

THE IMPACT OF CRITICAL THINKING STRATEGIES ON THE FORMATION OF STUDENTS' COGNITIVE INDEPENDENCE

ALBINA VOLKOTRUBOVA, JIE LIU, TETIANA REMEKH, LARYSA LYTVYN*, IRYNA BONDAR

*Corresponding author: larysaivanchenkova@gmail.com

Abstract. The purpose of the study is to ascertain the efficacy of innovative pedagogical methods that foster the development of critical thinking and student independence. To achieve the goal, a comprehensive array of theoretical, empirical, and statistical methodologies was employed, including questionnaires, pedagogical experiments, as well as regression analysis. The findings revealed notable disparities between the experimental group (EG) and the control group (CG). Notably, the indicators of the motivational criterion of cognitive independence demonstrated correlations with the components of critical thinking, yielding coefficients ranging from 0.42 to 0.51 ($p < 0.001$). The peculiarity of the study lies in its two-country design (Ukraine and Kyrgyzstan), which enables a comparison of the effectiveness of innovative critical thinking strategies across different cultural and educational contexts. It was found that in both samples, the experimental groups significantly outperformed the control groups by all indicators. The programme, which included case studies, project-based learning, and the theory of inventive problem solving, proved effective in both countries, albeit with some local adaptations. The scientific novelty of this study resides in its thorough examination of the interconnections between critical thinking and various facets of cognitive independence. Prospective avenues for future research encompass a more comprehensive exploration into the impact of critical thinking strategies on academic performance across diverse disciplines and contexts. The practical significance of the study lies in the possibility of implementing the proposed programme in higher education institutions, both within special courses and in the format of interdisciplinary integration of critical thinking into the educational process.

Keywords: critical thinking, autonomous learning, learning autonomy, active learning strategies, education for sustainable development, pedagogy.

1. INTRODUCTION

In today's rapidly evolving globalized world, where technology and methods of acquiring information are rapidly changing, the cultivation of critical thinking has emerged as an indispensable facet of student development (Shekhar & Rahnev, 2021). Contemporary education emphasizes not merely the accumulation of knowledge but also the enhancement of students' capacity to independently analyze, assess information, ultimately arriving at informed conclusions. This underscores the significance of fostering critical thinking, as it underpins the intellectual autonomy and cognitive independence of students, which are essential foundations for successful learning and professional endeavors (Fomin et al., 2022).

Critical thinking encompasses a broad spectrum of cognitive processes, including analysis, logic, reflexivity, as well as exploratory engagement. It empowers students to not only evaluate information but also to actively seek it out, take into consideration diverse perspectives, and consequently make

judicious decisions (Boyko & Semakova, 2022). However, for these competencies to flourish, it is imperative to employ innovative pedagogical strategies that will facilitate their development.

The use of innovative strategic methodologies, such as case studies, project-based learning, and the theory of inventive problem-solving, fosters an environment for cultivating critical thinking within the educational process. As Kostenko (2023) observes, these methodologies not only enhance cognitive abilities but also nurture students' capacity for collaboration, practical application of knowledge, and the stimulation of independent activities. The implementation of such approaches possesses significant potential for elevating the cognitive independence of students, as they invigorate the processes of self-education and self-development (Terno, 2023). Scholars hold that activities aimed at fostering critical thinking "enhance autonomous learning" (Kairgozhin et al., 2023).

The purpose of this study is to investigate the influence of critical thinking strategies on the advancement of students' cognitive independence.

Empirical tasks to achieve the aim of the present study are as follows:

- to evaluate the extent of critical thinking development among EG and CG students following the implementation of innovative pedagogical methodologies;
- to examine the impact of case study approaches, project-based learning, and the theory of inventive problem-solving on the enhancement of students' cognitive independence;
- to identify the interrelationships among the components of critical thinking and the criteria for students' cognitive independence through correlation and regression analyses.

2. LITERATURE REVIEW

In contemporary pedagogical discourse, critical thinking is frequently regarded as an essential asset for cultivating students' intellectual autonomy (cognitive independence). In this light, McPhee and Cox (2024) contend that the primary objective of fostering critical thinking is to attain "intellectual autonomy" – the capacity to analyze and assess information independently. Therefore, educational strategies designed to enhance critical thinking should facilitate the learners' growth in independence. Other scholars further underscore that critical thinking trains students to be critical of their learning and make informed decisions, thereby reinforcing the autonomy of their learning process.

Smolinska et al. (2024) concentrate on the psychological dimensions that influence students' self-regulation, particularly increasing the significance of assertiveness in organizing the learning experience. The authors observe that the degree of assertiveness is profoundly correlated with students' proficiency in time management and decision-making. This makes it possible for us to claim that personal attributes such as assertiveness exert a direct influence on the capacity for independent learning and the development of cognitive independence. A similar view is supported by Semenets-Orlova et al. (2023), who emphasize the importance of innovations in educational management, which also facilitate the advancement of critical thinking and student independence. Specifically, their research accentuates the effect of organizational transformations and management strategies on the educational process, which directly intertwines with the enhancement of autonomy through the improvement of educational practices.

A number of studies describe specific pedagogical strategies that combine the cultivation of critical thinking with the enhancement of student autonomy. Notably, problem-based learning (PBL) is recognized as an effective approach: it engages students in the resolution of authentic problems collaboratively, thereby fostering reflection, analysis, and informed decision-making. Consequently, Msc et al. (2025) demonstrated that PBL "encourages reflection, analysis, and informed decision-making." This research aligns with the findings of Veettil and Binu (2022), who similarly assert that PBL promotes students' autonomy, thereby enhancing their capacity for independent learning. However, these results may be limited to the elementary school context, as the group learning strategy might prove less effective for older students or in particular domains of study. Hence, it is imperative to consider the

unique characteristics of the students' age group engaged in PBL. In contrast, Saidul and Widiasari (2024) followed a strategy of systematically diminishing teacher support (scaffolding): under conditions of gradual reduction of prompts and increase of students' responsibility, they gradually "learn to manage their learning, develop critical thinking strategies, and gain confidence in problem-solving".

Recently, numerous empirical studies corroborate the positive correlation between critical thinking strategies and students' cognitive independence. Yüce (2023) examined the interplay among critical thinking propensity, autonomous learning, and academic engagement among prospective English educators. According to the researcher, students exhibiting a higher level of critical thinking showed a markedly enhanced capacity to organize their learning processes. Similar findings are obtained in a study conducted by Ekeh and Venketsamy (2023), who showed that the implementation of critical thinking development methods directly facilitated the cultivation of students' self-assurance and independence. Applying a participatory research approach, they concluded as follows: "the strategy of teaching critical thinking fostered students' autonomy." In a similar vein, Bolaños-Medina and Núñez (2022) demonstrated in their study that autonomy support and critical thinking competencies exert a favorable influence on the advancement of students' strategic competence. Although this investigation did not directly quantify "autonomy," the capacity for independent decision-making regarding tasks (strategic competence) was found to increase in conjunction with high levels of critical thinking and autonomy support.

It is worth noting that while Yüce (2023) and Ekeh and Venketsamy (2023) primarily concentrate on enhancing independence through the cultivation of critical thinking within the framework of traditional pedagogical methods, Pereles et al. (2024) underscore the significance of metacognitive strategies, which interlink critical thinking with self-regulation and empower students to take charge of their learning processes. The approach of Pereles et al. (2024) is notably more holistic, as it encompasses not only the advancement of critical thinking but also the refinement of planning and self-assessment skills, thereby allowing for a perception of learning as a more autonomous and self-directed endeavor. Further, Lin et al. (2024) hold that digital literacy plays a pivotal role in fostering critical thinking among foreign language educators through the incorporation of digital technologies. They accentuate the necessity of integrating digital tools into teaching practices, which enhances educators' analytical competencies. Conversely, Adylbek Kyzy et al. (2024) contest Lin et al.'s (2024) viewpoint, positing that the foundations of critical thinking are more deeply entrenched in traditional pedagogical approaches, suggesting that innovative methodologies may prove less effective unless they are suitably tailored to the learners' cultural contexts.

3. RESEARCH METHODS AND MATERIALS

A. Research Procedure

The study was conducted in several stages, each designed to explore the influence of critical thinking strategies on students' cognitive independence.

Preparatory stage. During this stage, a questionnaire was administered to gather preliminary data regarding the levels of critical thinking and cognitive independence among students. Participants were acquainted with the aims and objectives of the research. The sample comprised first-year and second-year students from Ukraine and Kyrgyzstan, thereby ensuring a culturally diverse representation.

The stage of the formative experiment. At this stage, innovative pedagogical methods were implemented within the experimental group (EG). Students were engaged in tasks that incorporated case studies, project-based learning, and the theory of inventive problem solving (TPS). Conversely, in the control group (CG) the training was conducted using traditional methods, without the use of innovative strategies. The structure of the program is delineated in Table 1.

Program structure

Program stage	Description of activities	Duration	Teaching methods
1. Introductory stage	Students are introduced to the main goals and objectives of the research. The teacher explains the importance of developing critical thinking and cognitive independence, and also introduces the methods that will be used during the experiment. Students obtain general information about case methods, project-based learning, and TPS (theory of inventive problem solving).	1 week	Lecture
2. Main stage	This stage focuses on active learning through case studies, project-based learning, and TPS methods. Students work on practical assignments, analyze real-world problems, solve problems, and apply theoretical knowledge in practice. While completing tasks, they actively interact, which promotes the development of critical thinking, independence, and teamwork. Each student is assigned an individual task to undertake, which allows them to showcase their development of analytical and reflective capabilities.	6 weeks	Case methods, project-based learning, TPS
3. Final stage	At this stage, a final discussion of the completed tasks takes place. Students share the results of their research and evaluate the results achieved. An integral aspect of this phase involves evaluating the degree of autonomy exhibited by students in the execution of their tasks, as well as identifying their ability to reflect and critically analyze their work. This is done through interviews, questionnaires, and seminar classes where students discuss the knowledge and practical skills they have gained.	1 week	Seminars, interviews, questionnaires

**Author's own contribution*

The final stage. After the completion of the training program, participants were tested again to evaluate alterations in their levels of critical thinking and cognitive independence. To this end, advanced statistical analysis techniques were employed to juxtapose the results of the experimental group (EG) and the control group (CG).

B. Sample

The study sample comprised 240 students, categorized into two primary national groups: 120 students from Ukraine and 120 students from Kyrgyzstan. Each national group was further subdivided into two categories: the experimental group (EG) and the control group (CG), with each category encompassing 60 individuals. Consequently, the overall composition of the groups was as follows: EG Ukraine – 60 students; CG Ukraine – 60 students; EG Kyrgyzstan – 60 students; CG Kyrgyzstan – 60 students.

A sample of 240 students is sufficiently substantial to yield reliable statistical outcomes. The distribution of participants across each group was determined by statistical requisites to ensure dependable results and facilitate accurate comparisons between groups. Given the participant numbers, the study has statistical power to detect significant effects and correlations. The Experimental Group (EG) was subjected to training employing innovative methodologies, which encompassed the active engagement of digital technologies, gamification elements, and problem-based learning techniques, whereas the Control Group (CG) received instruction through traditional pedagogical approaches. The sample was representative, as it encompassed students from diverse cultural and educational

backgrounds, thereby enabling a comprehensive evaluation of the influence of instructional strategies on varied student populations.

The allocation of participants in each group was ascertained based on statistical criteria to ensure reliable outcomes. The students who participated in the study were enrolled in various educational institutions situated in Ukraine and Kyrgyzstan. In Ukraine, the participants were from the Interregional Academy of Personnel Management (IAPM), where they pursued higher education in linguistics and humanities. In Kyrgyzstan, students were affiliated with the International University of Kyrgyzstan and the I. Arabayev Kyrgyz State University, focusing on linguistics and delving into both theoretical and practical dimensions, encompasses phonetics, morphology, syntax, semantics, and pragmatics. These institutions also equipped students with knowledge in social sciences and other humanities disciplines, thereby providing them with a comprehensive academic training that fosters critical thinking across a variety of contexts.

The selection of Ukraine and Kyrgyzstan as two culturally and educationally distinct contexts enabled a comprehensive evaluation of the efficacy of innovative pedagogical methods across diverse socio-cultural landscapes. This juxtaposition not only facilitated an exploration of the adaptability of contemporary methodologies within varying educational frameworks but also highlighted the unique characteristics of each nation's educational infrastructure. Ukraine has a more advanced system for the integration of modern educational technologies, whereas Kyrgyzstan is a nation undergoing significant development in higher education and the incorporation of novel pedagogical approaches. All participants were selected to ensure equality in terms of gender, age, and fields of study. This deliberate selection process mitigated potential biases linked to these variables, thereby enhancing the validity of comparisons drawn between the groups.

C. Methods

The pedagogical experiment was conducted to enhance students' critical thinking capabilities. The California Critical Thinking Skills Test (CCTST) served as an evaluative instrument that measured students' analytical, logical, and reflective faculties. This assessment encompassed a diverse array of tasks designed to measure cognitive skills effectively. The Critical Thinking Inventory (CTI) functioned as a questionnaire aimed at determining the extent of students' critical thinking proficiency, which was employed to assess participants both before and following the experiment. The Motivated Strategies for Learning Questionnaire (MSLQ) was utilized to evaluate motivation and learning strategies, thereby enabling an assessment of students' cognitive independence. To ensure correct interpretation of the results, the Ukrainian and Kyrgyz versions of the questionnaires were pre-piloted, and the wording was adapted to the educational and cultural context of each country. The scales of the questionnaires were tested for reliability using Cronbach's α coefficient (all values exceeded 0.7), which confirms the internal consistency of the instruments. In addition, some statements in the MSLQ and CTI were modified to clarify concepts that could cause misunderstandings among respondents from different educational systems.

Regression analysis was employed for statistical analysis, utilizing Student's t-test to compare mean values across distinct groups, while correlation analysis was conducted to elucidate the relationship between critical thinking and cognitive independence. Student's T-test was used to compare the mean values of critical thinking and cognitive independence indicators between the experimental and control groups within each country separately (Ukraine, Kyrgyzstan), as well as for the generalised sample. Regression analysis was used to determine the impact of individual criteria of cognitive independence on the components of critical thinking. The characteristics of the methods used and the peculiarities of their application are presented in Table 2.

Tab. 2

Characteristics of the methods used and peculiarities of their application

Method / Instrument	Purpose of application	Scale construction and levels of interpretation	Validity and adaptation
California Critical Thinking Skills Test (CCTST)	Assessment of analytical, logical and reflective critical thinking skills	34 multiple-choice questions; scoring on a scale from 0 to 34 points	Standard tool; licensed adapted version used
Critical Thinking Inventory (CTI)	Determining the level of critical thinking (before and after the experiment)	Likert scale (1-5); 30 statements grouped into 3 subscales: analytical, flexible, reflective	Preliminary piloting; adaptation of terms to cultural context; Cronbach's $\alpha = 0.79$
Motivated Strategies for Learning Questionnaire (MSLQ)	Measuring cognitive independence, motivation and learning strategies	Likert scale (1-7); 3 levels of independence are distinguished: low (1-3.9), medium (4-5.4), high (5.5-7)	Psychometric validation; modification of wording for two countries; Cronbach's $\alpha = 0.81$
Analytical methods	Comparing groups and identifying relationships between variables	Student's t-test (intergroup comparison); correlation and regression analysis	Applied to the data of each country separately and for the aggregate sample

**Author's own contribution*

D. Statistical Methods

Statistical methods were utilized to process the data, in particular the Mann-Whitney U-test and Pearson's χ^2 test. These methods make it possible to identify the statistical significance of changes in the level of critical thinking and cognitive independence between the EG and CG. The median values between EG and CG were compared using the Mann-Whitney test in cases where the data did not follow a normal distribution (determined by the Shapiro-Wilk test). The χ^2 test was used to test the dependence between categorical variables, in particular when analysing the frequency of responses to the questionnaire on learning strategies.

E. Tools

To process statistical data, the SPSS 23.0 program was used, which is one of the most common in scientific research for conducting complex data analysis.

4. RESEARCH RESULTS AND DISCUSSION

After the implementation of the formative influence, four components of critical thinking were evaluated: analytical, logical, reflective, and exploratory activities. A comprehensive analysis of the indicators within each of the four categories is as follows, accompanied by a comparative assessment of the results between the Ukrainian and Kyrgyz samples (Table 3).

Tab. 3

Comparison of critical thinking results between Ukraine and Kyrgyzstan

Indicator	EG Ukraine ($\bar{x} \pm \sigma$)	CG Ukraine ($\bar{x} \pm \sigma$)	EG Kyrgyzstan ($\bar{x} \pm \sigma$)	CG Kyrgyzstan ($\bar{x} \pm \sigma$)	t	p
Analytics	22.4 \pm 2.9	19.8 \pm 3.2	24.3 \pm 2.8	18.7 \pm 3.0	2.34	< 0.05
Logic	21.1 \pm 2.5	18.5 \pm 2.7	21.9 \pm 2.4	18.2 \pm 2.8	1.45	< 0.05
Reflexivity	23.1 \pm 2.6	20.2 \pm 3.1	21.9 \pm 2.7	19.3 \pm 3.2	1.65	< 0.05
Search activity	25.7 \pm 3.2	21.4 \pm 3.4	23.5 \pm 3.1	20.0 \pm 3.3	2.13	< 0.05

**Author's own contribution*

Note: \bar{x} is the mean, σ is the standard deviation, t is the Student's t -test, p is the significance level

As can be seen, in Kyrgyzstan, the greatest growth was observed in analytical skills (+5.6 points), as well as in logical skills (+3.7), reflexivity (+2.6), and search activity (+3.5). In Ukraine, the highest increase was found in search activity (+4.3), with notable increases also in reflexivity (+2.9), analytical skills (+2.6), as well as logic (+2.6).

The comparison reveals that Kyrgyz students exhibit a higher level of analytical skills, whereas their Ukrainian counterparts demonstrate an elevated engagement in exploratory activities. Reflexivity and logical skills remain at a comparable level. Overall, the program proved to be effective in both nations, each showcasing its unique strengths. For the sake of clarity, all alterations in the indicators of both groups are illustrated in Fig. 1.

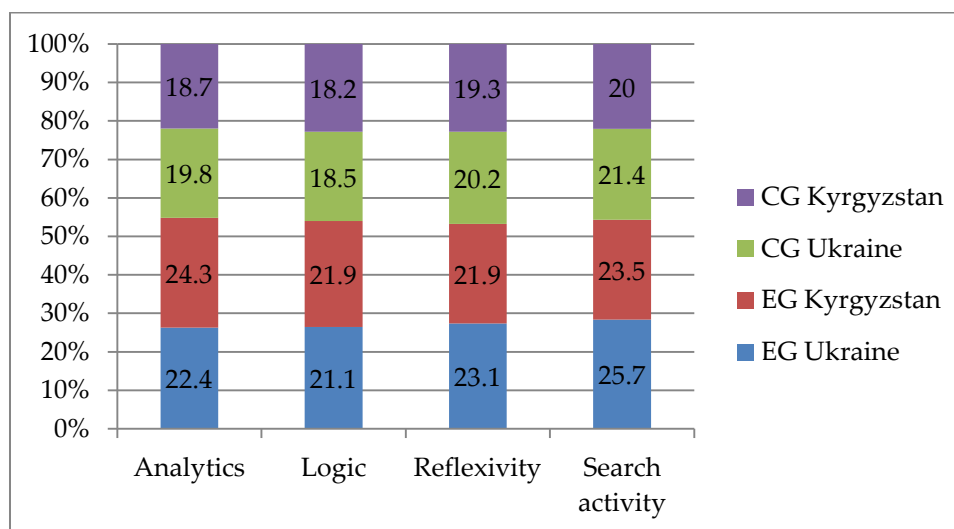


Fig. 1. Results of critical thinking in the CG and EG of Ukrainian and Kyrgyz students after the formative experiment

**Author's own contribution*

As evidenced by the statistical analysis of the primary empirical data, significant disparities in the components of critical thinking were observed between EG and CG students following formative interventions (Table 4).

Tab. 4

General, average critical thinking scores in EG and CG

Indicator	EG ($\bar{x} \pm \sigma$)	CG ($\bar{x} \pm \sigma$)	t	p
Analytics	24.3 \pm 2.8	19.8 \pm 3.2	8.14	< 0.001
Logic	21.9 \pm 2.4	18.5 \pm 2.7	7.32	< 0.001
Reflexivity	23.1 \pm 2.6	20.2 \pm 3.1	5.65	< 0.001
Search activity	25.7 \pm 3.2	21.4 \pm 3.4	7.19	< 0.001

**Author's own contribution*

Note: \bar{x} is the mean, σ is the standard deviation, t is the Student's t -test, p is the significance level

In the generalized indicators of the experimental groups, we see that the average values for all components of critical thinking strategies were significantly higher than in the CG: analytics – 24.3 versus 19.8; logic – 21.9 versus 18.5; reflexivity – 23.1 versus 20.2; search activity – 25.7 versus 21.4 ($p < 0.001$). These findings suggest a profound developmental impact resulting from the implementation of a program that employs a suite of innovative critical thinking strategies.

In the EG of students from Kyrgyzstan and Ukraine, the average values for all components of critical thinking were significantly higher than in the generalized CG data: analytical skills – 24.3 versus 19.8; logical skills – 21.9 versus 18.5; reflexivity – 23.1 versus 20.2; search activity – 25.7 versus 21.4 ($p < 0.001$). These results indicate a significant developmental effect of innovative teaching methods. These findings underscore a significant developmental impact of innovative pedagogical approaches.

Pearson correlation analysis revealed close relationships between the components of critical thinking and the characteristics of students' cognitive independence (Table 5).

Tab. 5

Relationships between critical thinking and cognitive independence of students (EG and CG)

Criteria for cognitive independence	Critical thinking indicators			
	Analytics	Logic	Reflexivity	Search activity
Students from Ukraine				
Motivational criterion (instrumental learning values)	EG: 0.42** CG: 0.33*	EG: 0.38** CG: 0.27*	EG: 0.47** CG: 0.39**	EG: 0.51** CG: 0.38**
Content-operational criterion (cultivation of general intellectual skills (GIS))	EG: 0.39** CG: 0.28*	EG: 0.35** CG: 0.24*	EG: 0.44** CG: 0.36**	EG: 0.48** CG: 0.32**
Volitional criterion	EG: 0.37** CG: 0.25*	EG: 0.32* CG: 0.20*	EG: 0.41** CG: 0.33**	EG: 0.45** CG: 0.30**
Students from Kyrgyzstan				
Motivational criterion (instrumental learning values)	EG: 0.40** CG: 0.31**	EG: 0.36** CG: 0.28*	EG: 0.45** CG: 0.38**	EG: 0.50** CG: 0.40**
Content-operational criterion (cultivation of general intellectual skills (GIS))	EG: 0.41** CG Kyrgyzstan: 0.30*	EG: 0.34** CG: 0.25*	EG: 0.46** CG: 0.38**	EG: 0.48** CG: 0.35**
Volitional criterion	EG: 0.36** CG: 0.28*	EG: 0.31** CG: 0.22*	EG: 0.42** CG: 0.34**	EG: 0.44** CG: 0.32**

**Author's own contribution*

*Note: the values of Pearson correlation coefficients are given; * – $p < 0.01$; ** – $p < 0.001$*

In Ukraine, more pronounced positive correlations are observed in EG between the elements of critical thinking and the attributes of cognitive independence than in CG. This substantiates the efficacy of innovative pedagogical approaches employed in Ukraine.

In Kyrgyzstan, the results also show positive correlations, although the increase in EG is somewhat smaller than in Ukraine. However, the correlations remain significant, indicating a positive impact of groundbreaking teaching methods.

A comparative analysis between Ukraine and Kyrgyzstan reveals that the correlations within the experimental groups in Ukraine are markedly more pronounced, suggesting a more profound integration of innovative pedagogical methods into the educational framework. While students from Kyrgyzstan also demonstrate significant advancements, the variance in outcomes may be attributed to these methods' adaptation to the specific local context. At the same time, it should be noted that in the Ukrainian educational system, innovative methods were introduced earlier and at a more systematic level, which could have influenced the higher EG rates. In Kyrgyzstan, some students initially faced difficulties in completing project assignments due to a lack of experience in independent learning, so at the stage of implementing the methodology, additional training was provided to teachers and clarification of tasks for students. These cultural and educational differences were taken into account when interpreting the results, especially when comparing the dynamics of the development of the analytical and search components. This partly explains the differences in the growth of different components of critical thinking. Thus, the cultural and educational context played a role both in the implementation of the methods and in their perception by students.

Given the objective of the study, which is to evaluate the influence of innovative pedagogical approaches on the cultivation of students' critical thinking abilities, it was decided to concentrate on the outcomes of the experimental group as the primary subjects of investigation. In this context, control groups trained through traditional methods were employed for comparative analysis, although they are not the principal focus of analysis.

Table 6 presents the results of the correlation analysis, reflecting the relationships between the components of critical thinking (analytical, logical, reflexive, and search activity) and the characteristics of students' cognitive independence who studied using innovative methods (EG). The statistical indicators delineated in the table substantiate a positive and significant correlation between the cultivation of critical thinking and the degree of cognitive independence, thereby confirming the effectiveness of the applied methods in developing the students' cognitive and volitional qualities.

Tab. 6

Relationships between critical thinking and cognitive independence of Ukrainian and Kyrgyz EG students

Criteria for cognitive independence	Critical thinking indicators			
	Analytics	Logic	Reflexivity	Search activity
Motivational criterion (instrumental learning values)	0.42**	0.38**	0.47**	0.51**
Content-operational criterion (formation of general intellectual skills (GIS))	0.39**	0.35**	0.44**	0.48**
Volitional criterion	0.37**	0.32*	0.41**	0.45**

**Author's own contribution*

*Note: the values of Pearson correlation coefficients are given; * – $p < 0.01$; ** – $p < 0.001$*

According to the data presented in the table, there is a significant positive relationship between the components of critical thinking and various criteria of EG students' cognitive independence. The strongest correlations were found between critical thinking and the motivational criterion (instrumental learning values), with correlation coefficients ranging from 0.42 to 0.51 ($p < 0.001$). This indicates that students with high levels of critical thinking have greater achievement motivation and value organization and diligence, which directly impacts their cognitive independence.

The correlations between critical thinking and the content-operational criterion (formation of general intellectual skills) are also significant (from 0.35 to 0.48, $p < 0.001$), which confirms the importance of developing cognitive skills for effective task performance and achieving a high level of cognitive autonomy. Moreover, the relationship between critical thinking and the volitional criterion (from 0.32 to 0.45, $p < 0.01$) underscores the significance of emotional-volitional factors, such as the capacity for independent work, tenacity, and sustained concentration.

Therefore, the results obtained indicate that a high level of critical thinking has a positive impact on the development of all major aspects of students' cognitive independence, including motivation, cognitive skills, and determination. These relationships confirm the importance of innovative teaching methods focused on the development of critical thinking for the formation of students' cognitive independence.

For a more profound analysis of the relationships between the components of critical thinking and cognitive independence factors, a multiple regression analysis was conducted (Table 7). Critical thinking indicators served as dependent variables, and criteria for students' cognitive independence served as predictors.

The constructed regression models elucidate between 29% and 38% of the variance in the dependent variables within the framework of students' cognitive independence. The most significant contribution to the development of all components of cognitive independence is attributed to the motivational criterion (instrumental educational values) and the content-operational criterion (the cultivation of general intellectual skills).

Tab. 7

Results of multiple regression analysis regarding the influence of critical thinking on the formation of students' cognitive independence in experimental groups (overall average values)

Dependent variable of critical thinking	Criteria for cognitive independence	β	t	p
Analytics	Motivational criterion (instrumental learning values)	0.34	4.21	< 0.001
	Content-operational criterion (formation of general intellectual skills)	0.29	3.58	< 0.001
	Volitional criterion	0.21	2.63	< 0.01
Logic	Motivational criterion (instrumental learning values)	0.32	3.96	< 0.001
	Content-operational criterion (formation of general intellectual skills)	0.26	3.22	< 0.01
	Volitional criterion	0.19	2.37	< 0.05
Reflexivity	Motivational criterion (instrumental learning values)	0.38	4.69	< 0.001
	Content-operational criterion (formation of general intellectual skills)	0.31	3.84	< 0.001
	Volitional criterion	0.24	2.98	< 0.01
Search activity	Motivational criterion (instrumental learning values)	0.42	5.17	< 0.001
	Content-operational criterion (formation of general intellectual skills)	0.35	4.32	< 0.001
	Volitional criterion	0.27	3.35	< 0.01

*Author's own contribution

Note: β is the standardized regression coefficient, t is the Student's t-test, p is the significance level

Analytical skills are positively correlated with all dimensions of cognitive independence. The most profound influence on the cultivation of analytical thinking is derived from the motivational criterion ($\beta = 0.34$, $p < 0.001$), underscoring the pivotal role of motivation in achieving educational objectives and enhancing the capacity to analyze and resolve intricate problems. Additionally, the impact of the content-operational criterion, which pertains to the development of general intellectual skills, on analytical proficiency is also noteworthy ($\beta = 0.29$, $p < 0.001$), accentuating the significance of intellectual competencies in fostering this essential component of critical thinking.

Logical skills show a strong correlation with the motivational criterion ($\beta = 0.32$, $p < 0.001$), thereby confirming that students with a high motivation level to succeed can logically process information and argue their positions. The impact of the content-operational criterion on logics ($\beta = 0.26$, $p < 0.01$) and the volitional criterion ($\beta = 0.19$, $p < 0.05$) underscores the significance of cognitive and volitional qualities in the formation of logical thinking.

Reflexivity exhibits a strong correlation with the motivational criterion ($\beta = 0.38$, $p < 0.001$), suggesting that students whose aspirations are driven by the attainment of learning objectives are more inclined to engage in self-reflection and critically assess their cognitive processes. Furthermore, the content-operational criterion exerts a significant influence on reflexivity ($\beta = 0.31$, $p < 0.001$), affirming the pivotal role of general intellectual competencies in cultivating the capacity for self-regulation and comprehension of one's actions.

Search activity demonstrates the greatest influence from the motivational criterion ($\beta = 0.42$, $p < 0.001$), which indicates a high level of initiative and willingness to explore new approaches among students with high cognitive motivation. The influence of the content-operational criterion on search activity ($\beta = 0.35$, $p < 0.001$) emphasizes the role of intellectual skills in initiative and active search for new solutions. The influence of the volitional criterion ($\beta = 0.27$, $p < 0.01$) is also significant, indicating the role of volitional qualities in supporting intellectual activity.

Therefore, the findings substantiate that critical thinking strategies, in particular analytical, logical, reflexive, and exploratory activity, have a significant impact on the development of students' cognitive

independence criteria. The interrelation of motivational, cognitive, and volitional factors is integral to the formation of cognitive independence, thereby enhancing the development of critical thinking and the efficacy of students' cognitive activity.

In order to better understand the impact of context on the effectiveness of the pedagogical strategies used, it is advisable to analyse the specific conditions of the experiment in Ukraine and Kyrgyzstan. Table 8 presents a comparative description of the educational systems, the level of training of participants, and the specifics of the implementation of the critical thinking methodology in both countries.

Tab. 8

Comparative analysis of educational conditions in Ukraine and Kyrgyzstan within the experiment

Criteria	Ukraine	Kyrgyzstan
Integration of critical thinking	Innovative approaches are enshrined in educational standards, and there is preliminary implementation practice	Active phase of updating educational programmes, interest in implementing modern strategies
Lecturers training	Lecturers have experience in applying case studies and project-based learning	Targeted trainings for teachers, high motivation to implement innovations
Students' reaction to the task	High level of readiness for independent work and analytical thinking	High involvement in the process, positive attitude to new formats
Adaptation of methods	The methodology was applied without significant changes	Local adaptation of tasks to suit the context and needs of students
Dominant strengths	Flexibility in performing complex search tasks	Perseverance, teamwork, rapid growth of the motivational component
Development dynamics	Steady growth in search and reflection activity	A marked increase in analytical thinking and interest in cognitive tasks
The context of educational reforms	Gradual modernisation within the framework of the European integration course	Systemic transformation with a focus on innovative and critical models

**Author's own contribution*

As the table shows, despite the difference in educational traditions and the pace of reforms, both Ukrainian and Kyrgyz students successfully mastered the elements of critical thinking, demonstrating positive dynamics in key criteria. High motivation, openness to innovation, and support from teachers were the determining factors in the effectiveness of the methodology in both countries. This result emphasises the universality of the studied strategies and their ability to be flexibly adapted in different cultural and educational contexts.

Most scholars agree that traditional teaching methods (such as lectures and seminars) do not sufficiently stimulate students' intellectual engagement, as they primarily emphasize the passive assimilation of pre-formed knowledge (Shin & Bolkan, 2021; Shi & Qu, 2022). Conversely, innovative methodologies (including case studies, projects, and problem-based learning) foster autonomous knowledge acquisition through extensive research endeavors, frequent shifts in cognitive strategies, and collaborative discourse (American Psychological Association, 2025; Renzulli et al., 2021), thereby creating a zone of proximal development for the formation of critical thinking. It should be taken into account that in the Ukrainian educational context, there has already been a gradual shift towards more flexible, student-centred methods, while in Kyrgyzstan such methods are only just being introduced. This could have affected the initial receptivity of students to experimental strategies.

The previous studies substantiate the developmental impact of various innovative methodologies, such as problem-based learning (Wu, 2023; Bulgaru & Radius, 2023), case technologies (Pratiwi & Waluyo, 2023), and others. Our work complements the data with a systematic analysis of a range of innovative approaches compared to traditional learning. One of the strengths of the experiment is the use of quantitatively measured criteria for the development of critical thinking on a valid sample of

students. However, unlike most of the studies mentioned above, ours covers two educational spaces with different teaching traditions. This allows us to assess not only the effectiveness of the methods but also the flexibility of their adaptation to the local context.

As it was mentioned, our empirical study showed that the use of critical thinking development strategies led to a significant increase in students' cognitive independence across all dimensions. In particular, the analytics indicator in the EG (24.3) exceeded the CG (19.8), logics – 21.9 versus 18.5, reflexivity – 23.1 versus 20.2, and search activity – 25.7 versus 21.4. Similar findings were noted by other researchers. For example, Rivas et al. (2022), when implementing the ARDESOS-DIAPROVE intervention, noted a significant improvement in both critical thinking and metacognitive awareness of students after the training program. Similarly, Demir and Çetinbaş (2023) found a significant positive relationship between the level of critical thinking and autonomous learning in a group of gifted students: critical thinking became a statistically significant predictor of autonomous learning. In our study, it was observed that students from Ukraine demonstrated consistently higher scores at the pre-test stage, while in Kyrgyzstan, the effect of the intervention was more noticeable, especially in the logical and search components. This may be explained by the different academic focus: Ukrainian universities place more emphasis on reflection and analysis, while Kyrgyz universities focus on the pragmatic application of knowledge.

The correlation between creative thinking flexibility and critical cognitive skills is confirmed by Karakuş (2024): students with higher levels of cognitive flexibility demonstrated higher propensities for critical thinking. Gajić (2021) proved a close relationship between students' critical thinking and their academic performance, which indirectly indicates the role of independent learning skills. Furthermore, Nizaruddin and Kusmaryono (2023) noted that in the higher education learning process, critical thinking is closely linked to independent learning and self-regulation, which are mutually reinforcing. Thus, the outcomes of our experiment generally align with international data as the development of critical thinking stimulates the growth of student autonomy. In the context of comparing different pedagogical approaches, the effectiveness of project-based learning should be underscored. It is worth noting that in Kyrgyzstan, students showed less flexibility in open-ended tasks, but demonstrated a high ability to search for resources on their own, possibly due to less methodological dependence on the teacher and more interpersonal support in groups.

In a study by Hryn et al. (2024), after the implementation of the project method, critical thinking in the EG reached a high level, while in the CG it remained average. The authors concluded that project-based learning is a powerful tool for developing students' critical thinking, as it allows them to combine theoretical knowledge with practice. All these findings correlate with our research: we observed the greatest growth in the analytical and logical components. At the same time, some differences and limitations should be mentioned. While our results demonstrate a smaller increase in the reflective component (approximately 2.9 points), this is consistent with the findings of Nedilia and Kmit (2021), where the fastest growth rate was in the ability to justify a position (only +21% versus +28% in logic). Hence, this shows that the formation of deep self-knowledge and analysis of critical thinking requires specially directed exercises. At the same time, numerous studies emphasize that developed critical thinking is inseparable from a student's discipline and self-control. Social factors should also be taken into account: in Kyrgyzstan, students more often pointed to external motivation (family approval, raising their ranking), while Ukrainian students pointed to internal motivation (self-realisation, analytical curiosity), which also affected the depth of the reflective component.

In particular, Nizaruddin and Kusmaryono (2023) prove that self-regulation enhances the effectiveness of critical thinking training, and independent learning reflects student responsibility for results. It is also worth considering that the experiments were conducted in different cultural and educational contexts: for example, in the study by Demir and Cetinbas (2023), the population was adolescents from art centers in Turkey, in Rivas et al. (2022) – students from Spain, and in our study – Ukrainian and Kyrgyz students. Although the overall trends are similar, these differences may affect

absolute indicators. In our study, the impact of cultural differences was particularly evident in attitudes towards group work: Ukrainian students demonstrated greater autonomy in individual task solving, while Kyrgyz students relied more on collective interaction, indicating different educational traditions of developing independence. Therefore, comparative analysis shows that the results of our experiment are consistent with international research: the development of critical thinking strategies increases students' cognitive independence. Nevertheless, the characteristics of individual components (analytical, reflective, etc.) may require additional adjustment of the methods. Further research should clarify which interventions (in particular, training in metacognitive strategies) are most effective for increasing learning autonomy in specific settings. In future research, it is advisable to expand the intercultural component: the inclusion of qualitative interviews or observations will help to better understand the reasons for differences in critical thinking outcomes depending on the educational models of countries.

A. Limitation

It is imperative to acknowledge certain limitations inherent in the analysis conducted. Firstly, the experiment encompassed students from only two fields of study, namely pedagogical and technical, which constrains the capacity to generalize the findings. Secondly, the dynamics of critical thinking were monitored over a relatively short timeframe. To draw more reliable conclusions, it would be expedient to undertake a longitudinal study.

5. CONCLUSIONS

The analysis of the outcomes of students' educational activities (essays, projects, reflective diaries) has enabled us to discern the principal indicators of critical thinking development in EG, signifying a marked enhancement in cognitive independence: the capacity to articulate a problem clearly and convey one's stance; a nuanced analysis of information, distinguishing between primary and secondary elements; the formulation and empirical testing of hypotheses, alongside an objective interpretation of data; logically sound argumentation substantiated by evidence and examples; the generation of alternative solutions and the consideration of diverse perspectives; a realistic assessment of one's intellectual resources coupled with a readiness to acknowledge errors; and an openness to novel ideas, accompanied by the willingness to adjust one's position.

In the CG, similar indicators were observed in a sporadic and fragmentary manner. Students in the CG predominantly displayed a one-dimensional analysis of information, an inclination toward stereotypes, an inability to transcend familiar frameworks, and a rigidity of thinking. These findings corroborate contemporary theoretical perspectives regarding the psychological and pedagogical mechanisms underlying the cultivation of critical thinking.

The study results substantiate that the implementation of critical thinking strategies markedly enhances the development of students' cognitive independence. Statistical analysis revealed a substantial advancement in these competencies among students who participated in the innovative program, thereby confirming the efficacy of applying novel strategies in the educational process. Specifically, correlation analysis revealed a close relationship between the critical thinking level and various aspects of students' cognitive independence. This underscores the significance of cultivating critical skills to bolster academic independence and the capacity for self-directed learning.

The scientific novelty of the study lies in its comprehensive examination of the innovative methods' impact on the enhancement of critical thinking and cognitive independence among students, as well as in elucidating the interrelationship between these constructs through rigorous statistical analysis. The research contributes to a more profound understanding of the mechanisms underlying the formation of students' cognitive independence within the contemporary educational landscape.

The practical implications of the study lie in the potential application of its findings to refine pedagogical approaches in higher education institutions. Specifically, the methods developed can be integrated into curricula aimed at fostering critical thinking and cognitive independence in students,

thereby increasing the effectiveness of the educational process and the training of future professionals.

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Albina Volkotrubova, PhD in Pedagogical Science, Associate Professor, Department of Linguistics, International University of Kyrgyzstan, Bishkek, Kyrgyzstan;

ORCID ID: 0000-0002-8343-719X

Address: International University of Kyrgyzstan, Lev Tolstoy, 17A/1, Bishkek, Kyrgyzstan.

E-mail: avolkotrubova@gmail.com

Jie Liu, PhD Student, Kyrgyz State University named after I. Arabaev, Bishkek, Kyrgyzstan;

ORCID ID: 0009-0004-1824-2662

Address: Kyrgyz State University named after I. Arabaev, Razzakov str., 51, Bishkek, Kyrgyzstan.

E-mail: 962733183@qq.com

Tetiana Remekh, PhD in Pedagogy, Executive Researcher, Head, Department of Society-Scientific Education, Pedagogical Institute of NAPS in Ukraine, Kyiv, Ukraine;

ORCID ID: 0000-0002-5666-6640

Address: Department of Society-Scientific Education, Pedagogical Institute of NAPS in Ukraine, Sichovykh Striltsiv str., 52-D, Kyiv, 04053, Ukraine.

E-mail: Tetiana_rem09@gmail.com

Larysa Lytvyn, Candidate of Philological Sciences (PhD in Philology), Senior Lecturer, Department of Ukrainian Literature, Faculty of Ukrainian Philology and Journalism, Poltava V.G. Korolenko National Pedagogical University, Poltava, Ukraine;

ORCID ID: 0009-0003-8701-528X

Address: Department of the Ukrainian Literature, Faculty of Ukrainian Philology and Journalism, Poltava V.G. Korolenko National Pedagogical University, Ostrogradski str., 2, Poltava, 36000, Ukraine.

E-mail: larysaivanchenkova@gmail.com

Iryna Bondar, Candidate of Pedagogical Sciences, Associate Professor, Department of the History and Methods of Teaching, Faculty of History, Political Science and International Relations, Rivne State Humanitarian University, Rivne, Ukraine;

ORCID ID: 0000-0002-2005-8141

Address: Department of the History of Ukraine, Faculty of History, Political Science and International Relations, Rivne State Humanitarian University, Stepana Bandery str., 12, Rivne, 33028, Ukraine.

E-mail: centuare126@ukr.net

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Волкотрубова Альбіна, Цзе Лю, Ремех Тетяна, Литвин Лариса, Бондар Ірина. Вплив стратегій критичного мислення на формування пізнавальної самостійності студентів. *Журнал Прикарпатського університету імені Василя Стефаника*, 12 (3) (2025), 6-22.

У статті розглядається вплив стратегій критичного мислення на розвиток пізнавальної самостійності студентів. Мета дослідження – з'ясувати ефективність інноваційних педагогічних методів, які сприяють розвитку критичного мислення та самостійності студентів. Для досягнення мети було використано комплекс теоретичних, емпіричних і статистичних методів, зокрема анкетування, педагогічний експеримент, регресійний аналіз. Результати дослідження виявили значні відмінності між експериментальною групою (ЕГ) та контрольною групою (КГ). Кореляційний аналіз також засвідчив значний позитивний зв'язок між критичним мисленням і пізнавальною самостійністю студентів. Зокрема, показники мотиваційного критерію пізнавальної самостійності продемонстрували кореляційні зв'язки з компонентами критичного мислення з коефіцієнтами від 0,42 до 0,51 ($p < 0,001$). Особливістю дослідження є двокраїнний дизайн (Україна та Киргизстан), що дозволяє порівняти ефективність інноваційних стратегій критичного мислення у різних культурно-освітніх контекстах. Встановлено, що в обох вибірках експериментальні групи значно перевищують контрольні за всіма показниками. Програма, що включала кейс-методи, проєктне навчання та теорію розв'язання винахідницьких задач, виявилася ефективною в обох країнах, проте із певними локальними адаптаціями. Наукова новизна цього дослідження полягає в тому, що воно ґрунтовно вивчає взаємозв'язки між критичним мисленням та різними аспектами когнітивної незалежності. Практичне значення дослідження полягає у можливості впровадження запропонованої програми в заклади вищої освіти як у межах спеціальних курсів, так і у форматі міждисциплінарної

інтеграції критичного мислення в освітній процес. Адаптивність методики до різних культурно-освітніх контекстів (зокрема українського та киргизького) свідчить про її універсальність і практичну придатність для широкого застосування.

Ключові слова: критичне мислення, автономне навчання, навчальна автономія, активні стратегії навчання, освіта для сталого розвитку, педагогіка.