



## **DEVELOPING STUDENTS' COGNITIVE ACTIVITY THROUGH THE ORGANIZATION OF INDEPENDENT WORK IN MEDICAL EDUCATION**

Ruzakhon Nasirovna Melibayeva,  
Doctor of Psychological Sciences, Professor,  
Head of the Department of Pedagogy and Psychology,  
Tashkent State Medical University, Tashkent, Uzbekistan

### **Abstract**

The article explores the theoretical and methodological foundations, as well as the evaluation criteria, for developing students' cognitive activity in medical education through structured independent work. The research defines cognitive, motivational, and operational-practical criteria that comprehensively assess the dynamics of professional competence formation. Based on psychological, pedagogical, and neurophysiological studies, the author substantiates the interrelation between cognitive activity, intellectual development, and professional readiness of future healthcare specialists.

**Keywords:** Cognitive activity, independent learning, cognitive criterion, motivational criterion, operational criterion, medical education, professional competence.

### **Introduction**

Modern trends in medical education emphasize the growing importance of independent learning as a major factor in forming students' cognitive activity and intellectual autonomy. Cognitive activity functions not only as an integrative quality of the personality but also as a key condition for professional maturity, fostering critical thinking, reflection, and clinical reasoning.

The relevance of this study stems from the urgent need to improve the methodological organization of independent work in medical universities and to establish measurable criteria for evaluating its effectiveness. The ultimate goal is to strengthen students' ability to acquire, analyze, and apply knowledge independently in clinical contexts.



Theoretical underpinnings of cognitive activity development trace back to the works of L.S. Vygotsky, S.L. Rubinstein, A.N. Leontiev, D.N. Uznadze, A.R. Luria, V.E. Rozhnov, and M.N. Skatkin, who emphasized that learning is an active and dynamic process of self-development. Rozhnov (1985) pointed out that “a large amount of information is assimilated by the nervous system unconsciously,” highlighting the neuropsychological mechanisms behind learning.

E.A. Golubeva (1990) demonstrated how temperamental and neurophysiological traits influence memory efficiency and information retention. M.N. Skatkin (1982) distinguished internal (motives, beliefs) and external (goals, results) aspects of cognitive activity, while K.M. Gurevich and E.I. Gorbacheva (1989) defined intellectual development as a system of generalized knowledge and skills forming the basis for self-directed progress.

Hence, cognitive activity is conceptualized as a systemic construct, integrating motivational, cognitive, and operational components within the learner’s personality structure.

## **2. Theoretical and Methodological Framework**

The methodological basis of this research integrates activity-based, learner-centered, and competence-based approaches. It aligns with the concept of active learning, which presumes that the learner’s cognitive process should be autonomous, exploratory, and creative.

The study aimed to design and test pedagogical conditions for developing cognitive activity among medical students during independent work, ensuring the balance between reproductive and productive learning modes.

The core research questions included:

1. How do structured independent learning models affect cognitive, motivational, and operational parameters of student activity?
2. What pedagogical tools and assessment models are most effective in stimulating cognitive engagement?
3. Which medical disciplines demonstrate the strongest response to methodological intervention?

### 3. Research Design and Methods

The quasi-experimental study was carried out at Tashkent State Medical University (TSMU) over two semesters (2023–2024). The total sample consisted of 306 students enrolled in three academic programs: *General Medicine* ( $n = 128$ ), *Pediatrics* ( $n = 96$ ), and *Medical Biology* ( $n = 82$ ).

Within each program, students were divided into experimental and control groups with equivalent baseline parameters (GPA, gender, year of study;  $p > 0.10$ ).

- Experimental groups participated in the enhanced independent learning model,
- Control groups followed traditional instruction without technological maps or self-assessment cards.

The enhanced model included the following didactic components:

1. Technological maps of independent work for each topic (objectives, key resources, multilevel tasks, criteria, self-control checklists).
2. Case-based learning (CBL) and problem-based learning (PBL): clinical scenarios with hypothesis formation, diagnostics planning, data interpretation, and SOAP-structured decision-making.
3. OSCE mini-stations (Objective Structured Clinical Examination): short practical exercises (5–7 min) on communication, history taking, and diagnostic reasoning.
4. Learning Management System (LMS) micro-modules: video-lectures, self-tests with instant feedback, glossaries, and reading trackers.
5. Self- and peer-assessment rubrics addressing cognitive, procedural, and communicative indicators.
6. “Reader tracks” combining required and optional professional literature lists validated through online quizzes.

The control groups studied without digital tracking, CBL/PBL elements, or OSCE integration.

A set of validated tools was used for quantitative and qualitative analysis:

- Cognitive Test Bank (50 items, KR-20  $\geq 0.78$ ) covering clinical disciplines;
- Written Case Essay (0–20 points; inter-rater  $\kappa = 0.74$ );
- Intrinsic Motivation Inventory (IMI) adapted to medical context ( $\alpha = 0.86$ );
- Reading Activity Reports in LMS (verified by short quizzes);
- OSCE Checklists for mini-stations ( $\alpha = 0.81$ );
- Clinical Reasoning Rubric (0–20;  $\kappa = 0.72$ );

- Readiness for Independent Work Scale (self- and expert-rated, 1–5).

Statistical analysis involved paired and independent t-tests, ANCOVA ( $T_1$  as dependent variable,  $T_0$  as covariate), and  $\chi^2$  tests for proportions. Effect sizes were reported using  $\eta^2$ , and significance was set at  $p < 0.05$  (Holm correction for multiple comparisons).

#### 4. Results

Table 1 presents the dynamics of cognitive indicators (mean  $\pm$  SD; % of “good/excellent” grades).

Program	Group	Test $T_0$	Test $T_1$	$\Delta$ p.p.	Quality $T_1$ (%)	Case Essay $T_1$ (0–20)
General Medicine	Exp. (n = 64)	61.8 $\pm$ 8.9	<b>78.6 <math>\pm</math> 7.5</b>	+16.8	86.9	16.2 $\pm$ 2.1
	Ctrl (n = 64)	62.1 $\pm$ 9.1	69.9 $\pm$ 8.6	+7.8	64.1	13.1 $\pm$ 2.6
Pediatrics	Exp. (n = 48)	60.7 $\pm$ 9.4	<b>74.2 <math>\pm</math> 8.2</b>	+13.5	78.3	15.4 $\pm$ 2.3
	Ctrl (n = 48)	61.0 $\pm$ 9.0	67.0 $\pm$ 8.8	+6.0	59.6	12.8 $\pm$ 2.7
Med. Biology	Exp. (n = 41)	63.0 $\pm$ 8.6	<b>73.5 <math>\pm</math> 7.9</b>	+10.5	72.0	14.7 $\pm$ 2.4
	Ctrl (n = 41)	62.5 $\pm$ 9.2	67.4 $\pm$ 8.7	+4.9	57.5	12.9 $\pm$ 2.5

ANCOVA results indicated significant main effects of the group variable across all disciplines:

- *General Medicine*:  $F(1, 124)=28.4, p<0.001, \eta^2=0.19$
- *Pediatrics*:  $F(1, 92)=17.2, p<0.001, \eta^2=0.16$
- *Medical Biology*:  $F(1, 78)=9.6, p=0.003, \eta^2=0.11$

The strongest gains were observed in General Medicine, likely due to richer exposure to clinical reasoning situations that foster “near-transfer” of knowledge to OSCE tasks.

Table 2 shows the dynamics of intrinsic motivation (IMI index), reading activity, and participation in research or student circles.

Program	Group	IMI $T_0$	IMI $T_1$	$\Delta$	Reading (units / month) $T_1$	Participation in Research (%) $T_1$
General Medicine	Exp.	4.2 $\pm$ 0.7	<b>5.6 <math>\pm</math> 0.6</b>	+1.4	5.1 $\pm$ 1.8	48.4
	Ctrl	4.2 $\pm$ 0.7	4.8 $\pm$ 0.7	+0.6	3.2 $\pm$ 1.4	29.7
Pediatrics	Exp.	4.1 $\pm$ 0.8	<b>5.3 <math>\pm</math> 0.7</b>	+1.2	4.3 $\pm$ 1.6	41.7
	Ctrl	4.1 $\pm$ 0.7	4.7 $\pm$ 0.7	+0.6	3.0 $\pm$ 1.3	27.1
Medical Biology	Exp.	4.3 $\pm$ 0.7	<b>5.1 <math>\pm</math> 0.6</b>	+0.8	4.0 $\pm$ 1.5	36.6
	Ctrl	4.2 $\pm$ 0.7	4.6 $\pm$ 0.6	+0.4	2.8 $\pm$ 1.2	24.4

All differences between experimental and control groups were statistically significant ( $p < 0.01$  for IMI and reading;  $p < 0.05$  for participation,  $\chi^2$ ). The strongest motivational improvement occurred in **General Medicine**, where the enhanced model's problem-based design and visible clinical relevance encouraged sustained interest.

Correlation analysis revealed consistent moderate associations:

- IMI  $\leftrightarrow$  Reading ( $r = 0.45, p < 0.01$ );
- Reading  $\leftrightarrow$  OSCE performance ( $r = 0.31, p < 0.01$ ).

These findings confirm that **intrinsic motivation and reading engagement act as mediators** between instructional design and practical achievement.

Table 3 presents the outcomes of OSCE mini-stations, clinical reasoning, and readiness for independent work.

Program	Group	OSCE T <sub>1</sub> (0–100)	Clinical Reasoning (0–20)	Readiness (Expert 1–5)
General Medicine	Exp.	<b>81.7 ± 7.2</b>	16.9 ± 1.9	4.3 ± 0.5
	Ctrl	72.9 ± 8.1	14.1 ± 2.2	3.6 ± 0.6
Pediatrics	Exp.	<b>78.3 ± 7.5</b>	16.2 ± 2.0	4.1 ± 0.5
	Ctrl	71.0 ± 7.9	13.8 ± 2.1	3.5 ± 0.6
Medical Biology	Exp.	<b>75.4 ± 7.8</b>	15.5 ± 2.1	3.9 ± 0.6
	Ctrl	69.6 ± 7.6	13.6 ± 2.0	3.4 ± 0.6

**ANCOVA** showed significant group effects ( $p < 0.001$  for all indicators). Effect sizes were largest in General Medicine (OSCE  $\eta^2 = 0.21$ ; Reasoning  $\eta^2 = 0.18$ ), confirming the strong influence of clinical immersion and structured self-assessment tools.

## 5. Discussion

Across all profiles, the extended model of independent work produced substantial improvements in cognitive, motivational, and practical domains.

- In *General Medicine*, gains were highest, attributable to dense exposure to diagnostic and decision-making scenarios that require rapid knowledge integration.
- In *Pediatrics*, progress was similar in cognitive and motivational components but slightly lower in OSCE skills, likely due to the specific communication demands of pediatric cases.

- In *Medical Biology*, results showed consistent yet moderate practical improvement, suggesting the need for greater emphasis on diagnostic interpretation and laboratory-to-clinic transfer tasks.

The integration of technological maps, CBL/PBL cases, and OSCE mini-stations created a feedback-rich environment that promoted self-regulation, autonomy, and reflective practice—all crucial traits for future physicians.

## 6. Conclusions

The findings of the quasi-experimental study confirm that an enhanced model of independent learning significantly improves the cognitive activity and academic performance of medical students across all specializations.

1. The combination of technological maps, CBL/PBL strategies, OSCE mini-cases, LMS modules, and self-/peer-assessment tools provided a comprehensive structure for developing higher-order thinking and reflective learning.
2. The strongest improvement was observed in the *General Medicine* program (cognitive +16.8 p.p.; motivation +1.4 IMI points; OSCE +8.8–9.0 scores), followed by *Pediatrics* and *Medical Biology*.
3. The research verified that independent learning, when supported by digital tracking and clear feedback, promotes self-efficacy, autonomy, and clinical reasoning—competencies crucial for professional growth in healthcare.
4. The integration of active learning elements led to measurable cognitive, motivational, and practical outcomes, confirming the effectiveness of the model as a pedagogical innovation within the context of higher medical education.

## 7. Practical Recommendations

Based on the experiment's results, the following recommendations are proposed for medical universities in Uzbekistan and beyond:

- Institutionalize technological maps of independent work across all departments.
- Expand library and LMS “reading tracks” with quiz validation to sustain reading discipline.
- Introduce OSCE mini-stations weekly in General Medicine and adapt pediatric scenarios emphasizing communication with parents.
- Implement dashboards for monitoring independent activity (tests, reading, research) with personalized feedback.



- Include self- and peer-assessment rubrics into ongoing course evaluation, accounting for up to 10 % of final grades.

These measures will ensure the continuity of active, self-regulated learning and align educational outcomes with professional standards of medical competence.

## 8. Limitations and Future Research

Although the study demonstrated robust results, several limitations must be acknowledged:

- Quasi-experimental design with administrative group allocation;
- Possible instructor effect, minimized by unified rubrics and shared test banks;
- Self-report bias in reading activity, mitigated by LMS-based verification;
- Potential test–retest effect controlled by parallel forms.

Future research should focus on longitudinal tracking of cognitive activity using digital learning analytics, exploring adaptive feedback algorithms and predictive modeling of student engagement trajectories.

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