

SCIENTIFIC AND THEORETICAL FOUNDATIONS OF IMPROVING THE QUALITY OF PEDAGOGICAL EDUCATION BASED ON THE ANTIFRAGILE APPROACH

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Annotation

This article examines the scientific and theoretical foundations of improving the quality of pedagogical education based on the antifragile approach. In the modern education system, globalization, digital transformation, the development of artificial intelligence technologies, and the complexity of social processes are setting new tasks for pedagogical education. In such circumstances, it is important not only to equip future teachers with professional knowledge and skills, but also to form them as specialists who can effectively operate in uncertain, changing, and complex pedagogical situations.

Keywords

antifragility, antifragile approach, pedagogical education quality, future teacher, professional competence, pedagogical innovation, reflection, creativity

Introduction

In traditional pedagogical approaches, the quality of education is often assessed by the level of knowledge acquisition, the formation of professional skills, and the achievement of established standards. However, in modern conditions, the concept of the quality of education has expanded even further, and is also determined by the teacher's ability to operate in conditions of uncertainty, problem-solving competence, creative thinking, and readiness for innovative activities. In this regard, the development of new methodological approaches to improving the quality of pedagogical education is one of the important scientific tasks.

The concept of antifragility is of particular scientific importance in solving this problem. The concept of antifragility was introduced by N. N. Developed by Taleb, it refers to the fact that systems can develop and improve, rather than weaken, as a result of disorder, stress, random changes, and external influences [1. p. 45.]. This concept is based on the idea of creating new opportunities from complex situations, as opposed to the simple concepts of stability or flexibility.

The antifragile approach in pedagogical education allows future teachers to prepare for the challenges of professional activity, direct them to creative solutions

to pedagogical problems, and form mechanisms for continuous self-development. Because the activities of a modern teacher constantly require mastering new educational technologies, adapting to various socio-psychological situations, and taking into account individual educational needs.

The issue of improving the quality of pedagogical education is also considered a priority at the international level. In particular, international studies emphasize that the quality of education is not only related to learning outcomes, but also to the professional competence of teachers, their readiness for innovative activities, and their ability to adapt to changes [3. p. 28.]. Therefore, there is a need to move from the traditional knowledge transfer model to a developmental, reflective, and competency-based model in the process of teacher training.

Today, pedagogical education pays special attention to the development of creativity, critical thinking, digital competencies, communication skills, and research activities. However, the issue of forming these competencies on a single methodological basis and preparing teachers to work effectively in complex and uncertain conditions has not yet been sufficiently studied. It is the antifragile approach that emerges as one of the promising theoretical foundations for solving this problem.

Review of thematic literature

The issue of improving the quality of modern pedagogical education is one of the current research areas of educational philosophy, pedagogy, psychology, and management sciences. The rapid changes in educational systems in the 21st century, the widespread introduction of digital technologies, the complexity of social processes, and the new requirements for professional activities require a rethinking of the process of teacher training. Therefore, modern scientific literature pays special attention to flexible, innovative and developmental approaches to improving the quality of pedagogical education.

One of the new concepts in this area is the theory of antifragility. The concept of antifragility was introduced by N. N. Developed by Taleb, it means that systems not only maintain their stability in the face of uncertainty, random changes, and external influences, but also develop by exploiting these influences. According to the scientist, while traditional stability (resilience) is aimed at maintaining the existing state, antifragility represents a development mechanism that takes the system to a qualitatively new level [1. pp. 45–52.]. Although this theory was originally applied in economics, finance, and complex systems analysis, in recent years it has also begun to gain methodological significance in the fields of education and pedagogy.

The issues of improving the quality of pedagogical education have also been widely studied by international organizations. The concept of Education and Skills 2030, developed by OECD, defines the development of competencies for students to solve complex problems, think independently, cooperate and adapt to changing conditions as the main tasks of future education [3. 18–25-b.]. This approach is consistent with the core principles of the antifragile pedagogue model, which emphasizes the need to develop the pedagogue as a lifelong learner, one who draws conclusions from experience and is ready for innovative activities.

Research on the development of pedagogical competencies also interprets teacher professional development as a continuous process. A modern teacher is considered not only as a person who conveys scientific knowledge, but also as a specialist who designs the educational process, manages the individual development of students, and uses innovative technologies. In this regard, the antifragile approach strengthens the teacher's reflective activity, ability to learn from professional experience, and ability to turn problem situations into opportunities for development.

Cognitive and constructivist learning theories are also important in understanding the scientific basis of the antifragile pedagogical approach. J. According to Piaget's constructivist theory, knowledge is not accepted in the finished form, but is formed through the active experience of the individual. The reader or educator reorganizes their existing knowledge when faced with new situations and forms new cognitive structures [4. 34–41-b.]. This process is directly related to the principle of "development through difficulty" in the concept of antifragility.

L. S. The cultural-historical theory of Vygotsky is also an important methodological basis in improving the quality of pedagogical education. The scientist emphasized the development of human thinking in the process of social activity and communication. Through the concept of the "zone of proximal development," he argued that complex pedagogical tasks expand the intellectual capabilities of the individual [2. pp. 79–86.]. This idea is consistent with the antifragile approach and allows us to explain the professional and personal development of a teacher through complex situations.

Research on metacognitive development also plays an important role in improving the quality of pedagogical education. J. According to Flavell's theory of metacognition, a person learns more effectively by understanding, controlling, and managing their thinking processes [5. pp. 29–35.]. Developing metacognitive competencies in future teachers expands their ability to analyze their own professional activities, evaluate pedagogical decisions, and develop new strategies.

Therefore, reflection and self-assessment are considered key components in the antifragile pedagogical model.

Research on critical thinking and creativity has also contributed significantly to the development of the antifragile education concept. D. Halpern defines critical thinking as the ability to analyze data, evaluate evidence, and make informed decisions [6. pp. 56–64.]. Such competencies are especially important in the work of a teacher, as a teacher is required to make quick and effective decisions in various pedagogical situations.

In the context of digital transformation, issues of improving the quality of pedagogical education are being studied in close connection with artificial intelligence and new technologies. UNESCO studies highlight the potential of artificial intelligence technologies in education, along with the need to develop new competencies for educators [8. pp. 22–31.]. This approach helps prepare educators for technological changes, effectively use digital tools, and improve the quality of education.

The development of artificial intelligence and digital learning tools is also changing the content of pedagogical activities. Researchers note that, in addition to technological literacy, a modern teacher needs competencies in critical thinking, information assessment, and innovative activities [7. pp. 96–105.]. This is in line with the main idea of the antifragile approach - to use change as a tool for development, not to be afraid of it.

Therefore, this study considers the antifragile approach as a methodological basis for improving the quality of pedagogical education and aims to identify its main principles, structural components, and practical possibilities.

Research Methodology

The methodology of this study was based on modern scientific approaches in pedagogy, psychology, educational management, and cognitive sciences. The methodological basis of the study was formed by the systematic approach, the competence-based approach, the principles of personality-oriented education, and the concept of antifragility.

The main theoretical and methodological basis of the study is N. N. It is based on the theory of antifragility developed by Taleb. According to this concept, complex systems can not only maintain their stability, but also develop and improve under the influence of external influences, uncertainty, and stressful situations [1. pp 60-62.]. Within the framework of the study, this theory was applied to the pedagogical education system and interpreted as a factor in the formation of future teachers' professional development, readiness for innovative activities, and the ability to effectively function in complex pedagogical situations.

In the study, the systematic approach was applied as one of the main methodological principles. On the basis of this approach, the quality of pedagogical education was considered as a complex system consisting of interconnected components. This system includes educational content, pedagogical process, teacher competencies, educational technologies, reflective activities, and mechanisms for professional development. Through a systematic analysis, the impact of the antifragile approach on these components and their interrelationships were identified.

The logical structure of the research methodology was formed based on the following sequence: changes in the educational environment → pedagogical problems → principles of the antifragile approach → developmental pedagogical technologies → formation of professional competencies → improvement of the quality of pedagogical education.

The scientific validity of the research results was ensured by the relevance of the sources used, the reliance on modern pedagogical and psychological theories, the integration of various scientific approaches, and the systematic development of the conceptual model.

Thus, the selected methodological approaches made it possible to link the concept of antifragility with the problem of the quality of pedagogical education, to identify mechanisms for the professional development of future teachers, and to develop a scientific and theoretical model that meets the requirements of modern education.

Results and discussion

The results of the study showed that, along with traditional approaches, there is a need for new methodological approaches that take into account the complexity and variability of the educational process in improving the quality of modern pedagogical education. In particular, the increasingly complex nature of pedagogical activity in modern conditions indicates the need to prepare future teachers not only to acquire ready-made knowledge, but also to think independently in uncertain situations, develop innovative solutions, and continue their professional development.

Based on the theoretical analyses carried out during the study, the antifragile approach was identified as a promising scientific and theoretical basis for improving the quality of pedagogical education. When the principle of antifragility is applied to the pedagogical system, difficulties, problematic situations, and changes in the educational process are not perceived as negative factors, but as a means of stimulating the professional development of the teacher. This approach

serves to increase the flexibility, creativity, and readiness for innovative activities of the pedagogical personality.

The antifragile pedagogical education model, developed based on the results of the study, is considered as an integral system for improving the quality of pedagogical education. This model consists of five interconnected main components: methodological foundations, external environmental factors, developmental pedagogical mechanisms, professional competencies, and outcome indicators.

The first component - the methodological foundations block - forms the theoretical foundation of the antifragile pedagogical education model. This block includes the concept of antifragility, a systematic approach, a competency-based approach, person-centered education, and the principles of reflective pedagogy. The concept of antifragility is the main ideological basis of this model, defining the ability of the pedagogical system to develop from changes and challenges. As Taleb points out, antifragile systems are not only protected from external influences, but also create new opportunities through these influences [1.49 p.]. This idea indicates the need to train future teachers in pedagogical education based on real professional problems.

The second component - the block of external environmental factors - covers the factors that influence modern pedagogical activity. The development of digital technologies, the introduction of artificial intelligence tools into education, the individual needs of learners, and the formation of new pedagogical standards require a high level of flexibility from educators. OECD studies also note that the future teacher must be able to operate in changing conditions, solve complex problems, and continuously develop [3. 31-b.].

The third component - the block of developmental pedagogical mechanisms - represents the practical tools for the formation of an antifragile pedagogue. According to the research results, problem-based learning, project-based learning, research activities, pedagogical practice, reflective training, and the use of case technologies contribute to the development of antifragile qualities in future teachers.

Problem-based learning technology is one of the most important tools of the antifragile approach. Because problem-based situations encourage students to independently analyze, develop different solutions, and make informed decisions, rather than searching for ready-made answers. Such a process contributes to the development of pedagogical thinking and the formation of professional competencies.

And project activities form the skills of independent research, teamwork, planning and evaluation of results in educators. In the process of project-based education, the student faces various uncertainties and gains practical experience by solving them. This process demonstrates the principle of antifragility - development through adversity.

The fourth component - the block of professional competencies - represents the main qualities of the antifragile pedagogical personality. Based on the results of the study, the following competencies were established as the main indicators of an antifragile educator: the ability to analyze pedagogical situations and make independent decisions, creative and critical thinking, the ability to apply innovative pedagogical technologies, the ability to reflexion and self-assessment, digital competencies, readiness for continuous professional development.

These competencies are the main factors determining the effectiveness of professional activity of a modern educator. According to the metacognitive approach put forward by Flavell, the individual functions effectively through the awareness and management of their own thought processes [5. 33-b.]. Therefore, reflection and metacognitive skills play an important role in the antifragile pedagogical model.

The fifth component - the outcome component - defines the final performance criteria of the antifragile pedagogical education model. Through this component, it is envisaged to achieve the following results: an increase in the quality of pedagogical education, the development of professional independence of future educators, the formation of specialists ready for innovative activities, the development of the ability to effectively operate in complex pedagogical situations, the transformation of the educational process into a flexible and developing system.

Thus, the antifragile pedagogical education model developed based on the results of the study appears as a comprehensive scientific and theoretical basis for improving the quality of pedagogical education. This model allows for the training of teachers to meet the requirements of modern education, the development of their professional competencies, and the formation of their ability to effectively function in a changing pedagogical environment.

Conclusions and recommendations

This study examined the scientific and theoretical foundations of improving the quality of pedagogical education based on the antifragile approach and revealed the methodological possibilities of this approach in the process of training modern teachers. The results of the study showed that in today's rapidly changing educational environment, the quality of pedagogical education is not determined only by the formation of knowledge and professional skills. Perhaps one of the

important criteria is the ability of a future teacher to effectively operate in uncertain situations, make innovative decisions, reflexively analyze their activities, and be ready for continuous development.

Based on the results of the study, the following recommendations were developed:

1. Integrate the principles of an antifragile approach into pedagogical higher education programs and develop subject modules aimed at preparing future teachers for complex professional situations.
2. Develop students' independent thinking and innovation competencies through the regular use of problem-based learning, project-based learning, and research activities in the educational process.
3. In the process of teacher training, special attention should be paid to the development of reflection and metacognitive skills.
4. Include in the criteria for assessing the quality of pedagogical education not only knowledge outcomes, but also indicators of creativity, flexibility, problem solving, and innovative activity.
5. Develop digital competencies of future teachers, form skills in the effective use of artificial intelligence tools in the educational process.
6. Pilot testing the antifragile pedagogical education model and assessing its effectiveness based on empirical research.

In general, the antifragile approach is a promising scientific and methodological direction for improving the quality of pedagogical education. Teachers trained in this approach will be able to effectively operate in the complex and changing conditions of the modern educational environment, develop innovative solutions, and take education to a new level.

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