ARPHA Proceedings

Proceedings IFTE-2021, 0531-0544
doi:10.3897/ap.5.e0531

VII International Forum on Teacher Education

Future teacher training for the formation creativity of students

Suriya I. Gilmanshina*(a), Rimma N. Sagitova (b), Iskander R. Gilmanshin (c), Victoria A. Minnakhmetova (d)

(a), (b), (c), (d) Kazan Federal University, 420008, Kazan (Russia), 18 Kremlyovskaya street, gilmanshina@yandex.ru
(c) Kazan National Research Technical University named after A. N. Tupolev-KAI, 420111, Kazan (Russia), 10 K.Marx street, is-er@yandex.ru

Abstract

The conducted research allows us to speak about the need to organize a system for the formation of creative thinking of students. At the same time, it is necessary to focus on the systematic conduct of a problem demonstration natural science experiment, the implementation of tasks in the PISA format, individual and group creative case studies, the use of mind maps in teaching, and regular extracurricular activities aimed at developing creativity on special natural science material. Organizational and pedagogical conditions for the preparation of future teachers for the formation creativity of students on the basis of natural science material are revealed. This is the inclusion of special topics in the practice of methodological disciplines; application and use of the possibilities of digital educational resources in the educational process of the university in order to form the creativity of students of teacher education; specially organized pedagogical practice with an emphasis on training future teachers in the formation of students' creativity. The analysis of the results of experimental activities showed a positive dynamics in the development of students' creativity in teaching chemistry during the period of teaching practice by students - future teachers. It was revealed that students of grades 8-9 of lyceums are able to generate useful ideas, to identify creative ways of solving educational research problems, to think out of the ordinary.

Keywords: science education, creativity, teacher training

Published by Kazan federal university and peer-reviewed under responsibility of IFTE-2021 (VII International Forum on Teacher Education)

* Corresponding author. E-mail: gilmanshina@yandex.ru

Introduction

For the innovative development of the country, technical, inventive, scientific and other types of creativeness that imply creativity are important. French scientists Lubart, Mushiru, Torjman, Zenasni (2009) define creativity as the property that most distinguishes a person from other living beings, which is the basis of human culture. It is no coincidence that from 2021, creativity of thinking will be considered as an indicator of education, according to the international monitoring of student achievement or the "PISA study". In addition, the development of creativity in teaching natural science disciplines is enshrined at the legislative level in the educational standards of the Russian Federation and other countries. An analysis of the works of domestic and foreign researchers (Azimov et al., 2016; Gilmanshin & Gilmanshina, 2017; Roberts, 2006) indicates the broad potential of national educational systems for the formation creativity of students. At the same time, the following learning technologies are distinguished: gaming, developing, project, technology of research activity and the development of critical thinking (Gilmanshina et al., 2018; Gilmanshina & Khalikova, 2016; Khalikova & Gilmanshina, 2017). There is no doubt that for this important pedagogical activity in a complex world, it is necessary to prepare future teachers in the process of studying at the university. At the same time, there are different concepts and approaches (Gafurov, Kalimullin, Valeeva, & Rushby, 2020; Kalimullin et al., 2020; Valeeva & Kalimullin, 2019) in the system of university teacher training.

Purpose and objectives of the study

Based on the above, the aim of the study is to develop and test pedagogical tools for the formation of students' creativity in teaching natural science disciplines in a complex world, as well as to identify the organizational and pedagogical conditions for training bachelors of pedagogical education in the chemistry profile of Kazan Federal University for the implementation of this process.

Literature review

Torrence, Maslow, Guilford considered creativity of thinking as a special creative ability (cited in Sternberg, 2000). We will adhere to this point of view in our research. In general, according to Sternberg (2000), creativity was studied for many years.

The development of creativity is still given a great deal of attention today. Higgins (2000) argues that the roots of creativity are to be found in general education. However, the national educational systems in many countries differ.

At the same time, innovative educational technologies focused on a creative approach, on the development of a person's creative potential are currently in demand in the educational process of any country.

According to Konowa's (2021) research, creativity strategy in education is actively being developed in the UK. Roberts (2006) writes that in Great Britain projects on formation of creative thinking of schoolchildren are successfully realized. There are projects aimed at cooperation and support of teachers in the development of creative potential of students ("Theatre Initiative", "CAPE UK"). According to Roberts (2006), creative education should be reflected in school curricula and teaching methods in order to increase students' motivation and personal qualities.

A number of European countries have productive experiences in developing creative abilities and forming a special educational environment that promotes a comfortable stay at school and the discovery of each student's individuality Konowa (2021). For example, the official website of the French school Ecole de Roches reports that it is based on the principles of creative pedagogy and creativity, and the curricula involve the creation of a sustainable creative environment and a balance in the teaching of humanities and science disciplines.

According to Bessarabova (2008), the USA has a different strategy for creative education than European countries. The emphasis here is on expanding the teaching of arts and humanities at all educational levels. Such subjects include languages, literature, ethics, art history and theory, philosophy, and visual and performing arts courses. The main goal of such creativity formation is the development of cultural competence, the ability to perceive someone else's and to create one's own work of art. There are many cultural layers in the USA, and the American educational system focuses on their equality and the formation of an individual with creative thinking, multicultural awareness, social and global vision (Bessarabova, 2008).

Research by Konowa (2021) has identified two approaches to creativity formation in Japan. The first approach is based on the North American scientific school of creativity aimed at stimulating inventive ability. The second approach focuses on traditional Japanese philosophy.

In general, all Japanese programs of creativity formation are implemented at the level of secondary (in university schools) and higher (including pedagogical) professional education. The topics of creativity programs are very diverse, ranging from the development of technical inventions to humanitarian research projects. Teacher training in Japanese universities includes special courses on the basics of theory and methodology of creative development (Tatsuno, 1990).

In addition, technology schools constantly organize creative courses and competitions for inventions in robotics, solar energy, computer programming (Konowa, 2021).

The development of creative abilities was given great attention in the Waldorf School, where the teaching material is aimed at activating the imagination and new ideas. Autonomous Waldorf schools exist in various parts of the world. According to the official website of the German Waldorf School Federation, the school day in a Waldorf school includes three types of practices. These are spiritual practice (development of productive thinking), soul practice (music, choreography) and creative practice (teaching creative technology).

In the European educational space on formation of creativity in recent years Finland is leading. The process of formation of creativity thinking steadily includes two types of activities - practical scientific and technical and research activities.

Students in Finnish schools do well in the disciplines of the science and mathematics cycle. As Deryabin (2003) writes, education in Finland is based on a powerful national idea - to preserve one's national identity, to survive, to constantly feel that education belongs to the "we" community. This idea unites Finns, makes them care about each other and their cultural traditions. The Finnish educational system also meets international standards for fostering creative thinking. Museum pedagogy programs have been developed and implemented to foster teachers' creativity, which serves as an indicator of cooperation between general education schools and museums in Finland (Deryabin, 2003).

The problem of forming creative thinking has not bypassed Russian pedagogy. Khutorskoy (2001) points out that in the second half of the twentieth century problem-based, heuristic, and developmental learning began to be used in Russian education. The programs of heuristic education found application in the "School of Free Development". Here students develop and defend innovative and creative projects in different subjects, participate in heuristic Olympiads, write publications, communicate with students from other educational institutions, and exchange experiences with them (Khutorskoy, 2001). Such modern technologies as problem-based, developmental, concentrated, differentiated learning, didactic games and critical thinking technologies contribute to the formation of Russian students' creativity.

According to Fedotova (2008), four developmental education programs (Elkonin-Davydov, Zankov, School-2000, and School-2100) are most common in modern Russia. In the Elkonin-Davydov program the main types of activity are play, learning, labor and communicative activities. The main goal of the Zankov program is the overall development of the child; instruction is built upon a combination of "a high level of difficulty" and "adherence to a measure of difficulty".

The School-2000 and School-2100 programs are based on a system-activity approach and are aimed at forming the ability to choose, plan, and execute what one wants; instruction is provided at different levels at an individual pace and is based on the principle of the development of creativity.

In addition to the above programs, numerous authors' schools are actively developing in Russian education (Yamburg, 2011; Lebidinzev & Sorokina, 2006 et al.).

In general, all national education systems in modern socio-economic conditions are more or less focused on the formation of students' creativity. This is also the aim of the international monitoring of educational achievements of students - PISA study, where in 2021 it is planned to introduce the assessment of creativity as a part of functional literacy (Avdeenko et al, 2019). Because, as noted in (Avdeenko et al, 2019), creative thinking is the basis for the emergence of new knowledge, innovative ideas, and the habit of thinking creatively increasingly affects the social and spiritual development, production development and serves as the most important source of personal development of the learner.

Methodology

The leading approaches to the study of the problem of training future teachers to form the creativity of students in a complex world are systemic-activity and competence approaches. The system-activity approach implies a systemic approach to learning and personality formation focuses attention on productive creative activity. The competence approach requires general cultural and professional preparation of the future teacher. The effectiveness of the competence approach in the study is characterized by a personal new formation (creative thinking). In general, for this study the system-activity and competence approaches are manifested in the development of technologies and organizational and pedagogical conditions of creating a situation of problem-solving and including students in practical creative activity.

Results

The study leads to the conclusion about the need to organize a system of formation of creativity thinking of students.

In the first stage of the study the technologies of creativity formation in the process of teaching science disciplines on the example of teaching chemistry were identified. The emphasis was placed on the technologies of the problematic demonstration chemical experiment, case studies, mind maps, performance of PISA-format exercises by students, creative extracurricular activities aimed at the development of creativity on special natural science material. Let us dwell in more detail on these technologies.

Problem demonstration chemical experiment is a very effective technology for the formation of students' creativity. It involves activation of the students' thinking activity when setting cognitive tasks. At the same time it should be visual, understandable and executed according to all the rules of safety. It is very important when carrying out a problematic chemical demonstration experiment to correctly designate the problem.

For example, when studying the amphoteric properties of aluminum hydroxide, you can use a problem experiment to allow students to discover this property themselves by answering the questions “Why did adding an excess of alkali dissolve the aluminum hydroxide precipitate, but not the calcium hydroxide? What properties does aluminum hydroxide have? Suggest at least two alternative experiments demonstrating the phenomenon of amphotericity”.

The next technology of forming creativity on the natural science material is case studies, which include composing and solving rebuses and crossword puzzles. For example, "Develop at least three rebuses on the subject: "Saturates. Alkanes".

The use of mind-map technology by teachers to form creativity is most justified in the generalization and systematization of complex educational material, in preparation for the Unified State Exam and the subject Olympiads. The founder of mind map technology is the English psychologist Tony Buzan (2018). This technology became widespread in Europe in the second half of the XX century. The purpose of creating mind maps is to develop associative thinking, to get a holistic picture of knowledge on a certain topic. The effectiveness of using mind maps is due to the fact that these maps work similarly to the human brain, which consists of a variety of neural outgrowths called dendrites (Sternberg, 2012). The authors of this publication have developed methodological recommendations for creating mind maps, which will help students - future teachers of chemistry to properly construct and systematize the material in mind maps in order to form the creativity of students.

The PISA exercises should be mentioned separately. Organizationally, this process requires the teacher to show methodological ability to make appropriate changes in didactic materials and additional time. We have developed didactic materials for the formation of creativity in the 8th grade on the material of school chemistry on such topics as "Transformation of substances. The role of chemistry in human life", "Acids", "Simple substances - metals".

Below are examples of some of the tasks:

A). Choose judgments that are appropriate for chemical and physical phenomena (separately). Get two words from the received letters. Time to complete the task is 5 minutes.

B). Match and form sentences using the logical connectives: "if", "that", "and that means". Encrypt each sentence with three digits (one digit from each column).

C). Make a cinquain on the topic "Simple Substances - Metals" according to the plan: in the first line one word (noun) is the topic; the second line is a description of the topic in two words (adjectives); the third line is a description of the action within the topic using three verbs; the fourth is a phrase of several words showing attitude towards the topic; the fifth is one synonym word expressing an emotional attitude towards the topic.

The second stage of the study revealed three organizational and pedagogical conditions for the preparation of future teachers to form the creativity of thinking students, the application of the above-mentioned technologies in the process of learning chemistry.

The first condition is the inclusion of special tasks for the formation of creativity in the practice of methodological disciplines (such as "Didactics of chemistry", "Theoretical foundations of chemical education"). We are talking about changing the content of practical lessons on the topics: "Development and education of students by means of the subject "chemistry", "Modern technologies in chemical education" in the course "Didactics of chemistry" of Bachelor's degree and "Theoretical concepts of general chemical education" in the course "Theoretical foundations of chemical education" of Master's degree. Students develop for the basic school the author's scientific and methodical materials on formation of creativity in accordance with the educational standard. They give not less than four examples of the implementation of the technology of formation of creativity of learner with the indication of the relevant topics, lessons, used educational-methodical complexes on chemistry.

The second condition - the application and use of digital educational resources in the educational process of the university in order to form the creativity of future teachers. The essence of this condition is explained on the example of the author's digital educational resource for undergraduate students "Theoretical foundations of chemical education". During the study of the discipline of the same name, students - future teachers perform individual creative tasks in the form of solving professional problems in a digital learning environment.

Here is an example of one version of the tasks.

Develop a lesson and an extracurricular activity in the 10th grade on a selected topic using problem-based learning and creativity formation technology in the conditions of digitalization; provide presentations to defence the developed lesson and extracurricular activity.

The author's digital educational resource "Didactics of Chemistry" was also developed to help undergraduate teachers. In order to test applied competencies, future teachers are offered to develop a group or individual practice-oriented project on creativity formation in the conditions of digitalization of the educational process, depending on the topic of practical classes. These are mini-project on teaching methods for solving computational chemical problems of different levels (topic 1); experimental mini-project for implementation at a chemistry lesson (topic 2); project on application of intelligence-card technologies and development of critical thinking in chemistry teaching (topic 3); project on development and application of video clips of real chemical experience and digital laboratories (topic 4). The implementation of these projects implies a creative approach to their development on the part of students - future teachers.

In general, the Didactics of Chemistry digital resource concludes with the completion of a multiple research project on chemistry education. The requirements and methodological guidelines for its implementation are presented in the "Final Assignment" section of the digital resource:

1. Develop a practice-oriented research project for students in grades 8-11 (optional).

1.1. Provide a reasonable list of equipment, reagents, and materials for the project.

2. In the developed project justify the implementation of the principles of practice-oriented, personality-oriented, problem-based learning, interdisciplinarity.

3. Specify how the regularities of chemical education (learning, education, development) are implemented in the developed project.

4. Specify how the project implements the formation of a scientific worldview, the formation of the foundations of chemical thinking and chemical-environmental culture.

5. Specify how the project implements innovative chemistry instruction.

6. Specify how the project integrates into a system of continuing chemical education.

7. Specify which of the methodological approaches of continuous chemical education are implemented in the developed project.

The third condition is specially organized pedagogical practice with a focus on teaching future teachers to form students' creativity. The pedagogical practice of the students of pedagogical direction of Kazan Federal University is continuous, starting from the 1st course, and takes place in the best gymnasiums, lyceums, and schools. In the first semester is an introductory practice, technological (design-technological) practice - in the 3rd semester, pedagogical practice to obtain professional skills and experience of professional activity - in the 6th semester, pedagogical practice - in the 6th and 7th semesters. Besides these practices in general educational institutions, students of pedagogical baccalaureate in chemistry have a number of design-technological and pedagogical practices on the basis of Kazan Federal University in 2, 4, 5, 7, 8 terms. These are the following project-technological practices: "Practicum on Chemical Demonstration Experiment", "Practicum on Methodology of USE Problem Solving in Inorganic Chemistry", "Practicum on Methodology of USE Problem Solving in Organic Chemistry", "Practicum on Methodology of Physical Colloid Chemistry", "Chemical Synthesis" and teaching practices: "Vocational guidance in Chemistry", "Additional Chemical Education".

All types of practices include tasks for creativity formation in the lessons and in extracurricular activities. Some assignments are aimed at the formation of students' creativity as future chemistry teachers, other assignments are focused on the formation of students' creativity in the real conditions of the complex world.

Discussion

An analysis of the psycho-pedagogical literature reveals significant research interest in the problem of shaping student creativity in school and university education (Trivić, Milanović & Šefer, 2018; Bang, Park, Song & Kang, 2011; Sakon & Petsangsri, 2021; Dwi Wiwik Ernawati, Damris, Asrial & Muhaimin, 2019; Hamid, 2017 and others).

However, the authors, pointing to the important role of creativity in professional activity, do not focus on the pedagogical conditions and different technologies of formation and development of creativity. Thus, Trivić, Milanović & Šefer, (2018) investigated students' creativity through solving open chemical problems. A corresponding achievement test was developed and implemented in 8th grades, where an indicator of creativity of thinking was the ability to formulate several acceptable answers to a given open chemistry problem. It is concluded that teaching chemistry contributes to the development of students' creativity in a rapidly changing world. However, there is no analysis of different technologies of creativity formation in chemistry education.

The development of creative thinking skills of college students in the field of natural sciences is addressed in (Bang, Park, Song & Kang, 2011), which emphasizes the development of problem recognition, hypothesis making, transformation, and interpretation of general chemistry experiment data. A study (Sakon & Petsangsri, 2021) examined creativity formation in computer design courses using STEAM Education in combination with the Guilford methodology. The conclusion is made about the importance of encouragement, exchange of ideas between students and their satisfaction from “thinking outside the box”. The development and application of an instrument to measure creative thinking of future chemistry teachers is addressed by (Dwi Wiwik Ernawati, Damris, Asrial & Muhaimin, 2019), which focuses on problem-based learning technology and measuring flexibility, originality, fluency, detail, sensitivity, and imagination of students. A focus on determining levels of critical and creative thinking is the work of (Hamid, 2017), which concludes from experimental data that creativity is related to cognitive abilities.

Thus, the analysis of scientific works devoted to the preparation of teachers to form creative thinking of adolescents on the natural science material is extremely scarce, and they are fragmentary and discursive in nature.

This article presents the theoretical justification and experimental verification of the developed organizational and pedagogical conditions of teachers' training for the formation of creative thinking of adolescents on natural science material in a complex world. Analysis of the results of experimental activities gave positive results. An indicator is an increase in the level of creativity of learners in the classes where students of the pedagogical bachelor's and master's degrees were practicing. The most successful was the activity of the students-practitioners as future teachers in the formation of creativity in specialized lyceums, such as lyceum № 131 (physics and mathematics profile), boarding lyceum № 7 (polylingual educational model with profiling in natural and mathematical and humanitarian subjects), IT lyceum (Physics and Mathematics, Chemical and Biology and Information Technology profiles) of Kazan. The students of these institutions of general education recorded positive dynamics of creativity in the process of learning chemistry. The level of creativity was determined in the process of observation of the creative activity of the student and by the Torrance creativity tests (Tunik, 1998) with the assessment of fluency, flexibility, originality of thinking (questionnaire to determine the level of creativity, diagnosis of the level of development of divergent thinking). The obtained result correlates with the results of Hamid's (2017) research on the dependence of creativity on cognitive abilities.

It was revealed that the students of 8-9 classes of the above-mentioned lyceums are able to generate useful ideas, to identify creative ways of solving educational and research problems, to think out of the box.

It is established, that display of creativity of thinking of students depends on their age, organizational and pedagogical conditions and professional and pedagogical activity of the teacher. The most popular for the formation of creativity in the process of chemistry learning were technologies of problem demonstration experiment, case-study, intellect maps, exercises in PISA format, creative extracurricular activities aimed at the development of creativity on special natural science material.

At the same time, it is necessary to note some conventionality of the results obtained due to the specifics of pedagogical science.

Conclusion

The study showed that the formation of creativity is one of the complex problems, which each country seeks to solve in its own way. In many countries of the world there are strategies and programs for the development of creativity in the process of school and university education. With the introduction of new educational standards, focused on system-activity and competence approaches, the problem of creativity formation has received a new impulse in the Russian system of education. Teachers play an important role in the formation of creativity in the younger generation.

The organizational and pedagogical conditions of teachers' training for the formation of students' creativity in a complex world on the example of chemical education were revealed. These are the inclusion of special tasks for creativity formation in the practice of methodological disciplines (such as "Didactics of chemistry", "Theoretical foundations of chemical education"); application and use of digital educational resources in the educational process of the university in order to form creativity of future teachers; specially organized teaching practice with an emphasis on teaching future teachers to form students' creativity.

Acknowledgements

This paper has been supported by the Kazan Federal University Strategic Academic Leadership Program.

References

Avdeenko, N. A., Demidova, M. Yu., Kovaleva, G. S., Loginova, O. B., Mikhailova, A.M., Yakovleva, S. G. (2019). The main approaches to the assessment of creative thinking in the project "Monitoring of the formation of functional literacy". *Domestic and Foreign Pedagogy, 4*(61), 124-145.

Azimov, Yu. I., Gilmanshin, I. R., Gilmanshina, S. I., et al. (2016). Modern technologies of waste utilization from industrial tire production. *In IOP Conf. Ser.: Mater. Sci. Eng. 134 (Jun. 2016) 012003 doi:10.1088/1757-899X/134/1/012003*.

Bang, D., Park, J., Song J., & Kang S. (2011). The development of teaching strategy for the enhancement of the creative problem solving thinking skills through general chemistry laboratory and the effects of its applications (I). *Journal of the Korean Chemical Society, 55*(2), 290-303.

Bessarabova, I. S. (2008). *The Current State and Trends in the Development of Multicultural Education in the United States.* Volgograd: VGPU.

Deryabin, Yu. S. (2003). Education, Science, and Innovation: The Finnish Miracle *Higher Education Today, 11,* 34-40.

Dwi Wiwik Ernawati, M., Damris, M., Asrial, & Muhaimin. (2019). Development of creative thinking skill instruments for chemistry student teachers in Indonesia. *International Journal of Online and Biomedical Engineering, 15*(14), 21-30. doi:10.3991/ijoe.v15i14.11354.

Fedotova, A. N. (2008). The development of the creative potential of the personality of a young student studying in the program "School 2100". *Elementary School Plus Before and After, 5,* 57-60.

Gafurov, I., Kalimullin, A., Valeeva, R., & Rushby, N. (Eds.). (2020). *Developing Teacher Competences: Key Issues and Values.* Nova. https://novapublishers.com /shop/developing-teacher-competences-key-issues-and-values/.

Gilmanshin, I. R., Gilmanshina, S. I. (2017). Competence formation of engineering directions students in the field of energy saving as a way to create new generation technologies. *In IOP Conf. Series: Materials Science and Engineering, 240 (Sep. 2017) 012022, doi:10.1088/1757-899X/240/1/012022.*

Gilmanshina, S. I., Gayfullina, A. Z., Gilmanshin, I. R. (2018). Formation of Environmental Culture In The Conditions of New Informational Environment (On The Example of Science Disciplines). *In 12th International Technology, Education and Development Conference (INTED) (Mar 2018). DOI: 10.21125/INTED.2018.0288.*

Gilmanshina, S. I., Khalikova, F. D. (2016). Teaching Gifted Adolescents in Terms of the Transforming Natural Sciences Education. *In IFTE - 2nd International Forum on Teacher Education. (Jul 2016). DOI: 10.15405/EPSBS.2016.07.9*

Hamid, A. (2017). Analysis of Students' Critical and Creative Thinking Style and Cognitive Ability on Chemistry. *Advances in Social Science Education and Humanities Research (SEADRIC 2017), 100,* 302-304.

Higgins, M. D. (2000). Drifting towards a homogenized future. *The AISLING Magazine*, 27.

Kalimullin et al. (2020). Post-Soviet Identity and Teacher Education: Past, Present, Future. *Education and Self-Development, 3*(15), 145-163. https://rep.bstu.by/xmlui/bitstream/handle/data/8283/145-163.pdf?sequence= 1&isAllowed=y.

Khalikova F. D., Gilmanshina S. I. (2017). Practical-oriented teaching of gifted youth in the field of natural sciences. *In IOP Conf. Series: Materials Science and Engineering, 240 (Sep. 2017) 012042. doi:10.1088/1757-899X/240/1/012042.*

Khutorskoy, A. V. (2001). How to teach creativity? Theory questions. *Additional education, 1,* 4-10.

Konowa, E. V. (2021). The Experience of Creative Personality Formation in Foreign Countries (Analytical Review). *Alma mater (Herald of Higher Education),* 4. DOI: https://almavest.ru/ru/node/1197.

Lebidinzev, V. B. & Sorokina, T. A. (2006). Multi-age organization of peer education plus immersion. *School technology, 3,* 72-77.

Lubart, T., Mushiru, K., Torjman S., Zenasni F. (2009). *The psychology of creativity*. Moscow: Cogito-Center.

Roberts, P. (2006). *Nurturing Creativity in Young People: A report to Government to inform future policy*. London: DCMS.

Sakon, T., & Petsangsri, S. (2021). STEAM Education for Enhancing Creativity in Packaging Design. *Archives of Design Research, 34*(1), 21-31. doi:10.15187/adr.2021.02.34.1.21

Sternberg, R. (2000). Creativity is a decision. *In A. L. Costa (Ed.), Teaching for intelligence II,* 85-89.

Sternberg, R. J. (2012). The assessment of creativity: An investment-based approach. *Creativity Research Journal, 24*(1), 3-12.

Tatsuno, Sh. (1990). *Created in Japan: From Imitators to World-Class Innovators*. Ballinger Pub Co.

Tony Buzan (2018). *Mind Map Mastery: The Complete Guide to Learning and Using the Most Powerful Thinking Tool in the Universe*. London: Watkins Publishing.

Trivić, D. D., Milanović V. D., & Šefer J. (2018). Students' achievements in the field of chemistry according to the indicators of creativity from the trefoil education paradigm. *Zbornik Instituta za Pedagoska Istrazivanja, 50*(1), 50-71.

Tunik, E. E. (1998). *Test E. Torrens. Creativity Diagnosis* St. Petersburg: Imaton.

Valeeva, R. & Kalimullin, A. (2019). Teacher education in Russia. *In Oxford Research Encyclopedia of Education.* Oxford University Press. DOI: http://dx.doi.org/10.1093/acrefore/9780190264093.013.446.

Yamburg, E. A. (2011). *School and its surroundings*. Moscow: Rudomino Book Center.