DEVELOPING CREATIVE THINKING IN COMPUTER SCIENCE TEACHERS IN THE PROFESSIONAL DEVELOPMENT PROCESS

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Abstract

Educational institutions around the world have trained teachers using a system of creative competencies that allows them to quickly adapt to changing trends in the labor market in an information environment. The Vision for International Education 2030, adopted by UNESCO, identifies “creating opportunities for quality education throughout life” as an urgent task. In the national and international educational environment, the world's leading universities place an emphasis on developing an active, critical and creative approach to the development of information technology in students, the formation of creative competence. This article was written with the aim of identifying the didactic possibilities for the development of creative thinking of teachers of informatics in the process of professional development. The following research objectives are determined: identification of pedagogical and psychological characteristics of the development of creative thinking of teachers of informatics in the process of professional development; substantiate the connection between the development of creative thinking and creative competence; improving the model of information resources of informatics teachers; identification of new organizational forms for the development of creative thinking of informatics teachers in the process
of professional development. Forms, methods and means of application are determined, conclusions on this problem are also developed.

**Keywords:** curiosity, creative competence, informatics teachers, advanced training system.

**Introduction**

In the process of professional development in the world, a number of scientific studies are carried out to improve the pedagogical mechanisms for the development of the creative thinking of informatics teachers, the development of technologies for the development of the creative potential of informatics teachers. In the process of advanced training, it is important to work out effective forms for the development of teachers' creative thinking, organize an environment for creative activity, and identify didactic opportunities to prepare for effective joint activities. Incheon Declaration, also UNESCO Information for All! will focus on informatization of teacher education. Modern science requires the formation of innovative thinking among teachers, the creation of a creative learning environment, the development of skills in building the educational process, considering the requirements of STEAM education.

Constant renewal in the country requires the expansion of professional knowledge, skills and abilities of teachers, increasing the necessary professional training to ensure the quality of education in accordance with modern requirements, the use of modern information and communication technologies in their pedagogical activities, the formation of personal and professional information space, scientific and pedagogical creativity. Particular attention is paid to the integration of knowledge into the methodology and main directions of development of science and the field of pedagogy. This process highlighted the need for research to enhance teachers' creativity, information, educational creativity and life integration. The Resolution "On the Concept for the Development of the Public Education System of the Republic of Uzbekistan until 2030" identifies such priorities as "updating the content and methods of teaching in advanced training and retraining courses, revising the assessment system." This requires an analysis of the state of creativity of existing educational technologies, the development of creative competence based on foreign experience, the
improvement of technologies for the development of creative abilities by expanding the pedagogical capabilities of informatics.

**Methods**

In the study, in accordance with its goals and objectives, observation methods, questionnaires, tests, pedagogical and psychological research methods, modeling, comparison, mathematical and statistical analysis and experimental methods were used.

**Methodology**

Purpose of the research: to identify the didactic possibilities for the development of creative thinking of informatics teachers in the process of professional development. Research objectives:

- identification of pedagogical and psychological characteristics of the development of creative thinking of teachers of informatics in the process of professional development;
- substantiate the connection between the development of creative thinking and creative competence;
- improving the model of information resources of informatics teachers;
- identification of new organizational forms for the development of creative thinking of informatics teachers in the process of professional development.

The object of the research was the process of developing the creative thinking of teachers of informatics at advanced training courses, in which 304 teachers of informatics from regional centers for retraining and advanced training of national education workers of Samarkand, Fergana and Namangan regions took part.

The subject of the research is the development of the content, form, methods and means of developing the creative thinking of informatics teachers in the process of professional development.

Scientific novelty of the research:

- the pedagogical and psychological characteristics of the development of creative thinking of teachers of informatics in the process of professional development are determined on the basis of ensuring compatibility with (dialect, originality, flexibility of thought, acuity of memory, speed of thinking, variety of ideas) scientific and
pedagogical creativity of the conceptual structure, consisting of methodological, social, technological, psychological, pedagogical and methodological training;

• reveals the connection between the development of creative thinking and creative competence on the basis of an empirical assessment of the sustainability of the creative environment associated with joint educational and developmental activities of subjects, in order to search for various options for solving new types of professional situations;

• the organizational component of the model of information resources of informatics teachers has been improved by expanding the database on textbooks, organizational work, extracurricular activities by improving experience and academic performance, modifying and systematizing the knowledge gained;

• new organizational forms of the development of creative thinking of teachers of informatics in the process of advanced training on the use of artificial intelligence, precedent, “falsification”, information resources, “reification”, associative methods, teaching through teleconferencing, effective use of computer modeling in educational practice.

The practical results of the study are reflected in the following:

• Criteria and indicators for the development of creative thinking of informatics teachers in the process of professional development were developed;

• components of creative competence and development assessment indicators were developed;

• didactic support for the development of creative thinking of informatics teachers in the process of professional development;

• systematized innovative forms, methods and means of developing creative thinking of teachers of informatics in the process of professional development.

Theory

Theoretical foundations for the development of teachers' creative thinking in the process of professional development.

In the context of the COVID-19 pandemic, the system of advanced training of teaching staff is characterized by a clear variable structure that allows for the implementation of individual strategies for the formation and development of a
pedagogical personality directly related to educational practice. Among the important tools for improving the process of continuous self-development of trainees-andragog-teachers in advanced training courses, the following can be distinguished:

1) analyze and discuss topical issues of pedagogy in the learning process, work in groups and find ways to solve them together;

2) pay special attention to a competent and creative approach when planning the educational process;

3) considering the personal and professional experience of students in the learning process, ensuring their subjectivity in the process of learning activities;

4) Accelerate the interaction of teachers and students.

Taking these aspects into account, professional knowledge and skills are necessary to ensure the educational process in the country at a high scientific and methodological level in accordance with qualification requirements, to promote the continuous development of professional and pedagogical skills in the field of advanced pedagogical and information technologies, as well as interactive teaching methods. ... Regular updates, acquaintance with new principles and modern methods of organizing the educational process, qualification requirements, regulatory documents - the main goal of retraining and advanced training courses for teachers.

In addition, the current regulations define a number of objectives for teacher development courses, including "the methodology of scientific and pedagogical creativity and knowledge acquisition in key areas of pedagogical science and development."

As a result of research on domestic and foreign psychological and pedagogical disciplines, theoretical and practical materials have been collected that are of great importance for the formation and development of teachers' creative thinking. These include the mental, theoretical and practical aspects of the problem of mental development, as well as the determination of human cognitive abilities (M.G.Davletshin [3.], R.I.Sunnatova [21], B.Kh.Khodzhaev [22], S.L.Rubinstein [14], N.A.Menchinskaya [10], D.B.Bogoyavlenskaya [2, 10], D.B.Elkonin [7], V.V.Davydov [4], L.V.Zankov [23]); study of the structure of creative thinking

Based on the content analysis of research areas related to the creative process, it is concluded that thinking is a separate type of activity that directly or indirectly reflects the results of the material-subject orientation of a person. In fact, thinking about materially objective activity requires evidence associated with that activity. From this point of view, the concept of activity is applicable only to man, and creativity also belongs to him.

Our research was based on the idea of the possibility of creativity and the ability to develop creative thinking. One of the principles for the development of creative thinking of teachers of informatics is a special formation of algorithmic, heuristic methods of mental activity in the learning process.

On the basis of the analysis of the manifestations of the manifestation of creative thinking in the course of the study, its specific features were identified, associated with the following general abilities: quick and easy assimilation of knowledge, their further improvement. That is, in the listener, these qualities are manifested as success in educational activities, quick and easy assimilation of new knowledge, expansion of the volume of knowledge, that is, the general ability to read.

Based on the analysis of psychological and pedagogical literature, the following features of creative thinking were identified: dialecticality, criticality, the ability to evaluate actions, originality, flexibility of thinking, the ability to easily draw general conclusions, readiness and acuity of memory, quick thinking, connections between existing and new knowledge. ability to make connections, variety of ideas, observation, richness of imagination and so on.

An important aspect of thinking that distinguishes it from other mental processes is its orientation toward acquiring new knowledge. In this regard, the independent
assimilation of new knowledge by the audience determines the level of development of creative thinking (of course, in the presence of other necessary conditions).

The development of creative thinking is associated with the creation of new models of educational activity, which allow increasing creativity and forming a creative personality. Therefore, the organization of the educational process on the basis of computer technology and the creation of information resources in the development of creative thinking of teachers of computer science in the process of professional development also guarantees the expected result.

The effectiveness of the on-the-job learning process is largely determined by its dynamism and flexibility, as well as its relevance to the real challenges that arise in connection with the requirements for schools today. The system of advanced training for informatics teachers is directly related not only to the development of pedagogical knowledge and skills, but also to the acquisition of methods of creative thinking, which is important not only for special, but also for professional and pedagogical training of teachers.

In our opinion, the development of the creative thinking of informatics teachers as an integral part of advanced training courses reflects the conceptual structure of methodological, social, technological, psychological, pedagogical and methodological training.

It should be noted that in the process of professional development, creative competence serves as the basis for the development of creative thinking of a computer science teacher. However, in most cases, creativity is not defined in normative documents as a basic competence. In fact, pedagogical activity takes place in the context of many non-standard, new situations. If creative competence is not defined as a foundation in basic education programs, then it should be introduced at the later stages of continuing education from educational level to developmental level. So:

1. Pedagogical creativity is not just a luxury, it is a modern educational requirement that does not allow a teacher to provide the necessary conditions for the preparation of a competitive, successful graduate without any education, that is, from preschool to higher education.
2. The presence of creative competence in the structure of the teacher's professional activity is an indicator of the teacher's own success.

3. Professional development programs for teachers should include modules aimed at the formation and development of creative competencies.

The use of a creative approach in practice allows the teacher to quickly and effectively achieve the set goal, to form not only a specific subject, but also interdisciplinary results, as well as enjoy cooperation with students. Consequently, the formation of creative competence in the process of professional development serves the development of professional creativity.

Pedagogical conditions reflect certain aspects that determine the achievement of a high level of formation of the teacher's creative competence. The conducted theoretical analysis made it possible to determine the following necessary pedagogical conditions for the development of a teacher's creative competence through continuous professional development:

1) the development of the teacher's creative abilities in the process of professional development is considered as a system-forming component of personal and professional development and involves the teacher in the process of active independent learning;

2) Methods and technologies used to develop the creative abilities of a teacher in the process of professional development, provide a systematic organization of the creative environment associated with joint educational and developmental activities of subjects, in order to discuss new types of professional situations and search for various solutions.

Thus, the teacher's creative competence is to come up with completely new unusual ideas, solve problems arising in the process of pedagogical activity, prepare for an individually differentiated approach, create different motivations for each student using different approaches and methods. the ability to master various pedagogical technologies, clearly set goals, in an understandable and acceptable way for students. Thus, creative competence is a combination of skills to find non-standard solutions to pedagogical problems in the formation of creative abilities in teachers.
Electronic pedagogical conditions for the development of creative thinking of informatics teachers in the process of professional development.

The results of the study allowed us to put forward a hypothesis that the acquisition of computer modeling skills from teachers of informatics in the process of professional development can have an effective impact on the development of their creative and pedagogical thinking.

Computer modeling technology is one of the main methods of scientific and practical knowledge of the environment, the development of which has a complex effect on the development of the professional and personal qualities of a computer science teacher through the acquisition of the following skills:

- formulation of the problem;
- forecasting research results;
- identification of primary and secondary factors for model development, performing a comprehensive assessment; identification of analogs and mathematical formulas;
- selection of compatible software;
- search for solutions to problems using computer programs;
- objective performance of computer experiments and comprehensive in-depth analysis.

Thus, the technology of computer modeling is reflected in education as a systematic method of creating, researching and using computer models. Thus, two main didactic features of computer modeling are clearly demonstrated:

1. The computer model is aimed at solving creative problems, and in the process of finding a solution, the computer serves as a necessary tool for conducting research and computational experiments, testing and determining evidence and hypotheses.

2. Possessing all the features of educational models and reflecting the source of information, the educational computer module acts as a computerized object of activity.

Therefore, computer modeling can be interpreted as an exploratory approach to learning, that is, the listener chooses a personal strategy of behavior based on personal
experience, tries to explain what happens as a result of his actions, and draws conclusions about the significance of the results. This ensures that learning takes place within an active creative framework where their creativity is demonstrated. Computer modeling technology reflects an activity strategy that combines modeling of a computer science teacher with modeling activities in the field of computer science.

The pedagogical activity of a teacher largely depends on the quality of the information used. Currently, the method of obtaining high quality information is widely used. Information processing is the process of communicating information useful to the teacher. The main task of information quality management is to provide the teacher with the necessary information. In the technical literature, usability and usefulness have been adopted as standard definitions as the main criteria for ensuring high quality information. These criteria are based on 15 descriptive aspects of information: accuracy, objectivity, reliability, accuracy, comprehensibility, security, relevance, added value, frequency, completeness, volume integrity, analytical basis, ease of understanding, generalization, data reliability.

These descriptive aspects are also the main problems that informatics teachers face when creating their own personal information resource. These problems include:

- lack of automated tools for analyzing the collected information;
- errors in the process of subjective assessment of information;
- the accuracy of the information is questioned by the use of multiple sources in obtaining any information;
- storage of a large amount of information complicates timely access to it;
- limited access to information in global networks due to lack of hardware resources and facilities.

As a solution to these problems, we can offer:

- use of a powerful graphical user interface;
- availability of an information environment for updating information systems;
- regular analysis of databases and information systems;
- modernization of education, which allows the teacher to provide a large amount of information resources for use in teaching.
A teacher’s information resource is a body of knowledge and information used by a teacher in pedagogical activities. That is, it is the semantic information that is stored and presented in modern devices for transmitting information that is necessary for teaching and educating students, providing knowledge in an understandable form. The most important aspect of a teacher's understanding of an information resource is that he has a clear form of the available knowledge necessary for his or her professional career. Knowledge is a reflection in the consciousness of a person of this or that aspect of an objective being, expressed in the form of ideas, concepts, ideas about a specific thing-event. However, there is another type - intuitive knowledge that arises in the mind, requiring a concept, that is, semantic expression. Knowledge is a living dialectical system that is transmitted by a teacher to a student, materializes and has three forms: "living" knowledge (classification), materialized knowledge and information (message).

A teacher's information resource is an intellectual resource, a factor of collective creativity. Let's look at the specifics of the teacher's information resource.

The first feature is that, unlike other types of resources (including material ones), the teacher's information resource has a rich characteristic; The development of society and the growing need for teacher knowledge do not eliminate the teacher's knowledge base, but rather expand it by improving experience and activities, modifying and systematizing the knowledge gained.

The second feature is that the teacher's information resource itself cannot exist independently and there may be no demand for it. Only in combination with other resources - experience, labor, skills, computer equipment, energy, its information resource becomes a necessary component of professional activity.

The third feature: the effectiveness of the teacher's use of an information resource is associated with the reproducibility of knowledge. Mutual exchange of information between the teacher and students allowed students to acquire new knowledge at a lower cost compared to salary, energy, time to master, and skills.

The fourth feature: the teacher's information resource reflects the integration of science with the educational process. In an informed society, science affects all spheres
of social development and directly reflects the productive force. In this society, the description of the movement of the teacher's information resource changes: the teacher's efficiency increases several times. There will be a transition to educational telecommunication systems that serve as information hypertext, knowledge bases and teachers' data.

The fifth feature is that the teacher's information resource arises as a result of not only his mental work, but also his creative activity. The usual component of mental work is associated with independent work on information: it does not reduce the possibility of obtaining harmful knowledge from the listener, does not change the idea of achieving the goal. Any mental work consists of two parts: normal and creative. An increase in mental labor on a conditional structural basis does not lead to an increase in the teacher's information resource. However, it takes time and a certain methodology to create, improve and use a teacher's information resource.

The sixth feature: the transformation of the teacher's information resource into knowledge depends on their coding, presentation and transmission. The communication system is an important factor in the formation, collection and use of the teacher's information resource based on the existing knowledge base.

Seventh specificity: the forms of presentation of the teacher's information resource can be different, but in modern conditions, each teacher must constantly improve and replenish his personal information resource and transmit it on the basis of modern interactive software.

The quality of the educational process, the effectiveness of achieving learning outcomes largely determines the implementation of a student-centered learning process, planning individual programs and educational routes for students. An educator with innovative potential helps to design and implement an individual learning pathway tailored to the individual needs of students. The problem of individualization of the educational process and its adaptation to the educational needs, interests and abilities of students can be effectively solved with the help of information and communication technologies in the educational process.

Based on this, we can say that for the effective use of innovative organizational
forms that allow to achieve new educational results, informatics teachers should be able to use these forms of learning based on a creative approach. The modern computer science teacher should be the organizer of individual and group counseling through creative thinking, including email consultations, educational forums, trainings, computer tests, teacher and student collaboration to support individual educational paths. must have the skills to achieve. Thus, individual training of students cannot be established without the use of modern forms of education by informatics teachers based on ICT tools.

The thesis describes the didactic possibilities of new forms of education:
Telecommunication projects are an improved version of the project method in the context of the globalization of information and telecommunications, and the project method itself is well known in world pedagogy. The pedagogical function of an educational project is to organize the activities of students to find solutions to specific educational problems that require a certain set of knowledge, skills and competencies. Another important function is to increase the cognitive activity of students in the implementation of an educational project, as well as the formation and development of skills in organizing students' independent activity.

Networking is a way of organizing student activities to share innovative, informational, teaching and learning resources provided by different computer science teachers. These resources can change during the interaction. Common ways to collaborate online include: www, ftp, email, blog, newsgroup, chat. These services are widely used in the implementation of interaction in the network, etc. They require small telecommunication resources. The activity of a computer science teacher in a network team is, first of all, in the formation of interest in the studied subject, the development of students' creative thinking, and creative teamwork.

Major technology learners take advantage of the global network and modern information and communication technologies to conduct teleconferencing, scientific advice, and educational and scientific information for computer science students and teachers. Undoubtedly, the success of this form of education lies in the fact that it allows students to quickly manage their activities. The case method allows computer
science teachers and students to develop independent creative thinking, the ability to listen and consider alternative points of view, the ability to present evidence of their opinion, and form a positive motivation for reading.

Information technology methods based on the use of artificial intelligence; precedent method; “Falsification” method; information resource method; Reification method; associative method; teleconferencing training; It has been found that educational computer modeling can be effectively applied in educational practice.

In the course of the study, the forms of organization of education from the point of view of the orientation of informatics teachers to achieve the intended results in school were classified as follows:

• meta-subject based on educational and universal actions (communicative, directive, cognitive, etc.);

• subject (information and methods of its presentation, the basics of algorithmic culture, the use of software systems and services, work in the information environment).

**Results**

In 2016-2019, experimental work was carried out to determine the effectiveness of didactic conditions for the development of creative thinking of informatics teachers in the process of professional development. The multifunctional description of the problem under study had many factors to test the hypotheses and the proposed conditions for the development of creative thinking of informatics teachers. The experimental work involved 304 participants of advanced training courses in informatics of regional centers for retraining and advanced training of people's education workers in Syrdarya, Fergana and Namangan regions.

The criteria for assessing the effectiveness of the development of creative thinking of teachers of informatics in the process of professional development were the following:

1) the richness and systematic description of the knowledge base in the field of computer science and information technology. This criterion is associated with the fact that new ways of knowing arise as a result of active thinking; the level of awareness of the activity itself, the presence of certain skills and abilities, as well as the level of
development of skills for performing creative tasks, reflecting the achievement of positive dynamics based on the use of computer modeling, the emergence of new ways of organizing training; informatics depends on the mastery of operations and methods of mental activity, which are reflected in the teacher's ability to consciously create and use information resources;

2) the level of development of skills in solving creative problems, reflecting the positive dynamics of the use of computer modeling;

3) the degree of proficiency in operations and methods of mental activity, which are reflected in the ability of a computer science teacher to consciously create and use information resources.

In the process of advanced training, the following levels of assessment of the level of development of creative thinking of teachers of informatics were determined: basic, research, high.

The innovative stage of experimental work was carried out in two stages: research and refinement. At the research stage of the pilot work, the current state, needs and prospects for the development of modules in the curriculum of advanced training courses for teachers of informatics and information technologies in secondary schools were identified; The existing curricula and teaching materials were analyzed, directions for the development of professional training and creative competencies of informatics teachers were determined.

In the process of formative experiments, the modules "Computer Modeling", "Innovative Forms of Teaching Computer Science and IT", "Organization of Collective Creative Work in Computer Science" were introduced as optional subjects for teachers of informatics. In the process of computer modeling, innovative forms of teaching, pedagogical software and information resources for teachers were developed to develop students' creative thinking.

During the study, we supervised graduates of the advanced training course on the following topics: "Computer modeling of situations", "Computer modeling of social tasks", "Electronic portfolio of a computer science teacher", "Computer modeling of economic problems", "Teaching computer science and IT". innovative
forms "and so on. Also developed a methodological manual "Requirements for the implementation of the diploma work of teachers of computer science."

In the process of advanced training, informatics teachers have reached a high level of development of creative thinking through in-depth study of the basics of computer modulation and the creation of information resources by teachers in accordance with new forms of education.

Also, in the process of advanced training in specially organized experimental groups, the competitive module "Innovative forms of teaching computer science and IT" was taught in accordance with the requirements of creative education.

The results showed that the effectiveness of the use of innovative forms of education in teaching computer science and computer science by the students of the experimental group was on average 48% higher than in the control group. This was confirmed using the Mann-Whitney U test.

The results of mathematical and statistical analysis showed that the effectiveness of the work of teachers of informatics of the experimental group is not accidental, the effectiveness of specially organized didactic conditions.

**Conclusion**

Based on the results of a study of the development of creative thinking of teachers of informatics in the process of advanced training, the following conclusions were made:

1. The system of advanced training for teachers in modern conditions has a clear variable structure that allows you to implement individual strategies for advanced training of teachers, characterized by the presence of popular and alternative forms. The following were identified as tools for the development of creative thinking of teachers of informatics in refresher courses:

   • analysis and discussion of topical issues of electronic pedagogy in the learning process, search for their solutions in cooperation;

   • pay special attention to a competent and creative approach when planning the educational process; to consider the personal and professional experience of students in the learning process, to achieve full disclosure of their subjectivity in the process of
learning.

2. Based on the content analysis of research areas related to the creative process, it is concluded that thinking is a separate type of activity that directly or indirectly reflects the results of the material-subject orientation of a person. The research is based on the idea of the possibility of creativity and the ability to develop creative thinking. The main principle of the development of creative thinking of teachers of informatics was the special formation of algorithmic, heuristic methods of mental activity in the learning process.

3. Based on the analysis of psychological and pedagogical literature, the following main features of creative thinking were identified: dialecticism, criticality, the ability to evaluate actions, originality, flexibility of thinking, the ability to easily draw general conclusions, the readiness and acuity of memory, the speed of thinking, connections between existing and new knowledge, ability to interact, variety of ideas, observation, richness of imagination and much more.

4. The system of advanced training for informatics teachers is directly related not only to the development of special, but also pedagogical knowledge and skills that are important for the professional and pedagogical training of teachers, mastering the method of creative thinking. The conceptual structure of the development of creative thinking of teachers of informatics, consisting of methodological, social, technological, psychological, pedagogical and methodological training, is revealed.

5. In the process of professional development, creative competence serves as the basis for the development of creative thinking of a computer science teacher. The creative competence of a teacher is to invent completely new unusual ideas, to solve problems arising in the process of pedagogical activity, to be ready to implement an individually-stratified approach, to create a unique motivation for each student using different approaches and methods, the ability to master various pedagogical technologies, to present them in an understandable and acceptable form for students.

6. Based on the results of the study, a hypothesis was put forward that the acquisition of computer modeling skills from teachers of informatics in the course of professional development can have an effective impact on the development of their
creative and pedagogical thinking. Computer modeling can be interpreted as an exploratory approach to learning, i.e. the listener chooses a personal strategy of behavior based on personal experience, tries to explain what is happening as a result of his actions, draws conclusions about the significance of the results.

7. Information resource of a teacher - a set of knowledge and information used by a teacher in pedagogical activities. That is, it is the semantic information that is stored and presented in modern devices for transmitting information that is necessary for teaching and educating students, providing knowledge in an understandable form. As part of the study, the model of the teacher's information resources was improved.

8. In order to effectively use innovative organizational forms that allow achieving new educational results, informatics teachers must have the ability to use these forms of learning in a creative way. The modern computer science teacher must be the organizer of individual and group counseling through creative thinking, must have skills to achieve including email consultations, educational forums, trainings, computer tests, teacher and student collaboration to support individual educational paths.

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