g.: continue a series of numbers...);
- Tasks that require making connections between different mathematical concepts;
- Tasks that require the use of mathematical procedures to solve problems from other contexts;
- Tasks that require independent composition of mathematical problems based on mathematical cases;
- Tasks that require investigating mathematical concepts (e.g., What questions should be asked to find out which of two girls is older?).

Example 2: critical thinking in history lessons

Describing the piloting of a curriculum module aimed to foster critical thinking in U.S. history classes, researchers (Vitulli, Santoli, 2013) show through a case study of one topic (states' westward expansion) how works of art can both teach a deeper understanding of historical events and foster critical thinking through immersion in art criticism.

At the beginning of the module, students discuss in groups a series of images (advertisements, paintings, photographs) related to a historical theme. They use questions as a guide to help them delve into how images convey subtle nuances of meaning. Toward the end of the module,

students are required to develop their own group poster design urging or warning against moving West and explain how their understanding of this historical theme has changed.

Teaching practices that foster creative and critical thinking

The most effective way to develop high-order thinking skills is through step-by-step problem solving (unstructured, loosely structured tasks) (Scott, Leritz, Mumford, 2004; Abrami et al, 2015; Cremin, Chappell, 2019). Let's take a closer look at the steps in this process (Mumford et al, 1991; Scott, Lonergan, Mumford, 2005) and give examples for three possible types of unstructured or loosely structured household and learning tasks.

Table 1. Stages in problem solving for household and learning tasks.

Problem solving process stage	**Household task: renovate the apartment**	**Learning project: create a comic book about the consequences of a particular historical event**	**Educational research: identify the causes of the phenomena of the world around us**
Set the problem/task (a real multidimensional situation needs to be transformed into a more formalized task)	We feel the discrepancy between the desired environment of the home and the reality, from which follows the desire to renovate. We determine the areas where we want to renovate and the available budget.	We identify a historical event as a turning point and decide to examine what its consequences are.	We observe a phenomenon in the world around us (e.g., the water in a glass turned cloudy after standing for a day) and decide to investigate its causes.
Gather the necessary information (Gaps in the knowledge needed to solve the problem have to be eliminated)	We gather information about how renovations are done (we study possible costs, techniques, designs).	We are looking for as much information about this event as possible from a variety of sources.	We observe a given phenomenon in different situations: in different vessels, at different temperatures etc., and study reference materials.
Search and select key concepts/categories (main categories that will guide the solution need to be identified)	Based on the information obtained, we determine several ways to make renovations: hire a team, do it yourself, call your friends and so on, determine the scale of the renovation.	For the event in question, we find opinions in various sources about its near and distant consequences.	We structure the observation outcomes for the phenomenon: we describe the main observations and their differences.
Combine concepts/categories (analogies, intersections, common properties of the selected categories are to be highlighted)	We decide on the best renovation method by combining elements of different methods.	We look for commonalities and differences in different sources, making a list of the immediate and distant consequences of the event in question.	We summarize what specific characteristics of this phenomenon we could observe.
Generate ideas (different ideas need to be put forward)	Based on the chosen renovation method, we come up with several apartment designs.	We identify the main characters in a comic book about the consequences of a particular historical event and sketch out a few designs.	We come up with several hypotheses about the causes of this phenomenon.
Evaluate ideas (the previously proposed options need to be looked at in light of the real-world constraints)	We evaluate the designs we come up with, guided by our resource constraints.	We evaluate the designs we come up with, guided by peer opinion and our aesthetic views.	We evaluate the hypotheses we come up with in terms of their testability and choose one.
Plan the process to implement the idea/solution (implementation of the solution identified needs to be planned)	We make an estimate, plan the purchase of materials for the renovation, make arrangements with the workers.	We draw the final version of the comic book.	We plan a way to test the hypothesis by means of an experiment.
Monitor implementation (it is necessary to monitor how successfully the identified solution is being implemented)	We make renovations based on the design project and the plan of action made earlier. We adjust the plan as needed.	We present the comic book and collect feedback.	We test the hypothesis and describe the results.

To foster creativity (Cremin, Chappell, 2019), it is also possible to stimulate student initiatives and proactivity, to use play as an opportunity to act from unconventional roles and explore the situation, to encourage a willingness to make mistakes and learn from mistakes, and to create opportunities for collaborative action and communication. These characteristics exist, for example, in practices such as project-based learning, which is often seen as a form to solve non-routine problems (Bell, 2010; Seechaliao, 2017). Also important is the figure of the teacher as a role model — a teacher who enjoys the process of reflection, inquiry, discussion.

When studying the relationship between project-based learning and creativity, researchers often compare a group receiving only project-based learning and a group receiving some additional explicit creativity training with specific methods (Zhou, 2012; Wu, Wu, 2020). The creativity of the second group is found to be higher after the training. Thus, project-based learning in itself can foster creativity, but it is better enhanced by specific techniques to foster creativity that will help one or another stage of the project work.

An example of a specific approach is the SCAMPER (Substitute, Combine, Adapt, Modify, Put to other uses, Eliminate, Rearrange) technique, which helps to modify existing ideas through various questions. Here is one question for each of the elements that make up the SCAMPER anagram:

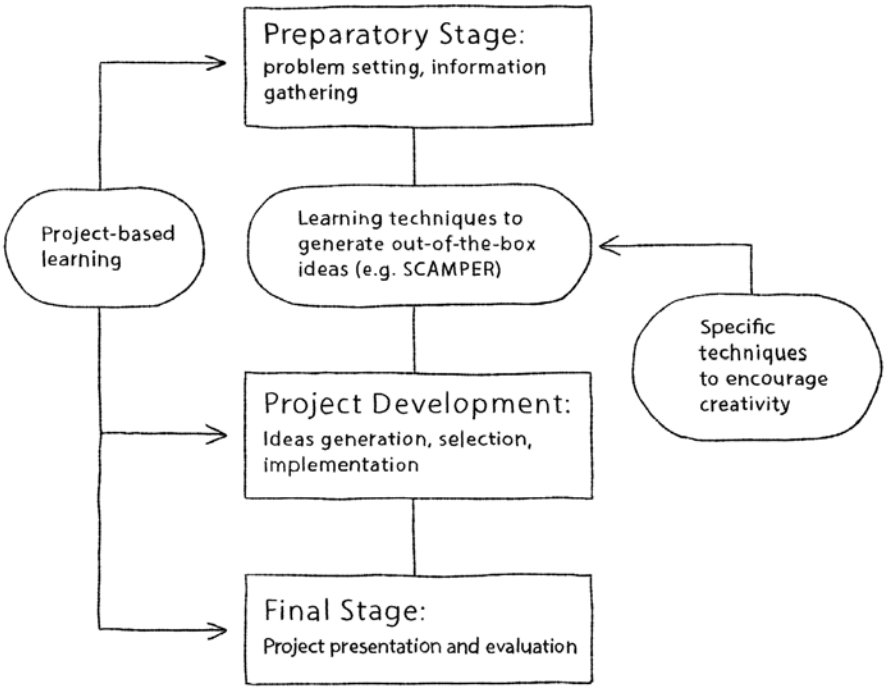
1) What can be used to substitute parts of this object?

2) Can the functions of this object and some other object be combined?

3) How might this object look in a different context?

4) How can this object be modified?

Figure 4. The combination of the general project-based learning principle and the specific SCAMPER method contributes to a more effective creativity formation.

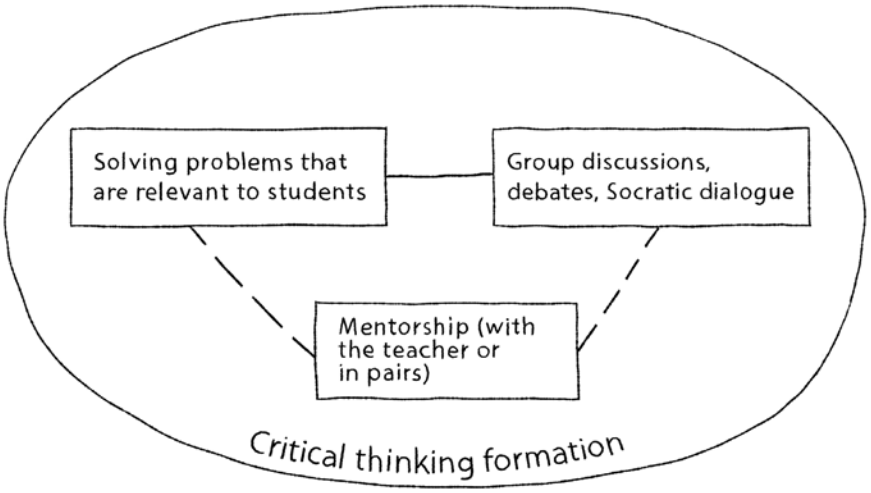


5) How can this object be used by someone else, such as a child?

6) What part can be eliminated from this object?

7) Can any components of the object be rearranged?

Figure 5. The most effective combination of practices for critical thinking formation.



Reviews describing the effectiveness of critical thinking practices suggest that the best way (Abrami et al, 2015) is to combine problem solving relevant to students (including hypothetical problems such as ethical dilemmas) and any practices that involve discussion (group work, debates, Socratic dialogue). The practice of mentoring also helps to further develop critical thinking - the students can observe, for example, the reasoning of a more experienced person. This practice is not very effective on its own, but it is productive when combined with problem solving and discussions.

Conclusion

We found out what is already known about the conditions and methods used to foster critical and creative thinking in education. But can schools teach thinking? Yes — provided that a certain learning environment is arranged and the teaching practices described above are fully implemented.

Further research under the project “Mechanisms and Factors of Key Skills and Competencies Development” related to the development of creative and critical thinking will address the implementation of effective practices, the impact of certain practices on different groups of students, combining subject matter knowledge and development of high-order thinking skills.

Reference

5. M. Dobryakova, I. Frumin. Changing world – changing education / Universal Competences and New Literacy: from Slogans to Reality /ed. By M. Dobryakova, I.Frumin; with K. Barannikov, N.Ziil, J.Moss, I.Remorenko, Y. Hautamäki; — M.: The Higher School of Economics Publishers, 2020. — C. 23-33.
6. Abrami, P. C., Bernard, R. M., Borokhovski, E., Wade, A., Surkes, M. A., Tamim, R., & Zhang, D. (2008). Instructional interventions affecting critical thinking skills and dispositions: A stage 1 meta-analysis. Review of Educational Research, 78(4), P. 1102–1134. https://doi.org/10.3102/0034654308326084
7. Abrami, Philip & Bernard, Robert & Borokhovski, Eugene & Waddington, David & Wade, C. Anne & Persson, Tonje. (2015). Strategies for Teaching Students to Think Critically: A Meta-Analysis. Review of Educational Research. 85. P. 275-314. 10.3102/0034654314551063.
8. Baer, J. (2010). Is creativity domain specific? In J. C. Kaufman & R. J. Sternberg (Eds.), The Cambridge handbook of creativity (pp. 321–341). Cambridge University Press. https://doi.org/10.1017/CBO9780511763205.021
9. Beaty R. E. et al. The roles of associative and executive processes in creative cognition // Memory & cognition. – 2014. – V. 42. – №. 7. – P. 1186-1197.
10. Bell Stephanie (2010) Project-Based Learning for the 21st Century: Skills for the Future, The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 83:2, P. 39-43, DOI: 10.1080/00098650903505415
11. Carson J. A problem with problem solving: Teaching thinking without teaching knowledge // The mathematics educator. – 2007. – V. 17. – №. 2.
12. Cheng M. H. M., Wan Z. H. Exploring the effects of classroom learning environment on critical thinking skills and disposition: A study of Hong Kong 12th graders in Liberal Studies //Thinking Skills and Creativity. – 2017. – V. 24. – P. 152-163.
13. Cowan N. Working memory underpins cognitive development, learning, and education // Educational psychology review. – 2014. – V. 26. – №. 2. – P. 197-223.
14. Cremin T., Chappell K. (2021) Creative pedagogies: a systematic review, Research Papers in Education, 36:3, P. 299-331, DOI: 10.1080/02671522.2019.1677757
15. Davies D. et al. Creative learning environments in education—A systematic literature review //Thinking skills and creativity. – 2013. – V. 8. – P. 80-91.
16. de Bruin, L. R., & Harris, A. (2017). Fostering Creative Ecologies in Australasian Secondary Schools. Australian Journal of Teacher Education, 42(9).
17. Ennis R. H. Critical thinking dispositions: Their nature and assessability //Informal logic. – 1996. – V. 18. – №. 2.
18. Ennis, R. H. (1989). Critical Thinking and Subject Specificity: Clarification and Needed Research. Educational Researcher, 18, P. 4-10.
19. Ennis, R.H. Critical Thinking Across the Curriculum: A Vision. Topoi 37, 165–184 (2018). https://doi.org/10.1007/s11245-016-9401-4
20. Facione P. Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction (The Delphi Report). – 1990.
21. Hadar, Linor & Tirosh, Mor. (2019). Creative Thinking in Mathematics Curriculum: An Analytic Framework. Thinking Skills and Creativity. 33. 100585. 10.1016/j.tsc.2019.100585.
22. Hitchcock D. Critical Thinking // Stanford Encyclopedia of Philosophy, 2018. URL: https://plato.stanford.edu/entries/critical-thinking/ (Дата обращения: 15.07.2021)

23. Kousoulas F. The interplay of creative behavior, divergent thinking, and knowledge base in students' creative expression during learning activity //Creativity Research Journal. – 2010. – V. 22. – №. 4. – P. 387-396
24. Lee C. S., Therriault D. J. The cognitive underpinnings of creative thought: A latent variable analysis exploring the roles of intelligence and working memory in three creative thinking processes //Intelligence. – 2013. – V. 41. – №. 5. – P. 306-320.
25. Lucas B., Claxton G., Spencer E. Progression in student creativity in school: First steps towards new forms of formative assessments. – 2013.
26. Mumford, M.D. & Mobley, M.I. & Uhlman, C.E. & Reiter-Palmon, Roni & Doares, L.M.. (1991). Process analytic models of creative capacities. Creativity Research Journal. 4. P. 91-122.
27. Scott, G. M., Lonergan, D. C., & Mumford, M. D. (2005). Conceptual combination: Alternative knowledge structures, alternative heuristics. Creativity Research Journal, 17(1), 79–98. https://doi.org/10.1207/s15326934crj1701_7
28. Scott, Ginamarie & Leritz, Lyle & Mumford, Michael. (2004). The Effectiveness of Creativity Training: A Quantitative Review. Creativity Research Journal. 16. P. 361-388. 10.1207/s15326934crj1604_1.
29. Seechaliao, Thapanee. (2017). Instructional Strategies to Support Creativity and Innovation in Education. Journal of Education and Learning. 6. P. 201. 10.5539/jel.v6n4p201.
30. Shehab H. M., Nussbaum E. M. Cognitive load of critical thinking strategies //Learning and Instruction. – 2015. – V. 35. – P. 51-61.
31. Sternberg R. J., Lubart T. I. The concept of creativity: Prospects and paradigms //Handbook of creativity. – 1999. – V. 1. – P. 3-15.
32. Vitulli P, Santoli S.P. (2013) Visual Arts and Social Studies: Powerful Partners in Promoting Critical Thinking Skills. Social Studies Research and Practice, 8(1), 117-144.
33. Wu Ting-Ting, Wu Yu-Tzu, Applying project-based learning and SCAMPER teaching strategies in engineering education to explore the influence of creativity on cognition, personal motivation, and personality traits, Thinking Skills and Creativity,Volume 35, 2020. https://doi.org/10.1016/j.tsc.2020.100631.
34. Zhou Chunfang (2012) Integrating creativity training into Problem and Project-Based Learning curriculum in engineering education, European Journal of Engineering Education, 37:5, 488-499, DOI: 10.1080/03043797.2012.714357.