CURRENT RESEARCH JOURNAL OF PEDAGOGICS
(ISSN –2767-3278)
VOLUME 05 ISSUE 09 Pages: 12-21
OCLC – 1242041055
Crossref doi Google Scholar WorldCat MENDELEY
Publisher: Master Journals

Journal Website: https://masterjournals.com/index.php/crjp

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Research Article

EXPERIMENTAL TEST RESULTS ON THE DEVELOPMENT OF STUDENTS' EDUCATIONAL AND CREATIVE ACTIVITY THROUGH TRIZ TECHNOLOGIES

Submission Date: Aug 30, 2024, **Accepted Date:** Sep 04, 2024,
Published Date: Sep 09, 2024
Crossref doi: https://doi.org/10.37547/pedagogics-crjp-05-09-03

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ABSTRACT

Creative activity skills should be developed from the initial stages in students studying in the technical direction of higher education institutions. It will be necessary to organize periodic repetitions of solutions to given tasks (getting out of the situation), as a result of which Experience (Data Foundation) is accumulated in students, skills and knowledge of creative activity are formed.

KEYWORDS

TRIZ-technologies, creativity, creative activity, circulation situation, student, technique.

INTRODUCTION

The main conflict in higher education is between the amount of research done and the time it takes to master it. The didactic possibilities of TRIZ, the main contradictions in students' learning in higher education, the approaches that allow to solve the contradiction, pedagogical and psychological resources were considered and studied.

Below is the content and essence of the organization and conduct of experimental work. The results of the implementation of experimental work at Islam Karimov Tashkent State Technical University Olmalik branch, Namangan Institute of Engineering and Construction, Navoi State University of Mining and

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Technologies, Andijan Mechanical Engineering Institute are presented.

In any educational system, and especially in the higher education system, there is a contradiction between the demand of the secondary system (society) to increase the volume of knowledge given to students and the student's (subsystem) acquisition of knowledge in a limited time to absorb the increasing volume of physical and psychological capabilities. Several attempts have been made to overcome this contradiction, starting with the deployment of the system, increasing the number of studied subjects, and ending with increasing the intensity of training using various "immersions", speed reading, etc. However, all this deepened the main contradiction.

METHOD

On the other hand, TRIZ has not yet fully realized the didactic possibilities that allow solving this contradiction. A number of TRIZ experts and higher education teachers [13,14,15] analyzed TRIZ pedagogy in higher education institutions. However, since this analysis was carried out at the first stages of the use (implementation) of TRIZ in higher education, the discussion is no longer about TRIZ pedagogy, but about teaching using TRIZ-technologies. In our opinion, the use of TRIZ as a basic, system-creating science (for example, mathematics, physics, computer science, mechanics and technical sciences) is a solution to solve the main conflict formed in higher education institutions. The first stage of scientific research works is 2020-2021, the second stage is 2021-2022, the third stage is 2022-2023 and 2023-2024 academic years. improved and tested.

Thus, the purpose of introducing TRIZ to universities is to increase the level of training of specialists through:

teaching methodology (system of methods and methods) for solving technical issues;

- formation and development of creative, strong thinking culture;
- transfer of technical knowledge in a systematic, concise, collected form.

Didactic possibilities of TRIZ

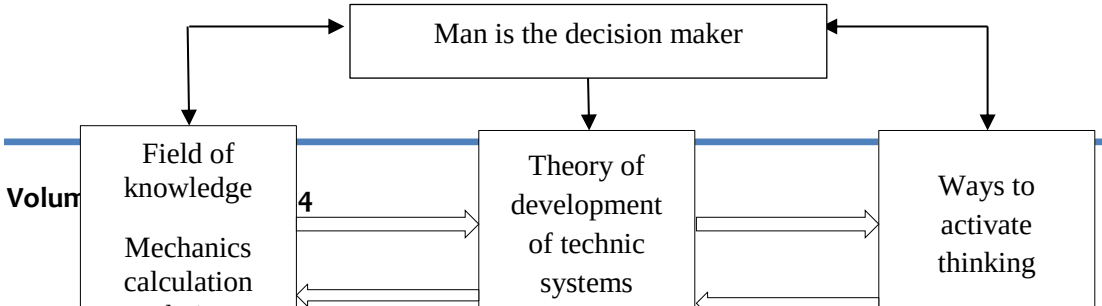
Let's start by considering the didactic possibilities of TRIZ. It should be noted that these opportunities are of interest to us only from the point of view of the goals of introducing TRIZ to higher education.

Method. Let's figure out how to achieve each of the goals described above. To do this, let's analyze three structural diagrams that show how people use TRIZ:

- solves his problems;
- develops creative imagination;
- systematizes knowledge.

It should be noted that these diagrams are not fundamentally new in TRIZ, they are necessary for a more visual presentation of the didactic capabilities of TRIZ and a natural transition to TRIZ technologies.

TRIZ as a tool for solving engineering problems TRIZ is the science of technical systems development. This science has been important since its inception, on the basis of which tools for solving technical problems have been developed. Structurally, the process of solving them can be expressed in the following form (Fig. 1).



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1 – picture. Block diagram of technical problem solving using TRIZ methodology

The following abbreviations are used in Figure 1: TTRQ - laws of development of technical systems (TRIZ section), ITR - development of creative imagination (TRIZ section). TRIZ tools are understood as: methods of identifying technical system resources and using them; indicators of physical, geometric, chemical and biological effects; methods of identifying technical and physical contradictions in technical systems, as well as methods of solving them; implementation of the analysis and methodology for the use of standards for the implemented transformations; algorithm for solving inventive problems (IMYEA (ARIZ)).

RESULT

The effectiveness of the proposed methodology in pedagogical research was justified by mutual comparison of the indicators recorded at the end of the experimental work. According to the idea put forward in the mathematical-statistical methods of re-analysis of the results, the re-analysis was evaluated by determining the difference between the indicators at the end of the experiment of the students who participated in the experiment and the control groups. For this purpose, according to K. Pearson's $\chi 2$ (xi square) criterion, the first stage final indicators of the students of the experimental and control groups were compared with the second, third and final stage indicators.

In this case, H0 was taken as a hypothesis that the expected probability of assessment types during the observation period in the experimental and control groups was equal, and the alternative H1 was not equal in the hypothesis. That is, H0 - there is no significant change in students' knowledge levels after conducting the experiment in the experimental and control groups.

H1 - significant changes are observed in experimental and control groups.

To test this statistical hypothesis, we first determine the significance level (a) to compare the empirical value with the critical value. In pedagogical studies, the value of α is limited to 0.05. Second, the reliability difference or difference 1 – a is calculated. In our case, 1 – 0.05=95 (ie 95% confidence level).

The critical value of $\chi 2$ at $\alpha = 0.05$ is given in [ ] (see table 3.3.1).

Table 3.3.1

Critical value of $\chi 2$ when $\alpha = 0.05$

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v	1	2	3	4	5
$\chi^2_{0,05}$	3,841	5,991	7,815	9,488	11,07

As we mentioned, the students' initial mastery levels were studied. The information about the pre-experiment results of the students who participated in the experimental work is presented in the table below. (See Table 3.3.2).

Table 3.3.2

Pre-experimental results of students who participated in the experimental work

Education institutions	**Groups**	**Number of students**	**Mark**			
			"2" Low	"3" Medium	"4" Good	"5" Excellent
TDTU OF	Experimental	56	29	18	6	3
	Control	53	27	17	7	2
TIQXMMI" National Research University	Experimental	20	5	8	5	2
	Control	17	6	7	3	1
AndMI	Experimental	53	20	23	6	4
	Control	33	16	10	5	2
TIQXMMI Karshi Institute of Irrigation and Agrotechnology	Experimental	34	15	12	4	3
	Control	22	10	9	2	1
Total	Experimental	163	94	82	31	16
	Control	125	65	46	20	8

Control of students' knowledge showed that the level of mastery did not exceed 46-49% when taught using traditional methods. The results of the effectiveness of the method of developing the educational and creative activity of students by means of IMYeN-technologies in conducting training sessions of the subjects of selected agricultural areas (theory of machines and mechanisms, machine details) that are read in groups obtained test, questionnaire, questionnaire questions and "Concept Analysis" pedagogical technology, and the final analysis of students' knowledge level showed the following results (see Table 3.3.3).

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Table 3.3.3

The results of the students who participated in the experimental work

Education institutions	Groups	Number of students	Marks			
			"2" Low	"3" Medium	"4" Good	"5" Excellent
TDTU OF	Experimental	56	21	16	12	7
	Control	53	25	18	8	2
TIQXMMI" National Research University	Experimental	20	2	3	9	6
	Control	17	5	6	4	2
AndMI	Experimental	53	12	19	13	9
	Control	33	14	9	7	3
TIQXMMI Karshi Institute of Irrigation and Agrotechnology	Experimental	34	9	7	10	8
	Control	22	9	7	4	2
Total	Experimental	163	44	45	44	30
	Control	125	53	40	23	9

DISCUSSION

Based on these results, separate empirical values for each of the four higher education institutions were checked and analyzed. The conducted research included a test, questionnaire, survey questions and "Concepts" conducted in experimental and control groups consisting of 2-3 year students of Tashkent State Technical University, Almalyk branch (56 students participated in the experimental group, 53 students participated in the control group) analysis" pedagogical technology results (values from table 3.3.3) are highlighted below in the form of a diagram (see Figure 3.3.1).

The results of the experimental work showed that, using the methodology of developing the educational and creative activity of students by means of IMYeN-technologies, the theory of machines and mechanisms, machine details were organized in the training sessions, students' in the experimental group of the experimental and control groups, compared to the total number of students, the mastery rate for the "excellent" grade increased from 5% to 12.5% (in the control group, from 3.8% to 4% without significant change), for the "good" grade and the mastery rate increased from 6% to 21.4% (from 13.2% to 15% in the control group).

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Those rated "medium" changed from 32% to 28.6% (32% to 34% in the control group). Those rated as "low" decreased from 52% to 37.52% (51% to 47% in the control group). It can be seen that the number of "Low" scores in the experimental group decreased compared to the control group.

It can be concluded as follows, that is, the use of the method of developing the educational and creative activity of students with the help of IMYeN-technologies significantly increases the educational and creative activity of students.

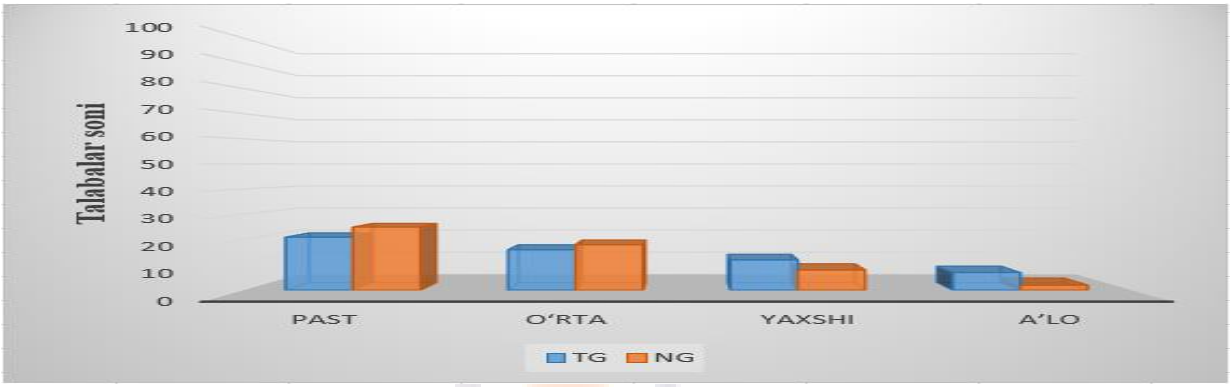

Figure 3.3.1. Diagram of the results of the test tasks and questionnaires conducted at the Olmaliq branch of the Tashkent State Technical University.

Now we calculate the empirical values for the experimental and control groups. We denote the indicators of the experimental group by niTs, the number of students by nT, the same values for the control group by niN, the number of students by nNs. We use the following formula [2].

$$\chi^2 = n_T n_N \sum_{i=1}^{g} \left[\frac{1}{n_{iT} + n_{iN}} \left(\frac{n_{iT}}{n_T} - \frac{n_{iN}}{n_N} \right)^2 \right]$$

The results of the experiment of the students who participated in the experimental work, we get the values from table 3.3.3.

$$\chi^2 = 56 * 53 \sum_{i=1}^{g} \left[\frac{1}{21+25} \left(\frac{21}{56} - \frac{25}{53} \right)^2 + \frac{1}{16+18} \left(\frac{16}{56} - \frac{18}{53} \right)^2 + \frac{1}{12+8} \left(\frac{12}{56} - \frac{8}{53} \right)^2 + \frac{1}{7+2} \left(\frac{7}{56} - \frac{2}{53} \right)^2 \right] \approx 21$$

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Using the table (see table 3.3.1), we find the critical value (ch_(critical.)^2) of the number of degrees of freedom V=g-1=4-1=3 at a significance level of 0.05. The critical value is 7.815, which is less than the observed value. Therefore, the inequality χ_(expr.)^2> χ_(critical.)^2 (21>7.815) is correct, which shows the reliability of the differences between the answers of the students of the experimental and control groups, and therefore our hypothesis confirms the experimental work, the students' educational as it is more effective in increasing creative activity (P<0.05 at χ_(expr.)^2 =21).

Sunday showed that the proposed methodology is effective, which means that hypothesis H1 can be accepted.

The average arithmetical values and performance indicators of the learning results of the experimental and control groups participating in the experimental work are as follows:

$$\bar{x} = \frac{1}{n_T} \cdot \sum_{i=1}^{4} M_i \cdot T_i = \frac{1}{56} \cdot [2 \cdot 21 + 3 \cdot 16 + 4 \cdot 12 + 5 \cdot 7] \approx 3{,}08.$$

$$\bar{y} = \frac{1}{n_N} \cdot \sum_{i=1}^{4} M_i \cdot N_i = \frac{1}{53} \cdot [2 \cdot 25 + 3 \cdot 18 + 4 \cdot 8 + 5 \cdot 2] \approx 2{,}64.$$

$$\eta = \frac{\bar{x}}{\bar{y}} = \frac{3{,}08}{2{,}64} \approx 1{,}16.$$

Here, Mi are grade indicators, x¯is the arithmetic mean of mastery grades in the experimental group, and y¯is the average value of mastery grades in the control group.

It was found that the performance indicators after the experiment increased by 16% in the experimental group compared to the control group.

It follows that, on the basis of the proposed methodology, the training of the theory of machines and mechanisms, machine details has increased the educational and creative activity of students, which has had a positive effect on the quality and efficiency of education.

Pedagogical experiment-test works based on hypothesis and alternative hypothesis in the same way "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National Research University 60810400-"Application of innovative techniques and technologies of agriculture", 60810300-"Technical service in agriculture and water management" The results obtained by the test, questionnaire, questionnaire questions and pedagogical technology "Concept Analysis" in experimental and control groups consisting of

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students of 2-3 courses (20 students in the experimental group, 17 in the control group) 3.3. The following diagram formed from Table 3 (see Figure 3.3.2) is presented.

The results of the experimental work showed that, using the methodology of developing the educational and creative activity of students by means of IMYeN-technologies, the theory of machines and mechanisms, machine details were organized in the training sessions, students' in the experimental group of the experimental and control groups, the rate of acquisition of the "excellent" grade compared to the total number of students increased from 10% to 30% (from 5.9% to 11.8% in the control group), the acquisition rate of the "good" grade and increased from 25% to 45% (from 17.7% to 23.5% in the control group).

Those rated "medium" changed from 40% to 15% (from 41.1% to 35.3% in the control group). Those rated as "low" decreased from 25% to 10% (from 35.3% to 29.4% in the control group). It can be seen that the number of "Low" and "Medium" scores in the experimental group decreased compared to the control group.

The results of the pedagogical experience obtained from the experimental and control groups were analytically processed based on the formulas given above. The identified analytical data are presented in the following table (see Table 3.3.4).

Table 3.3.4

Analysis of experimental work conducted in four HEIs overall result.

	Experimental group E=163				**Control group C=125**			
Grade value	2	3	4	5	2	3	4	5
Number of matching grades	44	45	23	9	53	40	23	9
Arithmetic mean value of grades	$\bar{x} = 3{,}41$				$\bar{y} = 2{,}91;$			
Efficiency coefficient	$\eta = \frac{\bar{x}}{\bar{y}} = 1{,}17;$							
Confidence interval	$3{,}39 \leq \bar{x} \leq 3{,}45$				$2{,}87 \leq \bar{y} \leq 2{,}94$			

From these results, it can be seen that the effectiveness of the result obtained at the final stage of experimental work was proven to be new, and the general ideas of the research were presented in the thesis.

CONCLUSION

1. According to the results of the experimental test carried out on the methodology of developing students' educational and creative activity by means of TRIZ-technologies, in the process of teaching specialized subjects, checking the pedagogical conditions for the effective operation of the model of developing the creative activity of students,

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diagnosing the results at the selected stages of determining the experience or control, according to all criteria, it was found that the students of the experimental group achieved higher results than the students of the control group.

2. The effective aspects of the model of development of students' creative activity during the teaching of specialized subjects were determined by conducting tests in experimental groups and control groups. According to all criteria selected during the experiment, the students of the experimental group achieved higher results than the students of the control group. It would be appropriate if the methodology of developing the educational and creative activity of students by means of TRIZ-technologies was introduced for the teaching of specialized subjects in technical higher education institutions.

3. Pedagogical experimental test works in the educational process, practical and laboratory works on the development of professional and creative activity with the help of TRIZ technologies using modern electronic educational tools in the teaching of specialized subjects to students of technical higher education institutions and their implementation in the future was established in order to develop the theory of solving inventive problems of engineers.

4. It was found that the students of the experimental group achieved much higher results than the students of the control group according to all the selected criteria when checking the pedagogical conditions for the effective functioning of the model for the development of creative activity of students in the process of teaching specialized subjects.

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(ISSN –2767-3278)
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OCLC – 1242041055
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Publisher: Master Journals

ахборотномаси: илмий журнал.-№Махсус сон (76), Хоразм Маъмун академияси, 2021 й. 102-104 б.

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