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DIDACTIC FOUNDATIONS FOR DEVELOPING CREATIVE THINKING IN FUTURE TEACHERS

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Abstract: This article investigates the didactic conditions and methodological foundations for developing the creative thinking of future teachers in higher education institutions. The aim of the study is to practically test the effectiveness of innovative technologies, such as TRIZ and SCAMPER algorithms, in transforming traditional education and fostering divergent thinking among students. The results of the experimental work demonstrated that the integration of these methodologies into the educational process increases the professional and creative competencies of future pedagogues to a statistically significant degree.

Keywords: Creative thinking, TRIZ pedagogy, SCAMPER algorithm, divergent thinking, didactic foundations, case-study, innovative education.

Introduction

In the 21st-century era of global informatization and digital technologies, the demands placed on the intellectual capacity of society have fundamentally changed. Today, the global educational paradigm is shifting away from traditional approaches based merely on acquiring ready-made knowledge and reproductive memory, focusing instead on the development of an individual's innovative, critical, and, most importantly, creative thinking. In particular, the World Economic Forum (WEF) has ranked creativity and complex problem-solving skills among the top 10 most essential skills for future professionals. In this process, the primary responsibility falls on the education system, specifically on the future teachers who will educate the next generation.

In recent years, large-scale reforms have been implemented in our republic to modernize higher pedagogical education. In training the new generation of pedagogues, not only a deep knowledge of their subject but also the ability to awaken curiosity and creativity in students is identified as the most important professional competence. Pedagogical theory and practice confirm that only a teacher with highly developed creative thinking can unlock the creative abilities of students. Therefore, reconsidering the didactic foundations of training future teachers in pedagogical universities, including institutes acting as regional base institutions, is of urgent importance.

Although the problem of developing creativity in global pedagogy has been widely studied by scholars such as J. Guilford, E. Torrance, and E. de Bono, serious gaps remain in practice. In many higher education institutions, templated lesson plans and standardized assessment criteria still dominate student training. As a result, although future teachers master theoretical knowledge thoroughly, they lack flexibility in unexpected pedagogical situations (cases) and experience psychological inertia (getting stuck in a mold) during divergent thinking (finding multiple solutions to a single problem). Furthermore, traditional didactics lack sufficient implementation of clear algorithmic mechanisms that teach the systematic resolution of problem situations.

One of the effective ways to solve this problem is the integration of TRIZ (Theory of Inventive Problem Solving) pedagogy and SCAMPER algorithms—which originated in the engineering and inventive fields but yield high results in pedagogy—into the educational process. Combined with the capabilities of digital technologies, these methods transform the student from a passive listener into an

active creator. Through them, the student acquires the skills to deconstruct, modify, and adapt existing pedagogical problems, and to design entirely new approaches.

Based on the above, the purpose of this study is to improve the didactic foundations of developing creative thinking in future teachers in higher education institutions and to scientifically substantiate the effectiveness of special educational and methodological approaches based on TRIZ and SCAMPER algorithms through practical experimentation. The obtained results enrich pedagogical theory with new empirical data and directly serve the practice of training pedagogical personnel.

Methodology

Within the framework of this research, mixed-methods (quantitative and qualitative approaches) were used to determine the level of creative thinking development in future teachers and to evaluate the effectiveness of the proposed didactic tools. The study was conducted based on a quasi-experimental design.

Participants

The pedagogical experimental work was carried out directly with the participation of undergraduate students studying at the Termez State Pedagogical Institute. A total of 100 students were involved in the experiment through random sampling and were divided into two equal groups:

Control group ($n=50$): Training sessions were conducted based on state educational standards and traditional didactic methods (lectures, seminars, reproductive tasks).

Experimental group ($n=50$): Innovative technologies developing creative thinking, particularly TRIZ and SCAMPER algorithms, were integrated into the lesson process in a complex manner.

The initial mastery indicators and academic achievements of the participants in both groups were ensured to be close to each other prior to the experiment, guaranteeing the purity of the experiment.

Instruments

To objectively assess the creative abilities of future teachers, E. Torrance's "Torrance Tests of Creative Thinking" (TTCT), widely recognized in global practice, was selected, and its verbal and figural parts were adapted to the local socio-pedagogical environment. The creative thinking of the students was evaluated based on the following three fundamental criteria:

Fluency: The ability to generate as many ideas as possible regarding a specific pedagogical problem within a given time frame.

Flexibility: The ability to use different approaches in solving a single problem, and the skill to quickly change strategy.

Originality: The degree of offering unique and non-standard solutions that are free from templates and go beyond standard thinking boundaries.

Procedure and Intervention

The experimental process was carried out over an entire academic semester. In the experimental group, traditional lesson explanations were abandoned, and practical classes were built entirely on the basis of an innovative didactic complex:

Via TRIZ pedagogy: Students were taught to find artificial contradictions in the educational process and solve them using inventive principles. For example, brainstorming sessions were held on didactic contradictions such as, "How can we give students a lot of information in class without tiring them out?" The practice of breaking psychological inertia was regularly applied among students.

Via SCAMPER algorithm: Future teachers were given the task of modifying traditional lesson plans and pedagogical cases. Here, students acted according to the SCAMPER stages: Substitute (replacing one method with another), Combine (integrating different subjects), Adapt (adjusting to the situation), Modify/Magnify (enlarging or shrinking an existing method), Put to another use (applying the subject for another purpose), Eliminate (removing unnecessary tools), and Reverse (reversing processes).

Case-study: At the end of each lesson, real conflict situations from school life were analyzed, and students were required to find not just one correct answer, but the 3 most unique alternative solutions.

Data Analysis

Data collected before the experiment (pre-test) and after the experiment (post-test) were processed using SPSS (Statistical Package for the Social Sciences) software. Student's t-test was used to determine the reliability and statistical significance of the difference in results between the groups. In all analyses, the significance level was set at $p < 0.05$.

Results

To evaluate the effectiveness of the proposed didactic complex in developing the creative thinking of future teachers, diagnostic work was carried out in the experimental and control groups at the beginning (pre-test) and end (post-test) of the semester based on the E. Torrance methodology.

Pre-test Analysis

Before the start of the experiment, the creativity indicators of the students in both groups were compared. Initial diagnostic results showed that there was no statistically significant difference between the control and experimental groups in terms of fluency, flexibility, and originality criteria ($p > 0.05$). In both groups, the average creativity score was around 40-45 points (on a 100-point scale), which confirmed the prevalence of templated thinking and the insufficient development of creative thinking among students.

Post-test Analysis

After applying innovative didactic tools based on TRIZ pedagogy and the SCAMPER algorithm in the experimental group during one semester, a final diagnosis was conducted. The obtained results were processed in the SPSS program and summarized in the table below.

Table 1. Dynamics of changes in creative thinking indicators in the experimental and control groups (Mean $\pm$ SD)

Assessment Criteria	Groups	Pre-test	Post-test	Growth Difference	t-value	p-value
Fluency	Control ($n=50$)	45.2 $\pm$ 4.1	48.1 $\pm$ 4.3	+2.9	0.84	$p > 0.05$
	Experimental ($n=50$)	44.8 $\pm$ 4.2	76.5 $\pm$ 5.1	+31.7	6.42	$p < 0.01$
Flexibility	Control ($n=50$)	42.6 $\pm$ 3.8	45.4 $\pm$ 3.9	+2.8	0.79	$p > 0.05$
	Experimental ($n=50$)	43.1 $\pm$ 4.0	79.2 $\pm$ 4.8	+36.1	7.15	$p < 0.01$
Originality	Control	38.4	41.2	+2.8	0.71	$p >$

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Assessment Criteria	Groups	Pre-test	Post-test	Growth Difference	t-value	p-value
	($n=50$)	$\pm$ 3.5	$\pm$ 3.7			0.05$
	Experimental ($n=50$)	39.0 $\pm$ 3.6	82.4 $\pm$ 5.4	+43.4	8.36	$p < 0.01$

(Note: Mean – arithmetic average, SD – standard deviation)

Analytical Interpretation of the Results:

According to the table data, the growth of indicators in the control group taught by the traditional method averaged 2.8 - 2.9 points during the semester, which is statistically insignificant. However, in the experimental group, a sharp and reliable ($p < 0.01$) increase was observed across all criteria:

Fluency indicator rose from 44.8 to 76.5 points. Brainstorming and TRIZ "contradiction solving" exercises helped remove cognitive barriers in students. As a result, they acquired the skill to generate more alternative ideas for a given pedagogical problem in a short time.

Flexibility indicator increased from 43.1 to 79.2 points (+36.1 points). This is a direct result of the SCAMPER algorithm. Students learned not to get stuck on the same type of solutions, but to use various strategies in designing the lesson process, such as substituting, adapting, or applying educational materials for other purposes depending on the situation.

Originality indicator demonstrated the highest growth dynamic (+43.4 points). While students mainly tried to give textbook and templated answers before the experiment, after the application of the innovative didactic complex, their work showed completely non-standard and creative pedagogical solutions free from templates.

Overall, the results of the experimental work fully proved in practice that the integration of TRIZ and SCAMPER technologies into the educational process is one of the most effective didactic mechanisms for developing creative thinking in future teachers.

Discussion

Scientific and practical interpretation of results

The results of the experimental work showed that developing creative thinking in future teachers is a complex cognitive process that is difficult to achieve through traditional lectures and reproductive tasks. The growth of the "Originality" criterion at the highest level (+43.4 points) in the experimental group has important scientific significance. This situation means that the psychological inertia (the habit of looking for only one correct answer to a problem) formed in students over the years was successfully broken as a result of the systematic application of TRIZ and SCAMPER algorithms. Students have now acquired the skill to approach pedagogical situations not as passive observers, but as inventor-designers who can constructively change the process.

Comparative analysis with global scientific research

The obtained results complement and expand the conclusions of leading scientists in the field of global pedagogy and cognitive psychology. In particular, although G. Altshuller's TRIZ theory was originally created for the engineering field, our study confirmed that it can be successfully adapted to higher pedagogical education didactics and that it shows high efficiency in the humanities as well. Moreover, a strong correlation was observed between our empirical results and E. de Bono's "lateral

thinking" as well as the conclusions of modern researchers Mishra and Koehler (2021) regarding teacher creativity. Unlike them, in this research, creativity was formed not in general, but in a purposefully directed manner directly through a didactic complex (SCAMPER + TRIZ + Case-study).

Implications for Practice

The didactic tools and algorithmic solutions developed within the study can be directly implemented into the practice of higher pedagogical education institutions, particularly base universities like the Termez State Pedagogical Institute. This methodology allows subject teachers to evaluate not only the memory of students but also their ability to visualize problem situations, analyze them, and find unconventional solutions.

Limitations and Future Research

Although the research results have high reliability, certain limitations must also be taken into account. First, the experiment was conducted only within one higher education institution ($n=100$ students) and during one semester. To generalize the results more broadly, it is necessary to repeat the experiment in universities in different regions and over a longer period. Second, the human factor (subjectivity) is involved to some extent in assessing creativity. Future scientific research plans to create automated assessment models of cognitive processes by integrating TRIZ and SCAMPER algorithms with digital educational tools (e.g., artificial intelligence or virtual reality).

Conclusion

21st-century schools need creative teachers who can provide their students not only with knowledge but also with the skills to adapt to a changing world and create. The conducted research allowed the formulation of the following final conclusions regarding the formation of these qualities in future teachers:

Need for an innovative approach: To develop the creative thinking of future teachers, it is necessary to strictly abandon traditional reproductive didactic models and transition to an open educational environment based on inventive logic (TRIZ) and heuristic algorithms (SCAMPER).

Empirical effectiveness: Experimental work confirmed that the practical implementation of this innovative didactic complex increases the level of fluency, flexibility, and originality-considered the main components of creative thinking in students-to a statistically significant degree (almost 2-fold).

Creativity can be managed: Creativity is not a spontaneous and uncontrollable process. With the help of systematic training and algorithmic exercises (solving contradictions, modifying ideas), the professional and creative potential of any future specialist can be increased to a predictable level.

Practical recommendation: It is considered appropriate to mandatorily include special modules such as "Creative Educational Technologies", "Pedagogical TRIZ", and "Analysis of Problematic Cases" in the syllabuses of specialized subjects like "Pedagogy" and "Teaching Methodology" in higher education institutions.

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