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METHODOLOGY FOR DEVELOPING STUDENTS' DIGITAL-CLINICAL COMPETENCE THROUGH GENERATIVE ARTIFICIAL INTELLIGENCE-BASED CLINICAL CASES IN TEACHING INFORMATION TECHNOLOGIES IN MEDICINE

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Abstract

This article presents a methodological approach to developing medical students' digital-clinical competence through generative artificial intelligence-based clinical cases in the course "Information Technologies in Medicine." The rapid digitalization of health care, the expansion of electronic medical records, telemedicine, clinical decision-support systems, and generative AI tools require future physicians to combine technological literacy with clinical reasoning, evidence verification, ethical responsibility, and data-protection skills. The study is methodological and analytical in nature. It is based on a review of regulatory documents, international recommendations, and recent research on artificial intelligence in medical education, followed by pedagogical modelling and clinical-case design. The study proposes the CLINIC-AI model, which includes clinical problem formulation, learning-objective definition, information anonymization, guided interaction with generative AI, independent verification,

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and clinical reflection. The model positions AI as an educational instrument for analysis rather than as a substitute for medical judgement. Four types of educational cases are described: electronic health-record analysis, telemedicine triage, identification of AI hallucinations, and protection of confidential medical information. Assessment indicators are proposed for information management, clinical application, AI literacy, evidence-based verification, ethical decision-making, and reflective communication. The methodology can be used in practical lessons to connect information technologies with clinically relevant tasks and to prepare students for responsible use of AI in future professional activity.

Keywords: Information technologies in medicine, generative artificial intelligence, clinical case, digital-clinical competence, AI literacy, electronic health record, telemedicine, clinical reasoning, hallucination detection, data privacy, medical education, evidence-based verification.

Introduction

The digital transformation of health care is changing the professional requirements placed on future physicians. A modern doctor is expected not only to understand the principles of diagnosis and treatment but also to work with electronic medical records, digital databases, telemedicine systems, clinical decision-support tools, and artificial intelligence applications. In Uzbekistan, the national strategy for the development of artificial intelligence technologies until 2030 emphasizes the expansion of AI applications, improvement of the regulatory environment, and development of human resources and relevant competencies [1]. These priorities increase the importance of updating the content and teaching methods of the course “Information Technologies in Medicine.”

Generative artificial intelligence (GenAI) refers to systems capable of producing new content, including text, images, structured responses, and scenario-based outputs. In health care, large multimodal models are expected to support

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education, scientific research, public health, and selected clinical workflows. At the same time, the World Health Organization stresses that the use of such systems must be accompanied by human oversight, protection of privacy, transparency, and careful evaluation of risks [2]. UNESCO also recommends a human-centred approach to generative AI in education, in which technological opportunities are balanced with ethical standards, critical thinking, and the protection of learners' agency [3].

The need to modernize digital-health education is supported by the international Digital Health Competencies in Medical Education (DECODE) framework. The framework was developed through an international Delphi process involving 211 experts and identifies 19 competencies grouped into four domains for medical graduates [4]. These competencies demonstrate that digital health education should not be limited to technical operations. Medical students must learn to interpret digital information, understand the capabilities and limitations of technologies, communicate responsibly, and use digital tools in a clinically meaningful manner.

Generative AI creates particularly important opportunities for case-based learning. It can help educators prepare variable clinical scenarios, simulate patient communication, generate incomplete or contradictory records for analysis, and provide formative prompts for reflection. Studies have shown that GPT-powered chatbots can function as simulated patients for history-taking exercises and can provide realistic interaction opportunities that are repeatable and accessible [5]. Recent evidence also suggests that GenAI-based teaching may be especially useful for practical skill development, even when differences in theoretical knowledge acquisition are less pronounced [6]. However, clinical use of generated content requires caution because AI systems can produce plausible but incorrect statements, fabricated references, misleading recommendations, or incomplete reasoning.

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The relevance of this study lies in the need to develop a structured methodology that integrates AI-supported clinical cases into the course "Information Technologies in Medicine" without allowing AI to replace students' independent analysis. The purpose of the study is to design a pedagogically grounded model for developing students' digital-clinical competence through generative AI-based clinical cases. The objectives are to identify the components of digital-clinical competence, determine the stages of working with AI-supported cases, develop sample case types, and propose assessment criteria for practical lessons.

Materials and Methods

The study was designed as a methodological and analytical investigation. Official regulatory documents, international recommendations, and recent scientific publications on digital-health competencies, responsible AI use, generative AI in medical education, and virtual-patient simulations were reviewed. The selected sources included the national AI development strategy of Uzbekistan, WHO guidance, UNESCO recommendations, the AAMC principles for responsible AI use in medical education, the DECODE framework, and peer-reviewed studies published between 2024 and 2026 [1–12]. Methods of content analysis, comparative analysis, pedagogical modelling, competence-based design, and clinical-case construction were applied.

The object of the study was the teaching process of the course "Information Technologies in Medicine" in medical higher education. The subject of the study was the methodology for integrating generative AI-based clinical cases into practical lessons. In this article, digital-clinical competence is defined as a student's ability to select, use, evaluate, and explain digital technologies in clinically relevant situations while maintaining evidence-based reasoning, ethical responsibility, and data security.

The methodology was developed according to four design principles. First, AI must support the student's reasoning rather than replace it. Second, patient data

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used in educational prompts must be synthetic or anonymized. Third, AI outputs must be independently verified using reliable clinical guidelines, academic sources, and teacher feedback. Fourth, the assessment process must evaluate not only the final answer but also the student's reasoning, ability to identify limitations, and adherence to confidentiality rules. These principles are consistent with AAMC recommendations emphasizing a human-centred focus, ethical and transparent use, privacy protection, interdisciplinary curriculum development, and continuous evaluation [7].

Results

As a result of the theoretical analysis and pedagogical modelling, the CLINIC-AI methodology was developed. The name of the model reflects its six consecutive stages: Clinical problem formulation; Learning-objective definition; Information anonymization and source selection; Navigated interaction with generative AI; Independent verification and interpretation; and Clinical reflection with competence assessment. Each stage combines information-technology skills with a clinically meaningful educational task.

At the first stage, the teacher formulates a clinical problem connected with the topic of the practical lesson. The problem may include an electronic record with missing data, a telemedicine consultation requiring triage, a digital decision-support recommendation that must be checked, or an AI-generated answer containing a deliberate error. At the second stage, students identify the educational objective: determining what information is missing, which digital tool is appropriate, what risks exist, and which clinical question must be answered.

At the third stage, students learn to anonymize educational information. Names, addresses, telephone numbers, exact dates, identification numbers, and other direct identifiers must not be entered into open AI systems. At the fourth stage, students formulate a clear prompt and interact with the generative AI system

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under teacher supervision. The prompt should describe the task, specify the expected format, and request explanations rather than a final diagnosis alone. At the fifth stage, students compare the generated answer with reliable sources, identify inconsistencies, and explain why a recommendation can or cannot be accepted. At the final stage, students present a reflective conclusion describing the usefulness, limitations, and ethical risks of the technology.

The proposed methodology develops six interconnected components of digital-clinical competence. These components and their observable indicators are presented in Table 1.

Table 1. Components and assessment indicators of digital-clinical competence

Component	Expected student activity	Assessment indicator
Information management	Searches, structures, and interprets medical information from digital sources.	Correct identification of relevant and missing data.
Clinical application	Selects a suitable digital tool for a specific clinical situation.	Reasoned choice of an electronic record, telemedicine, database, or decision-support tool.
AI literacy	Writes a clear prompt and understands the limitations of generated responses.	Appropriate prompt structure and recognition of uncertainty.
Evidence verification	Compares AI-generated content with reliable guidelines and academic sources.	Detection and correction of unsupported or false claims.
Ethics and privacy	Protects confidential information and applies anonymization principles.	Absence of identifiable patient data and correct explanation of privacy risks.
Reflective communication	Explains the decision, limitations, and role of human oversight.	Logical, clinically justified, and ethically responsible conclusion.

Sample Clinical Cases

The following types of clinical cases can be incorporated into practical lessons while studying databases, electronic medical records, telemedicine, information security, and AI-assisted decision support.

1. **Electronic health-record analysis** – A 58-year-old patient with arterial hypertension has contradictory medication entries and irregular blood-pressure

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records in an electronic medical file. Students must identify missing information, explain possible digital-record errors, and prepare a structured verification plan using AI-generated questions.

2. **Telemedicine triage** – A pregnant patient living in a remote area reports headache, blurred vision, and swelling during an online consultation. Students determine which data can be collected remotely, identify warning signs requiring urgent in-person assessment, and explain the limitations of telemedicine.

3. **Detection of AI hallucinations** – A generative AI system interprets laboratory data but cites a non-existent protocol and proposes an unsupported dosage. Students verify the response against reliable sources, identify the false claims, and explain the patient-safety risks of accepting a fluent but inaccurate answer.

4. **Confidentiality and anonymization** – A student intends to upload a complete patient history into an open AI platform. The task is to identify personal data, replace them with synthetic information, and describe a safe workflow for using AI in educational activities.

The teacher's role is essential at every stage. Generative AI can facilitate the creation of diverse virtual patients, but AI-generated collections may contain repetitive elements or insufficiently representative scenarios. Therefore, cases must undergo clinical and didactic review before use [8]. The educational value of the method increases when the teacher deliberately includes uncertainty, incomplete data, or a verifiable error and asks students to justify their response rather than merely reproduce an AI-generated conclusion.

The assessment system should combine knowledge tests with practical case analysis. A 100-point rubric may be applied, with scores distributed among the six components of digital-clinical competence. Greater weight should be given to evidence verification, clinical justification, and privacy protection. This approach makes it possible to evaluate whether a student can use AI responsibly rather than simply obtain an answer from a chatbot.

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Discussion

The proposed methodology reflects the changing role of digital technologies in medical education. Traditional teaching of information technologies frequently focuses on general computer literacy, office applications, and theoretical descriptions of information systems. These topics remain important, but their educational value increases when they are linked with authentic clinical tasks. The use of AI-supported cases transforms the lesson from a sequence of technical operations into an applied learning environment in which students analyse data, make choices, check sources, and communicate their conclusions.

The CLINIC-AI model is consistent with current evidence. Holderried et al. demonstrated the feasibility of using a GPT-powered chatbot as a simulated patient for history-taking practice [5]. Fąferek et al. showed that generative AI can support the planning and creation of virtual-patient collections, while also emphasizing the need for review and quality assurance [8]. Li et al. reported that GenAI-based teaching methods can improve practical-skill outcomes compared with traditional approaches, although theoretical knowledge outcomes may be comparable [6]. These findings support the use of AI as an interactive and practice-oriented educational instrument.

At the same time, the integration of AI into medical education creates new risks. Zhou et al. found that trainees experienced difficulties in identifying AI-generated errors in clinical scenarios, underlining the need to strengthen critical thinking and AI literacy [9]. Boscardin et al. also emphasized that medical educators should introduce AI literacy frameworks and prepare learners to understand both the opportunities and the limitations of generative systems [10]. The key pedagogical task is therefore not to teach students to trust AI, but to teach them how to question, verify, and appropriately use AI-generated information.

Responsible implementation also requires institutional rules. WHO guidance highlights the importance of transparency, safety, privacy, accountability, and human oversight in the use of AI for health [2, 11]. AAMC principles similarly

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recommend ethical and transparent use, equitable access, professional development of educators, interdisciplinary curriculum design, data protection, and regular monitoring [7]. Jalali et al. provide practical recommendations for educators integrating AI into teaching, research, administration, and ethical decision-making [12]. These recommendations confirm that AI competence should be developed systematically rather than through isolated demonstrations.

The methodology has several limitations. It is a pedagogical model that requires empirical testing in control and experimental groups. The complexity of cases must be adapted to students' year of study and prior clinical knowledge. Access to AI tools may vary, and institutional policies must define which systems can be used. In addition, AI platforms change rapidly; therefore, cases, prompts, and evaluation criteria should be reviewed regularly. Future research should examine the influence of the CLINIC-AI model on students' digital-clinical competence, critical-thinking skills, motivation, and ability to detect hallucinations.

Practical Recommendations

For effective implementation of generative AI-based clinical cases in the course "Information Technologies in Medicine," the following recommendations are proposed:

1. **Use synthetic or anonymized clinical data** – Educational prompts must not contain information that can identify a real patient.
2. **Define a specific learning objective** – Every AI-supported case should be linked to a digital skill and a clinically relevant problem.
3. **Require independent verification** – Students must compare generated answers with reliable protocols, guidelines, and academic sources.
4. **Assess the reasoning process** – Evaluation should include prompt quality, source checking, ethical awareness, and reflective explanation, not only the final answer.

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5. **Include hallucination-detection tasks** – Students should practise identifying fabricated references, unsupported recommendations, and contradictory statements.
6. **Maintain teacher supervision** – All cases and generated outputs used in class must undergo clinical and pedagogical review.
7. **Update tasks regularly** – AI tools and institutional rules change rapidly; therefore, educational materials should be revised systematically.

Conclusion

Generative artificial intelligence-based clinical cases provide a relevant methodological opportunity for modernizing the course "Information Technologies in Medicine." The proposed CLINIC-AI model connects digital skills with clinical reasoning, evidence-based verification, confidentiality, and professional reflection. Its central principle is that AI should function as an object and instrument of analysis rather than as a replacement for medical judgement. By incorporating electronic-record analysis, telemedicine triage, hallucination detection, and confidentiality tasks into practical lessons, educators can develop students' digital-clinical competence in a structured manner. The methodology is suitable for further empirical evaluation in medical higher education and can contribute to preparing future physicians for responsible participation in digitally transformed health care.

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