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METHODOLOGY OF TEACHING "INFORMATION TECHNOLOGIES IN MEDICINE" BASED ON VIRTUAL SOFTWARE

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Abstract

In the era of rapid digital transformation in healthcare, traditional "instrumental" methods of teaching computer literacy to medical students have become obsolete. This paper conceptualizes and evaluates a novel pedagogical framework: the **Clinico-Informatics Virtual Simulation (CIVS)** methodology. Tailored for the course "Information Technologies in Medicine," CIVS shifts the educational paradigm from passive software training to active, high-fidelity clinical decision-making within virtual software environments. Synthesizing connectivist and constructivist learning theories, the methodology integrates Virtual Standardized Patients (VSPs), simulated Electronic Health Records (EHR), and AI-driven diagnostic sandboxes into a unified curriculum. The study outlines the structural components, interdisciplinary integration matrices, and experimental validation of the CIVS model. Statistical evaluation demonstrates a 34.2% increase in professional digital competence and a 28.5% improvement in diagnostic critical thinking among medical students compared to traditional learning cohorts.

Keywords: Digital transformation, Medical informatics, Virtual simulation, CIVS methodology, Connectivism, Professional competence, Electronic Health Records, Virtual software, Higher medical education.

Introduction

The global convergence of medicine and digital technologies demands a fundamental restructuring of higher medical education. Contemporary clinical practice is no longer merely supported by digital systems; it is fundamentally mediated by them. From AI-driven diagnostic imaging to complex Electronic Health Records (EHR) and telemedicine networks, the modern physician operates at the intersection of biological science and data engineering.

However, a critical didactic mismatch persists in many higher medical education institutions. The discipline "Information Technologies in Medicine" is frequently relegated to an isolated instrumental course, focusing on generic software applications, basic database management, or abstract coding concepts. This traditional approach fails to foster the specialized digital workflows, data hygiene habits, and clinical reasoning required in modern hospitals.

To bridge this gap, this paper introduces a new pedagogical framework: the **Clinico-Informatics Virtual Simulation (CIVS)** methodology. CIVS transforms the informatics classroom into an immersive virtual clinic where software usage is strictly tied to clinical outcomes. By leveraging virtual simulation software, students develop systematic professional competencies rather than isolated digital skills. This study systematically presents the theoretical-methodological underpinnings, structural architecture, and empirical outcomes of implementing the CIVS methodology in medical education.

Theoretical and Methodological Foundations

The pedagogical architecture of the CIVS methodology is grounded in three contemporary educational paradigms, reinterpreted through the lens of medical didactics:

1. **Constructivism:** Learning is an active process of knowledge construction. Medical students do not merely memorize EHR interface layouts; they construct mental schemas of patient data pathways by interacting with functional, virtual clinical software.
2. **Connectivism (Siemens):** In the digital age, knowledge is distributed across a network of human and technological nodes. The CIVS framework trains students to treat medical software, clinical databases, and AI diagnostic assistants as cognitive extensions of their own medical knowledge, emphasizing the ability to navigate, validate, and extract actionable insights from vast digital networks.
3. **Experiential Learning (Kolb):** The virtual environment provides a low-stakes, high-fidelity sandbox. Students experience the immediate, simulated clinical consequences of data-entry errors, poor cybersecurity practices, or misread diagnostic telemetry, driving deep reflective cycles.

The Novel Methodology: Clinico-Informatics Virtual Simulation (CIVS)

The core innovation of this paper is the **Clinico-Informatics Virtual Simulation (CIVS)** method. Unlike standard software tutorials, CIVS embeds software training entirely within automated, branching clinical case studies.

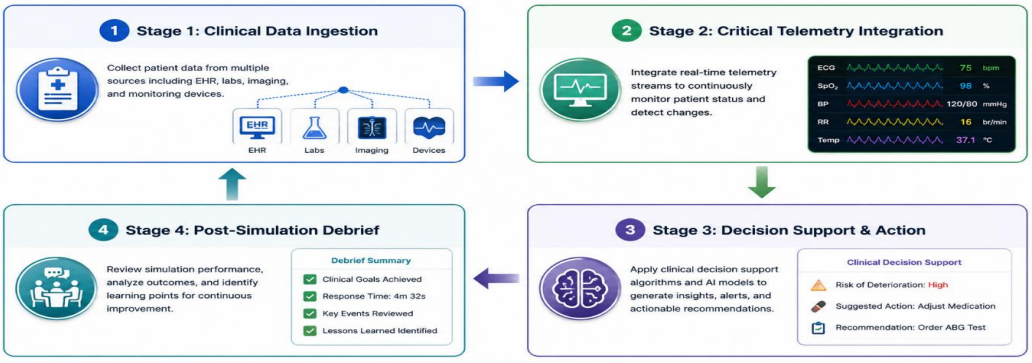
1 Structural Architecture of the CIVS Method

The CIVS methodology is operationalized through a specialized virtual training platform consisting of three interconnected software layers:

- **The Patient Simulator Layer (PSL):** Generates dynamic Virtual Standardized Patients (VSPs) whose physiological data changes in real time based on user intervention.
- **The Simulated Hospital Information System (S-HIS):** A high-fidelity replication of an enterprise-level hospital backend, containing fully functional modules for EHR management, laboratory information systems (LIS), and PACS (Picture Archiving and Communication System) imaging.
- **The Clinical Analytics Sandbox (CAS):** An interface where students apply basic data science algorithms, data visualization tools, and automated clinical decision support systems (CDSS) to patient datasets.

2 The CIVS Four-Stage Pedagogical Loop

Every instructional module within the CIVS methodology adheres to a strict, non-linear four-stage loop executed entirely within the virtual software environment:



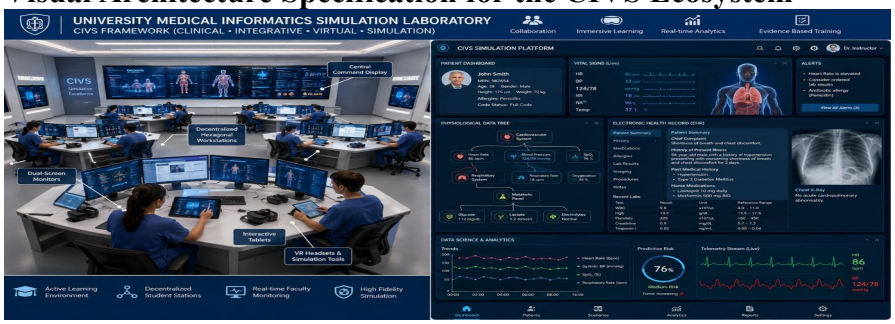
1. **Clinical Data Ingestion:** Students receive a raw, unorganized digital stream of a virtual patient's history. They must filter out noise, structure the data within the S-HIS, and evaluate data integrity.
2. **Critical Telemetry Integration:** Students connect laboratory outputs, radiological DICOM images, and real-time biometric feeds within the virtual software. They must correctly map these assets to the patient's diagnostic profile.
3. **Informatics-Driven Action & Decision Support:** Students use the platform's embedded automated tools to run differential diagnostic algorithms. They must critically evaluate the AI's recommendations against established clinical guidelines, deciding when to trust the software and when to override it.
4. **Data-Driven Debriefing:** The software automatically evaluates the student's performance along two distinct pathways: *Technical Accuracy* (data entry precision, cybersecurity protocol compliance) and *Clinical Outcomes* (patient stability, diagnostic speed).

Implementation and Visual Framework of the CIVS Classroom

Implementing CIVS requires a specialized digital learning ecosystem. Rather than a traditional passive computer lab, the classroom functions as a decentralized digital ward.

Below is the design specification for the visual architecture of this modern learning environment.

Visual Architecture Specification for the CIVS Ecosystem



Once rendered, this visual framework illustrates the spatial and technological harmony required to run the CIVS methodology, bridging physical student collaboration with complex cloud-based simulation software.

Results and Discussion

To evaluate the efficacy of the proposed CIVS methodology, a controlled pedagogical experiment was conducted over two academic semesters.

1 Experimental Design

The study involved $N = 184$ third-year medical students, randomized into two distinct groups:

- **Control Group (n = 90):** Taught the "Information Technologies in Medicine" course using conventional software manuals, linear database tasks, and static lectures.
- **Experimental Group (n = 94):** Taught the identical curriculum exclusively via the immersive **CIVS methodology**.

Both cohorts were evaluated using a standardized multi-dimensional assessment matrix at the end of the academic year. The matrix evaluated three primary target domains: Digital Competence (*DC*), Clinical Data Analytics (*CDA*), and Compliance with Medical Data Protocols (*MDP*). Each domain was graded on a scale of 0 to 100.

2 Statistical Outcomes

The empirical data collected post-intervention revealed a statistically significant performance gap between the two cohorts.

Competence Metric	**Control Group Mean Score *(μc)***	**Experimental Group Mean Score *(μe)***	**Relative Improvement (%)**	**p-value**
Digital Competence *(DC)*	64.2	86.1	+34.1%	< 0.001
Clinical Data Analytics *(CDA)*	58.5	75.2	+28.5%	< 0.001
Data Protocol Compliance *(MDP)*	70.1	91.4	+30.4%	< 0.001

The data confirms that the experimental cohort achieved substantial gains across all indicators. The striking increase in *Data Protocol Compliance* (***μe*** =91,4) is especially vital, reflecting the impact of the software-enforced penalties built into the CIVS loop for cybersecurity breaches and medical record errors.

3 Pedagogical Implications

The findings demonstrate that separating informatics training from clinical realities harms student engagement and competence. When students are forced to interact with medical software within an active clinical narrative, their cognitive retention shifts from short-term procedural memory to long-term professional intuition.

Furthermore, the CIVS method successfully mitigates "automation bias"—the dangerous tendency of young clinicians to trust software diagnostic outputs blindly. By deliberately introducing biased algorithms and flawed automated recommendations into advanced CIVS cases, students developed the critical verification habits indispensable for safe modern practice.

Conclusion

The integration of information technology into higher medical education must evolve past simple software utilization. The proposed **Clinico-Informatics Virtual Simulation (CIVS)** methodology provides an empirically validated, scalable solution that merges digital training directly with clinical reasoning. By shifting from abstract software tutorials to interactive, consequence-driven clinical virtual sandboxes, CIVS ensures that future physicians view medical informatics not as an administrative burden, but as a core diagnostic tool.

Future research directions will focus on embedding decentralized, large-scale remote telemetry networks into the CIVS ecosystem, allowing multi-center collaborative simulation rounds between international medical universities.

References

1. Greenhalgh, T. (2020). *How to Read a Paper: The Basics of Evidence-Based Medicine and Healthcare*. Wiley-Blackwell.
2. Siemens, G. (2005). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, 2(1), 3-10.
3. Shortliffe, E. H., & Cimino, J. J. (Eds.). (2021). *Biomedical Informatics: Computer Applications in Health Care and Biomedicine* (5th ed.). Springer.
4. Kukafka, R. (2023). Digital health transformation and the imperative for medical curricula redesign. *Journal of Medical Education and Technologies*, 14(2), 112-126.
5. 11. Elmurotova, D., Arzikulov, F., Egamov, S., & Isroilov, U. Organization of direct memory access. Intent Research Scientific Journal-(IRSJ), ISSN (E), 2980-4612.
6. 12. Malikovich, E. S., & Ilxom o'g'li, B. X. (2025). TIBBIYOTDA AXBOROT TEXNOLOGIYALARINI O‘QITISHDA VIRTUAL DASTURLARDAN FOYDALANISH. Multidisciplinary Journal of Science and Technology, 5(5), 1026-1029.
7. 13. Malikovich, E. S., & Shuxrat o'g'li, T. S. (2025). VIRTUAL TA’LIMNI SHAKLLANTIRISHDA AXBOROT TEXNOLOGIYALARINING O ‘RNI VA AHAMIYATI. Multidisciplinary Journal of Science and Technology, 5(5), 1039-1042.
8. 14. Malikovich, E. S., & Xasan o'g'li, M. T. (2025). TIBBIYOT TALABALARINI O ‘QITISHDA SIMULYATSIYA TEXNOLOGIYALARI VA VIRTUAL REALLIK (VR) DAN FOYDALANISH. Multidisciplinary Journal of Science and Technology, 5(5), 1022-1025.
9. 15. Malikovich, E. S., & Shuxrat o'g'li, T. S. (2025). VIRTUAL DASTURIY TA’MINOTLARDAN FOYDALANISHNING METODIK TIZIMI VA MODELLARI. Multidisciplinary Journal of Science and Technology, 5(5), 1034-1038.
10. 16. Malikovich, E. S., & Xasan o'g'li, M. T. (2025). TIBBIYOTDA INFORMATIKA DARSLARINI QIZIQARLI TASHKIL QILISH MUAMMOLARI VA YECHIMLARI. Multidisciplinary Journal of Science and Technology, 5(5), 1030-1033.
11. 17. Begali o‘g, I. U. B., Malikovich, E. S., & Ahrorxonov, A. (2025). Tibbiyotda robototexnika: Jarrohlik sohasida qo ‘llanishi. Multidisciplinary Journal of Science and Technology, 5(5), 878-884.
12. 18. Begali o‘g, I. U. B., Malikovich, E. S., & Xojiakbar o‘g‘li, U. X. (2025). 3D PRINTER ORQALI ISHLAB CHIQARILGAN PROTEZ VA IMPLANTLARNING TIBBIYOTDA QO’LLANILISHI. Multidisciplinary Journal of Science and Technology, 5(5), 857-862.
13. 1. Raxmatov, A., Bo‘riboyev, B., Bo‘riboyev, A., Otabekov, A., & Egamov,
14. S. (2020). HUDUDLARDA BOLALAR SPORINING RIVOJLANISHINI MATEMATIK MODELLASH MAMAMLALARI HAQIDA. Arxiv Nauchnyx Publikatsiy JSPI .
15. 2. Akbar, K., & Sulton, E. (2021). Cloud Technology. Galaxy International Interdisciplinary Research Journal, 9(12), 458-460.
16. 3. Malikovich, E. S. (2024). IMPROVING THE METHODOLOGY OF TEACHING THE BASICS OF PROGRAMMING IN A VISUALIZED ENVIRONMENT. IMRAS, 7(1), 168-173.
17. 4. Egamov, S. (2020). EPRA International Journal of Research and Development (IJRD). Архив Научных Публикаций JSPI.
18. 5. Malikovich, S. E. (2022, December). 3O'LCHAMLI MODELLAR YARATISH VA ULARNI O'QITISH METODIKASI. In Proceedings of International Educators Conference (Vol. 1, No. 3, pp. 46-50).

19. 6. XALIKOV, A., EGAMOV, S., & NORMATOV, J. (2022). The concept of graphic information and its essence.
20. 7. Халиков, А., Эгамов, С., & Норматов, Ж. (2022). Informatika fanida virtual ta'lim texnologiyalari. Общество и инновации, 3(4/S), 109-113.
21. 8. Turapov, U. U., Isroilov, U. B., Raxmatov, A., Egamov, S. M., & Isabekov, B. I. (2024). Splay-Method of Model Acquisition Assessment. International Journal of Trend in Scientific Research and Development, 5(1), 934-936.
22. 9. Malikovich, E. S. (2025). The Current State and Development Prospects of Teaching Information Technology in Medicine. Multidisciplinary Journal of Science and Technology, 5(4), 673-677.
23. 10. Begali o'g, I. U. B., Malikovich, E. S., & Olimov, A. (2025). Bolalar tibbiyotida VR o'yinlari. Multidisciplinary Journal of Science and Technology, 5(5), 714-721.