

Developing Technical Creativity in Future Engineering Educators

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Abstract: The dynamics of scientific and technological progress incorporates new content into the goals and objectives of special education in training specialists as creative and thinking individuals. As a result, it leads to specific problems that must be solved immediately. There is a need to rethink theoretical and psychoeducational foundations and accumulated practical experience of higher education institutions. The research aims to prove theoretically and to verify the effectiveness of pedagogical conditions for developing technical creativity in future engineering educators experimentally. The pedagogical conditions for developing technical creativity in future engineering educators are as follows: creating appropriate content and nature of teachers' activities; providing a creative environment for developing technical creativity. It must be noted that 261 students were involved in the experiment (a bachelor's degree): the control group (CG) consists of 134 students and the experimental group (EG) – of 127 students. Relevant control tests and questionnaires were employed during the experimental stage, which allowed assessing the effectiveness of the proposed activities. According to the results of the calculations, the statistics of the criterion is $T_{obs} > T_{crit}$ ($14.94 > 11.34$). Thus, with a probability of 0.99, one can argue that the level of technical creativity in EG students differs from the level in CG. Indeed, the high level is 29.92% G and the average level in 53.54%. At the same time, the high and average levels of CG students are 16.42% and 47.76% respectively. The analysis of experimental work shows the expediency of the justified and verified pedagogical conditions for developing the technical creativity in future engineering educators.

Keywords: *pedagogical conditions; problem approach; problem elements; search for creative solutions; creation of appropriate content; specialized course.*

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Introduction

The educational activity of the present needs a careful and precise fulfilment of social order related to the development of a socially adapted, competitive teacher who has professional mobility, seeks to improve himself or herself, knows several modern pedagogical technologies aimed at boosting creative activity and developing his or her abilities. Adequate training of young people for creative activity in the vital society in the continuum for existence and development is one of the objectives of the Ukrainian system of pedagogical and scientific workers' training. It is also necessary to focus on overcoming the difficulties that arise during its organization, even in such institutions where the appropriate material base was established. However, it needs to be improved, which is predetermined by modernization and innovative changes in education in general.

S. Koroteiev (2000) finds the primary methodological conditions for developing technical creativity in teacher students (differentiating the educational process relative to students oriented to the organization of technical creativity; selecting based on the holistic study of personality and taking into account individual orientation of students towards organizing activities in the field of technical creativity; organizing creative potential by specially selected methods).

N. Malinnikova (2000), studying the development of creative skills in future teacher in the process of study, has developed and implemented the system of seminary classes devoted to the development of creative skills in the process of study, which allow preparing future teachers for this activity, as well as the system of seminar classes for teachers from comprehensive schools. It can contribute to the systematization and correction of their knowledge and skills on the problem of developing creative skills.

L. Veretennikova (1997) proposes the system for developing creative skills in future teachers that implements with the help of solving general medical tasks based on the active and conscious use of theoretical, methodological, methodical, practical knowledge and skills in the field of pedagogy and psychology of creativity, developmental technologies.

The researchers mentioned above have identified the necessary components which are essential for preparing future engineering educators to organize the technical creativity of students in vocational schools. Today, it is essential to develop and implement state standards of vocational education in professions of broad qualifications, improve the system of training future engineering educators and, in particular, change the content and methods of such training. It is also vital to retrain and provide advanced

training to engineering educators so that they can develop the technical creativity of students at specialized vocational schools. At the same time, theorists and practitioners pay little attention to the conditions for developing professional qualities future specialists need to organize the technical creativity of students at vocational schools.

The relevance of this research is to reconcile the contradictions between the requirements of society for the level of technical creativity in young people and the current conditions for organizing appropriate professional training of students in the system of vocational schools; the need for vocational education teachers with a high level of technical creativity and a well-established, traditional content of professional training of engineering educators; the existing innovative technologies for developing technical creativity and the outdated methodology for it in the system of higher and vocational education.

The analysis of the current state for developing creative skills in future engineering educators shows that the system of professional training for future engineering educators does not pay enough attention to the development of technical creativity. Accordingly, the level of training is not high enough. Having critically worked out psychoeducational sources, the authors have formulated the research hypothesis, that is, the process of developing technical creativity in future engineering educators can be useful if: to prove pedagogical conditions oriented towards improving competences in future engineering educators; to increase their level of general training based on improving the content (introducing the course 'Developing Technical Creativity') and using traditional and innovative methods of study, which model the creative aspect of students' activities in higher pedagogical institutions (task approach, generalization and comparison, questionnaires, diagnostic testing, self-evaluation, demonstration, stimulation, pedagogical observation, brainstorming, problem situations, the project method).

Material and methods

The pedagogical experiment was conducted in the context of the real educational process of technical and pedagogical faculties of higher pedagogical educational institutions: Taras Shevchenko Chernihiv National Pedagogical University, Olexandr Dovzhenko Hluhiv National Pedagogical University, Hryhorii Skovoroda Pereiaslav-Khmelnitskyi State Pedagogical University, Pavlo Tychyna Uman State Pedagogical, National University of Biological Resources and Environmental Management of Ukraine.

It must be noted that *261 students were* involved in the experiment at the level of undergraduate education (a bachelor's degree): the control group (CG) consists of 134 students and the experimental group (EG) – of 127 students. Special attention was paid to the fact that CG and EG students were in identical conditions, namely, the same age, brought up in a similar environment. Also, the amount of material collected was monitored to be sufficient for subsequent statistical processing.

The diagnostic tools were improved to verify the effectiveness of developing technical creativity in future engineering educators. They include the following: components (motivational, cognitive, practical and active, evaluative and reflexive), criteria, indicators and levels (high, average, sufficient and low) for developing technical creativity in future engineering educators.

Relevant control tests and questionnaires were employed during the experimental stage, that allowed assessing the effectiveness of the proposed activities. If necessary, some changes were made to improve the technical creativity of future engineering educators.

The authors have used the statistical method of determining the criterion χ^2 (the chi-square test) to analyze the obtained results after the completion of the formative stage of the pedagogical experiment and verify the hypothesis of the equal probability of students being at low, sufficient, average and high levels for specific indicators in CG and EG.

Pedagogical conditions for developing technical creativity in future engineering educators were determined based on the analysis of pedagogical research and literature (Aleksyuk, Aiurzanain & Pidkasystyi, 1993; Babanskyi, 1989; Gerasymova, *et al.*, 2019), the authors' experience and practice of organizing creative development of students.

The first pedagogical condition implies creating appropriate content and nature of university teachers' activities, which will contribute to developing creative skills future engineering educators. It provides for the successful application of certain organization forms of educational activities and training methods. Teachers, when interacting (directly or indirectly) with students on or off pairs (in free communication, play, work, art) should have a real opportunity to organize the educational processes in the context of personality-oriented education. At the same time, they do not create particular forms of work and do not take into account the integrity of educational activities. A real teacher does not play a role but performs educational functions. He or she exists in the sphere of spiritual relations with pupils and realizes teacher' position in the unity of consciousness and activity.

The development of creative skills in future engineering educators takes place under the influence of the content and nature of university

teachers' activities, that is, the central aspect in educating and developing the student's personality becomes the creative and professional cooperation between teachers and students.

The second pedagogical condition means providing a creative environment for developing technical creativity in future engineering educators (introducing task approach, problem elements, methods of finding creative solutions). This condition contains prognostically effective forms and methods of organizing the development of personality in future engineering educators. It is characterized by skills to create necessary external conditions and innovative environment for developing technical creativity in students.

The task approach is aimed at developing the function, which allows improving future engineering educators' ability to skilfully apply new scientific approaches and concepts in the technical sphere, to predict results of theoretical knowledge application, implement them in practice (in the production sphere) and improve their professional qualities. All this is achieved by the set and solved technically creative tasks of various direction and thinking load.

The introduction of *problem elements* is realized by creating the problem situation of technically creative nature, which causes intellectual complication for future engineering educators, due to inability to explain the phenomenon, fact or process that occurs, inability to achieve the aim in known ways. Students will be prompted to search for new ways of explaining or acting in this situation. The solution of the set tasks by students takes place under the conditions of the problem situation of different complexity created by a teacher, which can be unleashed only during analyzing the situation problem, putting forward proposals, hypotheses, proving and verifying the correctness of the proposed solutions.

The introduction of *methods for searching creative solutions* is achieved by studying already existing technically creative proposals in this sphere (scientific, production) to introduce new, creative ideas, ways of implementing already known projects and make new inventions. It is implemented based on the independent creative search activities (developing cognitive interests and abilities, technical erudition, involvement, innovation and invention activities) of future engineering educators.

The third pedagogical condition suggests introducing the course "Developing Technical Creativity". The course material is designed for students of technical faculties of higher educational institutions, who study under the branch "Professional Education". The programme of the course is designed for 30 hours, including 10 hours for lectures, 10 hours for

practical classes and 10 hours for independent work of students, preparation and defence of practical works.

The following *topics of lectures* were chosen for developing technical creativity: “Developing technical creativity as a sociopedagogic problem”; “Psychoeducational foundations of technical creativity”; “Methodological basis for planning technical creativity in the educational system”; “Material and technical basis for developing technical creativity”; “Methodology of technical creativity development. Innovative technologies in technical creativity”. The topics of practical works are also selected as follows: solving technical contradictions; field analysis for the substance; ideal result; basic concepts of system analysis; development of creative imagination.

The authors intend to characterize *the topic* “Developing technical creativity as a socio-medical problem”. The issues such as the essence and concept of technical creativity, peculiarities of technical creativity, solving creative problems as the basis of technical activity, which allows understanding the importance for developing technical creativity in society, are revealed below. The authors suggest different interpretations of technical creativity, taking into account pedagogical and psychological points of view. They note that technical creativity needs additional knowledge about technology, and creative activity contributes to developing a turning attitude to the surrounding reality. Within this topic, 2 hours and 1 hour respectively are allocated for independent work of students.

Results

The indicators of developing technical creativity in CG and EG students were determined for the proposed tests and questionnaires at the completion stage of students’ training within the limits of modular control, examinations and comprehensive state certification (see Table 1, Figure 1).

Table 1. Determining the criterion statistics χ^2 (the chi-square test) based on the distribution of students by the level of technical creativity after the experiment

Sample	Category 1 (a low level)		Category 2 (a sufficient level)		Category 3 (an average level)		Category 4 (a high level)		Sample number n_i	Statistical criteria T_{obs}
	Quantity	%	Quantity	%	Quantity	%	Quantity	%		
CG	21	15.67	27	20.15	64	47.76	22	16.42	134	14.94
EG	8	6.30	13	10.24	68	53.54	38	29.92	127	

Using χ^2 (the chi-square test) criterion, one can test the hypothesis of equal probability of the development of technical creativity in students at low, sufficient, average and high levels for specific indicators in CG and EG.

By the results of calculations, the statistical criteria are $T_{obs.} > T_{crit.}$ ($14,94 > 11,34$). Thus, with a probability of 0.99, one can argue that the level of technical creativity in EG students differs from that in CG. Indeed, the high and average levels in EG are 29.92% and 53.54% respectively. At the same time, the high and average levels in CG are 16.42% and 47.76% respectively. The number of CG students with a low level is 15.67%, the number of EG students at a low level – only 6.30%.

The number of students with interest in the future profession at a low level is also indicative: there was 15.67% in CG and only 6.30% in EG.

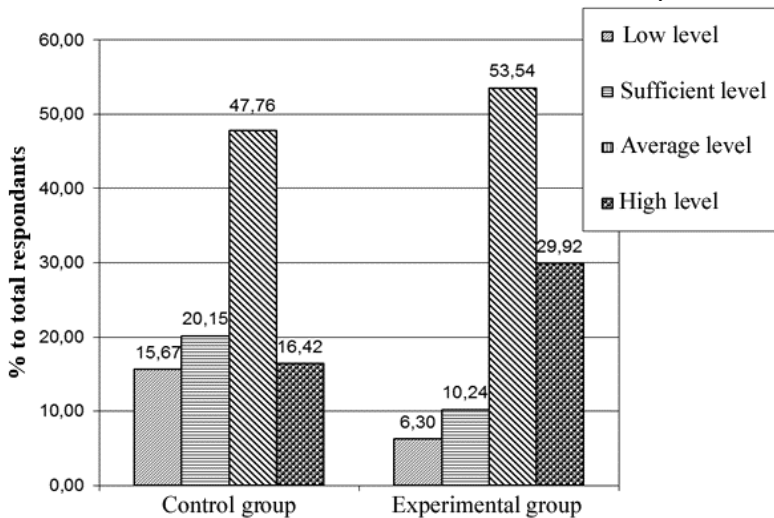


Fig. 1. Data on the development of technical creativity in future engineering educators in CG and EG after the experiment

Quite indicative is the increase in the number of students with a high level of technical creativity. Thus, it is 8.21% in CG and 22.05% in EG.

The difference us 5.78% with an average level for the students' benefit in EG.

Discussion

Summarizing the existing points of view and taking the research by R. May (2001) as a basis, the authors believe that scholars only conditionally highlight two opposite life positions of the individual, namely, an attitude towards life as already towards the set task (by society, traditions) and an

attitude to life as a creative task. Therefore, the life journey can become a creative act for a person's self-realization only under certain conditions.

In general, the definition of creative skills is reduced to identifying them with mental skills (Lerner, 1989; Matyushkin, 1993). Thus, creative skills are individual features, humane qualities, which determine the success of the creative activity of various kinds. In turn, creative activity is an activity that arises or creates new in different plans and scales, both materially fixed and materially loose. Agreeing with O. Holovachova (2008), the authors note that only individuals with creative skills can perform creative work successfully.

A. Andrianov, A. Halahuzova, & P. Katkova (1986) reveal the unity of the creative process of children and adults and *prove* that creativity regardless of age, has a single psychological basis. In particular, the authors have *confirmed* that the creative task remains so as long as the way of solving it is unknown regardless of who decides it, namely, a scholar or a student. The stages of the creative process and the activity of children's activity are similar relevant moments of adult work. Everything said above *allows the authors to approach* the essence of the researched phenomenon due to age.

Most often, the process of intuition is not fixed at all. Scientists and inventors repeatedly note that the most responsible stages of activity are intuitive, uncontrolled by consciousness and will (Simonov, 1992). *Experimental studies show* that an intuitive solution arises in subject-matter activities available to objective analysis. For one, 182 surveyed researchers out of 232 reported that the solution to the scientific problem came suddenly, not as a result of a transparent, logical chain of reasoning.

A. Luriya (2006), studying issues of the emergence of mental processes during the diachronic test, agrees with the statement of predecessors that "the basis of mental activity needs to be looked for in dense substance of the brain, in particular, in its cortex". The scholar, leaning on the research of L. Vihotskyi (1991), offers the theory of system dynamic localization of the highest mental functions. According to it, physiology of mental functions is the functional folding system, whose activity is concentrated in the person's brain. So, to carry out scientific knowledge of the creative act, it is necessary to learn mental processes which happen in the person's brain more in details. Scholars note that the most mysterious among various functions of the person's brain is its ability to create, that is to produce virtually new knowledge, different from that which had the previous generations at the order. In a brain activity, relying on S. Freud's prediction (1990), today they allocate both realized and extramental. Consciousness usually speaks as specific knowledge of the person about the

environment, in particular about him or her that can be transmitted through words and symbols to other people. Events which are perceived by people as conscious are processed by the language system of the brain differently. People understand thought as the reality issued by language signs (Maksymchuk *et al.*, 2018). As for the unconscious activity of a person's brain, it is worth *agreeing with observations* which were noted by P. Simonov (1992) about the allocation of at least three groups of the phenomena: 1. Irresponsibility – biological needs of the person for water, food, also reproduction, that is so-called unconditioned reflexes (Pavlov, 1951). According to S. Freud's theory (1990), this group of the phenomena is related to the concept "it". 2. Subconsciousness is realized or that which can become such under certain conditions. These are the acquired skills, social norms which are genuinely acquired by the person which turned into beliefs that are functionally regulated as experience, "the call of the heart". The most characteristic feature of subconsciousness considers conservatism which causes innateness illusion of some of its manifestations. P. Simonov (1992) convinces that to some extent, it is possible to speak about absence in the subconscious creative beginning. 3. "Superconsciousness is unconscious recombination of earlier accumulated experience. It wakes up and goes the prepotent need for search of means of its satisfaction. Unsensibleness of these initial stages of any creativity is the protection of hypotheses and plans against the conservatism of consciousness, against the excessive pressure of evidence of direct observations, against the dogmatism of strong acquired norms".

Thus, the mechanisms of superconsciousness attract the beginning of brain activity. At the same time, consciousness stores functions of the problem advancing and formulation, there is a repeated selection of the hypotheses generated by superconsciousness. It is necessary to remember that inopportunately to perceive superconsciousness as especially accidental recombination of traces kept in memory. The activity of superconsciousness is caused as follows: earlier accumulated practical experience; the task which is put forward by consciousness at superconsciousness; essential requirement.

Relying on relevant scientific research (Babanskyi, 1989; Goldin, 1979; Diachenko, 1989; Ilyinskaya, 1985; Bakhmat *et al.*, 2019; Bezliudnyi *et al.*, 2019; Melnyk *et al.*, 2019; Sheremet *et al.*, 2019), *allocated study methods, significant for this work*, the full application is found problem-search near traditional, in particular by search methods of new technical solutions (Bychkov, 1990). Today there is not accurate, descriptive characteristic of complex intersubject problem tasks which are, undoubtedly, effective latest

means of study which speed up work and stimulate towards creative search in pedagogy. Therefore, *the authors consider* it necessary to offer the specified and complemented interpretation of this concept. *Complex intersubject problem tasks* are the type of creative task based on the interrelation of subjects and directed to complete perception with the following assimilation of objects or phenomena of the material world.

It is essential that the choice of innovative technologies which takes root would be evidence-based for this educational institution. *The authors agree* with V. Khymynets (2009) that the choice has to lean on such components of the educational process as the purpose which is set by the educational institution; a professional level of teachers and masters who will introduce this innovation; an innovative legal process. The climate in a collective where the innovation and motivation to such activity of all participants take root depends on this component.

This research *confirms* that the study of individualization at the same time provides the differentiation of training material, the system of creative tasks of different complexity and volume. The solution to these tasks in many respects depends on the contents and techniques of future engineering educators' training.

Conclusions

The paper determines, theoretically justifies and experimentally verifies pedagogical conditions for training future engineering educators to develop the technical creativity in students at vocational schools. They are as follows: creating appropriate content and nature of university teachers' activities, which will facilitate the development of creative skills in future engineering educators; providing a creative environment for developing technical creativity in future engineering educators; systematizing and synthesizing the main components of preparing future engineering educators to develop technical creativity in students. The paper also determines the criteria and indicators of readiness of future engineering educators to develop the technical creativity in students at vocational schools (motivational component – the level of cognitive motives in the process of studying professional disciplines, moral personal qualities; cognitive component – the level of knowledge about professional disciplines, as well as the ability to use it in practice; practical and active – the level of training for conducting creative activities; evaluative and reflexive – the level of future engineering educators' training to identify and analyze their creative products). The conducted research has made it possible to improve the

content of professional training for future engineering educators (the implemented author's course "Developing the Technical Creativity in Students at Vocational Schools"); the methods of training future engineering educators for developing the technical creativity in students at vocational schools based on the use of creative tasks, problem-based tasks, creative solutions.

The analysis of results obtained from experimental work confirms the expediency of the proved and approved pedagogical conditions for developing technical creativity in future engineering educators. A particular increase in the manifestation extent of self-assessment and introspection of one's activity and professional consciousness are observed in most students. Besides, the level of self-education, self-development, adequacy in the assessment of one's creative potential as a future expert has increased in EG students.

This research also proves the efficiency of pedagogical conditions of future experts' training on certain indicators for developing technical creativity in future engineering educators, before the beginning of the experiment and after it, based on the criterion χ^2 (the chi-square test). The experimental check $T_{obs.} > T_{crit.}$ ($14,94 > 11,34$) confirms some positive dynamics of creating an indicator for developing technical creativity in future experts which certifies a positive impact of certain pedagogical conditions and the author's technique.

The practical value of the obtained results lies in the development and implementation of the author's course "**Developing the Technical Creativity in Students at Vocational Schools**" in the educational process. This course aims to develop key cognitive and practical components of training future engineering educators for developing the technical creativity in students at vocational schools. The paper suggests methodical recommendations for experimental verification of the effectiveness of pedagogical conditions and means for developing technical creativity, focused on improving professional skills in future engineering educators based on the identification of development levels of creative experience (student-centred, algorithmic, heuristic and creative).

The obtained scientific results allow offering practical recommendations at such levels: *legislative* (developing and deploying state standards of education in professions of broad qualifications; updating and approving the optimum list of professions in the training of skilled workers); *organizational and methodical* (upgrading a syllabus of bachelors and masters' professional education by optimizing the list of disciplines and improving their contents which will provide the greatest potential opportunities for

developing technical creativity in future engineering educators); *organizational and administrative* (a network optimization of professional educational institutions of different types, professional directions and forms of ownership, taking into account demographic forecasts, regional specifics and requirements of the labour market; creating industrial practice complexes; improving the mechanism of forming the state order for training of personnel according to real requirements of economy, regional labour markets, inquiries of society); *methodical* (developing and introducing programmes in professional training of engineering educators in the educational process based on the assimilation of the experience accumulated by representatives of psychology and pedagogical education, new technologies of study connected with the optimization, application of forms (lectures, seminars, practical classes, laboratory works, laboratory practical work, club work, independent and individual work, research activities, educational and pedagogical practitioners, remote study, trips to production), methods (task approach, generalization and comparison, questioning, estimation, demonstration, stimulation, pedagogical observation, brainstorming, problem situations, the project method) and means (the course “Developing technical creativity”, educational websites, electronic databases, electronic libraries, computer training programmes, electronic encyclopedias, books, textbooks, dictionaries, electronic practical work, Internet resources); *practical* (introducing the monitoring of future engineering educators’ technical works for the purpose of control and correction of professional qualities, personal characteristics, motivators and abilities during the study of special disciplines; developing the programmes of professional development for scientifically pedagogical staff of higher education institutions according to theoretic and methodical provisions of the dissertation research).

Research material and guidelines can be used in professional training of future engineering educators, in the teaching of specialized disciplines, research activities of students, postgraduate students, as well as in the system of advanced teacher training.

References

- Aleksyuk, A. M., Aiurzanain, A. A., & Pidkasystyi, P. I. (1993). *Organizing students’ independent work under the conditions of intensification study*. Ukraine, Kyiv: ISDO.
- Andrianov, P., Halahuzova, M., & Katkova, L. (1990). *Developing technical creativity in junior school pupils*. Russia, Moscow: Education.

- Babanskyi, Y. K. (1989). *Selected pedagogical works*. Russia, Moscow: Pedagogy.
- Bakhmat, N., Maksymchuk, B., Voloshyna, O., Kuzmenko, V., Matviichuk, T., Kovalchuk, A. ... Maksymchuk, I. (2019). Designing cloud-oriented university environment in teacher training of future physical education teachers. *Journal of Physical Education and Sport*, 19(4):1323–1332.
- Bezliudnyi, O., Kravchenko, O., Maksymchuk, B., Mishchenko, M., & Maksymchuk, I. (2019). Psycho-correction of burnout syndrome in sports educators. *Journal of Physical Education and Sport*, 19(3): 1585–1590.
- Bychkov, A. V. (1990). *Foundations of inventive culture*. Russia, Moscow: Moscow worker.
- Diachenko, V. K. (1989). *The organizational structure of the educational process and its development*. Russia, Moscow: Pedagogy.
- Freud, S. (1990). *Psychology of unconscious*. Russia, Moscow: Education.
- Gerasymova, I., Maksymchuk, B., Bilozero,va, M., Chernetska, Yu., Matviichuk, T., Solovyov, V., & Maksymchuk, I. (2019). Forming professional mobility in future agricultural specialists: the sociohistorical context. *Revista Romaneasca pentru Educatie Multidimensionala*, 11(4Sup1): 345-361.
doi:<http://dx.doi.org/10.18662/rrem/195>
- Goldin, I. I. (1979). *Problem training in vocational and technical schools*. Russia, Moscow: Higher Education.
- Holovachova, O. (2008). Developing creative skills in pupils of technical training colleges of sewing profile in the course of studying “art modelling of clothes”. *Master*, 5: 94–96.
- Ilyinskaya, I. A. (1985). *Problem situations and ways of their creation during a lesson*. Russia, Moscow: Knowledge.
- Khymynets, V. V. (2009). *Innovation educational activity*. Ukraine, Ternopil: Mandrivets.
- Koroteiev, S. G. (2000). *Developing professional qualities of a technical creativity organizer in students from pedagogical universities*. (PhD thesis). Armavir State Pedagogical Institute, Armavir.

- Lerner, P. S. (1989). *Training for prospective production*. Russia, Moscow: High Education.
- Luriya, A. R. (2006). *Lectures on general psychology*. Russia, Saint-Petersburg: Peter.
- Maksymchuk, I., Maksymchuk, B., Frytsiuk, V., Matviichuk, T., Demchenko, I., Babii, I. ... Savchuk, I. (2018). Developing pedagogical mastery of future physical education teachers in higher education institutions. *Journal of Physical Education and Sport*, 18(2): 810–815. DOI:10.7752/jpes.2018.02119
- Malinnikova, N. A. (2000). *Future teacher training for the development of creative abilities at pupils in the course of training*. (PhD thesis). I. G. Petrovsky Bryansk State Pedagogical University, Bryansk.
- Matyushkin, O. M. (1993). *Riddles endowments: problems of practical diagnostics*. Russia, Moscow: School Press.
- May, R. (2001). *Courage is to create*. Russia, Moscow: Initiative.
- Melnyk, N., Bidyuk, N., Kalenskyi, A., Maksymchuk, B., Bakhmat, N., Matviienko, O. ... Maksymchuk, I. (2019). Models and organizational characteristics of preschool teachers' professional training in some EU countries and Ukraine. *Zbornik of the Institute for Pedagogi*, 51(1):46–93.
- Pavlov, I. P. (1951). *Selected Works*. Russia, Moscow: Academy of Pedagogical Sciences of RSFSR.
- Sheremet, M., Leniv, Z., Loboda, V., & Maksymchuk, B. (2019). The development level of smart information criterion for specialists' readiness for inclusion implementation in education. *Information Technologies and Learning Tools*, 72: 273–285.
- Simonov, P. V. (1992). Brain and creativity. *Issues of Philosophy*, 1: 3–24.
- Veretennikova, L. K. (1997). *Future teacher training for the formation of creative potential at pupils*. (PhD thesis). Udmurt State University, Kazan.
- Vihotskyi, L. S. (1991). *Imagination and creativity in childhood: a psychological essay*. Russia, Moscow: Education.