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THE ROLE AND IMPORTANCE OF FORMING CLINICAL THINKING IN MEDICAL STUDENTS

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Abstract
This article addresses the issue of developing clinical thinking in medical university students in the context of modern requirements for medical education. It analyzes cognitive, pedagogical, and digital factors influencing the development of diagnostic and analytical abilities of future physicians. Special attention is given to empirical studies, innovative educational technologies (web quests, case method, interdisciplinary simulations), and the analysis of scientific publications from the Web of Science and Scopus databases. Promising research directions are identified, including neurocognitive mechanisms, the impact of molecular medicine, and the use of digital platforms. Practical recommendations are proposed for medical universities to implement systemic strategies for developing clinical thinking.

Keywords : Clinical thinking, medical education, cognitive operations, web quest, digital technologies, diagnostic reasoning, interdisciplinary approach.

Introduction

Modern medical education is undergoing a stage of profound transformation caused by both technological progress and changes in professional requirements for doctors. In the context of evidence-based medicine and a personalized approach, the ability of future specialists to clinical thinking is of particular importance - a special type of intellectual activity aimed at making a diagnosis, choosing therapy and substantiating medical decisions.

Despite the fact that clinical thinking is traditionally considered as a professional competence formed in the process of practical activity, modern studies (Smirnova et al., 2021; Zhang et al., 2023) indicate the possibility and necessity of its gradual formation already in the early years of study. The task of integrating cognitive and practice-oriented components of the educational process is especially acute.

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Clinical thinking is a complex process that combines the cognitive operations of analysis, synthesis, abstraction and forecasting. Its specificity lies in the simultaneous interaction of scientific knowledge, empirical experience and the context of a particular patient. Unlike formal logical thinking, clinical thinking relies not only on objective data, but also on intuitive assumptions, "mental scenarios" and heuristic strategies.

The main components of clinical thinking include:

- diagnostic analysis: understanding symptoms, comparing them with nosological models.
- prognostic hypothesis: constructing a probabilistic forecast of the course of the disease.
- determination of a therapeutic decision: choosing the most effective and ethically justified treatment strategy.

According to the works of Norman & Eva (2003), the development of clinical thinking is inextricably linked with the dual process theory, which distinguishes between:

- System 1 - intuitive, automated, pattern-based;
- System 2 - analytical, conscious, requiring cognitive effort.

At the initial stages of training, future doctors mainly use system 2, while experienced specialists more often rely on the automated patterns of system 1. Therefore, training should be aimed at developing both systems - both analytical abilities and clinical intuition.

From the point of view of educational psychology (Vygotsky, 1978; Bruner, 1996), the development of thinking is possible only under conditions of targeted pedagogical support, including:

-creation of cognitive difficulties (educational paradoxes);
-support for the internalization of mental operations;
-encouragement of reflexive activity.

Despite the recognition of clinical thinking as a key professional competence, empirical studies indicate that it is insufficiently developed in medical students, especially in their junior years. One of the most striking examples is a study conducted at the Omsk State Medical Academy (2021–2024), during which a comparative analysis of cognitive operations (abstraction and generalization) in 2nd-year students was carried out. The results are presented in the table. 1 .

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Table 1

years	Speciality	Low level (%)	Average level (%)	High level (%)
2010–2011	Лечебное дело (n=88)	55	35	10
2011–2012	Педиатрия (n=83)	65	25	10

The analysis of the results showed:

• More than half of the students do not have basic cognitive operations necessary for clinical analysis.

• The pediatric direction demonstrated even lower indicators (65% with a low level), which may be due to the emphasis on care rather than diagnostics in the early years.

Reasons for the recorded deficiencies:

1. Insufficient practical orientation of the curriculum of the 1st and 2nd years.
2. Lack of interdisciplinary tasks stimulating cognitive operations.
3. Underestimation of the role of the humanities (for example, psychology and pedagogy) in the development of reflective and analytical abilities.

Thus, without targeted pedagogical intervention, the development of clinical thinking turns out to be spontaneous and unsystematic.

In the context of digitalization of education and the development of hybrid forms of education, technologies aimed at activating the mental activity of students are of particular importance. Among them, the following turned out to be the most effective:

Despite their "non-core" nature, psychology and pedagogy play a key role in the development of analytical thinking.

Analysis of the Web of Science publication database (Q1–Q2 journals for 2019–2025) demonstrates a steady growth of interest in clinical thinking as an interdisciplinary phenomenon. The research agenda is developing especially actively in the following areas. Modern studies published in the journals Frontiers in Neurology, Cognitive Science, and Clinical Neurophysiology focus on the brain mechanisms underlying clinical decisions. For example, Filimonova et al. (2025): a study of hippocampal abnormalities in patients with chronic neuralgia — parallels were found between structural disorders and a decrease in diagnostic flexibility in doctors. Pashkov et al. (2025): a positive correlation was found between the

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functional connectivity of the prefrontal cortex and the ability to retain hypotheses in working memory when solving clinical cases.

Thus, clinical thinking has a neurophysiological basis, which opens up prospects for diagnosing cognitive readiness in students. The journals BMC Medical Education and International Journal of Molecular Sciences publish articles linking molecular processes with clinical thinking. Pashkina et al. (2024): a study of the effect of hyaluronic acid on cognitive functions in cancer patients. Work on epigenetics suggests the presence of markers of "professional stress" that can inhibit clinical decision-making. The journals Medical Teacher, Journal of Clinical Education, Education Sciences actively discuss: the use of virtual reality (VR) and augmented reality (AR) in the formation of thinking through modeling clinical situations; adaptation of digital simulators (for example, Body Interact, SimX) for practicing diagnostic scenarios with subsequent analytical reflection. Systematic development of clinical thinking is possible only if a number of organizational and methodological conditions are met. Based on the analysis of empirical data and Web of Science publications, the following recommendations are offered:

✅ . Early practical orientation

• Implementation of web quests and case simulations already in the 1st and 2nd years.

• Formation of connections between theoretical disciplines (anatomy, biochemistry) and clinical tasks.

• Conducting interdisciplinary modules with the participation of students of different specialties.

✅ Systemic cognitive diagnostics

• Use of psychometric scales and case tests to identify the level of thinking.

• Maintenance of individual cognitive profiles.

• Correction of educational trajectories taking into account cognitive deficits.

✅ Strengthening the research component

• Involving students in writing analytical reviews that include clinical hypotheses.

• Encouraging publication activity in student journals and participation in grants.

• Introduction of elective courses on clinical thinking based on the latest data from Scopus/WoS.

✅ Development of pedagogical competence of teachers

• Advanced training courses on thinking development.

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• Creation of a bank of cases and digital tasks.
• Involvement of teachers in research projects on thinking pedagogy.

Development of clinical thinking is not just teaching diagnostics and therapy, but a holistic cognitive-behavioral process that includes the development of intellectual operations, reflection, decision-making under conditions of uncertainty and interdisciplinary analysis.

Thus, the analysis showed:

• the need for an early start in teaching clinical thinking;
• the critical role of digital and cognitive technologies;
• high efficiency of integration of humanitarian and natural science components;
• the growing importance of international publications as an indicator and source of methodological innovations.

The strategic objective of medical education is to train doctors who are capable of thinking not algorithmically, but clinically: adaptively, flexibly, with high sensitivity to the individual patient.

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