A Preliminary Discussion on a Teaching Mode Based on the Combination of Virtual Simulation and AI Humanoid in the Context of New Medicine

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Abstract

Medical staff are facing challenges in both their knowledge and practical skills in this era of New Medicine. However, the lack of experimental resources and the difficulties in the application prevent the medical staff from learning through practice and cause an even bigger gap between their theoretical knowledge and practical skills. The emergence of virtual simulation and humanoid technologies is a solution to both problems mentioned above by improving the practical skills of medical staff or medical students and their clinical thinking.

Keywords

Virtual Simulation Technology, Context of New Medicine, AI Humanoid, Clinical Thinking

1. Current Difficulties in Medical Education

1.1. Difficulties in the Combination of Theory and Practice

Medical education in China relies on mainly the mode of traditional Chinese medicine—"the inheritance of experience". In this predominant mode, generally, medical students learn theories for 3 - 4 years before starting clinical practices where they develop themselves into mature medical practitioners by practicing the theories they learned on the patients as much as possible under the instructions of their mentors as well as refining their knowledge. However, the precise treatment of the patient always requires both a solid theoretic foundation and great practical skills of the practitioners. The pain point of practical education is

that the subjects of medical experiments are special, for example, it is extremely hard to include clinical patients with acute illnesses in the practical education due to the severity and emergency of their conditions and the irregularity of such illnesses; Meanwhile, the chances of on-site observation and clinical practice are also limited by the concerns that the students, due to their lack of proficiency, may cause secondary injury to the patients and are not skilled and experienced enough to assume the main responsibility in first aid and emergencies (Qin, Yang, Deng, Li, Deng, Li, & Luo, 2021).

1.2. The Specificity of Learning Objects and Their Uniqueness as Individuals

1) **The specificity of experiment objects.** Medicine is a highly applied discipline used on people. Operation and treatment of patients—especially those with acute, dangerous and serious illnesses—by a student, once allowed in practical teaching, is a violation of medical ethics and a risk threatening the patients' safety and life. Therefore, the challenges for students to practice their skills on real person prevent them from developing their clinical skills, which require repetitions and practices.

2) **The insufficient and dangerous experimental environment.** Treatment of patients with acute or serious illnesses includes pre-hospital first aid, in-hospital care and specialized treatment. However, in the actual teaching, it is hard to reproduce the scenarios of acute, dangerous and serious illnesses, and the medical ethics and potential dispute need to be considered; in addition, the sites for pre-hospital first aid are always risky-after the occurrence of an earthquake there are risks of aftershocks or collision of buildings, and on a construction site there are risks of dropping objects. Medicine is a highly applied and practical discipline where the dangerous and insufficient experimental environment limits the development of medical practitioners to some extent.

3) **The insufficient experiment resources.** Practical medical skills are obtained through enough practices in real or simulated conditions, and the key to on-site first aid for acute and dangerous illnesses is quick and effective measures taken with medical equipment, devices and medicines. However, the teaching is limited by the large amount of nursing students, the relative insufficiency of teaching resources and the lack of systematic, complete and specialized teaching. Meanwhile, the research ability and technologies also limit the sharing of quality experimental resources.

1.3. Further Requirements on Clinical Thinking

The development of clinical thinking is not completed in a day. Instead, it requires repetition and life-long refinement during practice. To some extent, traditional education of clinical practice is now in a plight where the patients and their families provide limited support for the internship-based teaching and clinical demonstration despite the efforts made to promote physician-patient communication. Therefore, medical students have rare chances of effective prac-

tice, let alone repeated trainings. In addition, today's teaching still relies on mainly the introduction to theories and video-based auxiliary learning. In labs, which are usually smaller than hospitals and lack equipment and reality, medical and nursing students are confined in theoretic learning without being able to develop clinical thinking which enables them to use the theories to identify and solve practical problems (Xiong, Wu, & Liang, 2022), that is why traditional education of medical practices calls for improvement and optimization.

2. Current Application of Virtual Simulation and AI Humanoid

2.1. Current Application in China and Foreign Countries

As a new technology combining VR and simulation, virtual simulation is internet-based and integrated. Nowadays, in China, virtual simulation (Lu, Sun, Huang, & He, 2022) has been applied in fields such as virtual operation, medical education, clinical diagnosis, remote treatment, rehabilitation, psychological treatment, experiment and research. In experiment-based teaching of medical students, virtual simulation, relies on its simulation of reality, 3D, multimedia and multi-channel features (Chen, Zhu, Wen, & Hao, 2021), provides students with first-handed experience without real experiment conditions; therefore, the technology is especially advantageous as a tool for teaching (especially practical teaching) (Li, Ye, Ye et al., 2021; Vergara, Antón-Sancho, Extremera et al., 2021; Li, Ye, Wu et al., 2022). The invention of the 1st humanoid HPS with physically driven functions by METI in 1997 allowed better simulation of clinical conditions and ushered in a new leaf of medical teaching that is highly realistic and clinical scenario-based.

In the experiments, scientists found that, the AI humanoid teaching system could well simulate the mankind not only in the appearance, but also in some basic physiological features, such as: Breathing frequency, pulse, heart rate, blood pressure and body temperature. When applying in comprehensive teaching, systematic setting and encryption are needed to enable the simulation of abnormal symptoms of some common diseases through the variation of physiological and pathological indicators, such as apnea, hyperpyrexia and arrhythmia, to realize the teaching goals. From the feedback of individual students on their interaction with AI humanoids it is known that, such humanoids are highly similar to real patients in their high sensitivity, more standard, multi-functional and controllable than traditional medical education, and thus a better support for the medical and nursing students to prepare for their further clinical treatment (Lei, Lu, Chen, Zeng, & Li, 2018).

2.2. Today's Combined Application of Virtual Simulation and AI Humanoid

The combined application of virtual simulation, a "virtual" tool for online teaching, and AI humanoid, a "physical" tool for face-to-face teaching, could improve the teaching effect by combining the advantages of both methods.

1) **Use online learning for virtual operation and theoretical teaching before introducing practices where simulation-based skill training is conducted with scenario simulated virtually and AI humanoid.** The students shall evaluate and diagnose the injury on the spot, develop and implement the treatment plan, observe the effect and dynamically assess the entire process. Virtual simulation and AI humanoid are used to simulate the environment and patients to enhance the students' sense of reality and immersion, cultivate their sense of mission by telling them "the weight of life and their responsibilities", and develop and refine their clinical thinking. Virtual simulation-based teaching follows the principle "better physical than virtual, combining the advantages of both"; operation on AI humanoid could make up for the insufficient tactility provided by virtual operation as a complement; the combination could develop the students' thinking virtually, train their skills practically and improve students' clinical thinking.

2) **Meanwhile, the lecturers assess the students' technical operation, clinical thinking and patient-oriented idea of systematic treatment.** Virtual simulation and AI humanoid could facilitate not only teach, practice, but also the assessment of the students. The virtual simulation system has an exercise module (operation instruction optional) and also an assessment module (no instruction); AI humanoid, based on the parameters set on the computer, could simulate certain illnesses for the students to practice their treatment on the "patient". The system could record and score the students' operations. The combination of exercise module and assessment module could facilitate the skill training and improvement of the students through the interaction of exam, learning and application.

2.3. Teaching Practice in Youjiang Medical University for Nationalities Nursing School

In the context of "The Development of Disciplines of Double First-class", our school in recent years has attached great importance to the experiment-based teaching of surgical nursing, as evidenced by the completion of our surgical nursing skill training room that integrates practical training, advanced AI simulation and virtual simulation to create real and professional scenarios. In 2019, the Teaching and Research Department of Surgical Nursing initiated the experimental training project based on the virtual simulation of chest injury (now available on https://www.ilab-x.com/), which was listed as a first-class undergraduate course of virtual simulation-based experimental teaching at the autonomous region level (and was recommended as a candidate project to the national level); In 2019, *Surgical Nursing* was approved as a provincial-level first-class undergraduate course for both online and face-to-face teaching; In 2020, *Surgical Nursing* was approved as a provincial-level first-class undergraduate course for online teaching, and the same course was listed as the 2nd batch of national first-class undergraduate course in 2022; In 2022, *Emergency Nursing* was approved as a provincial-level first-class undergraduate course for both

online and face-to-face teaching. Virtual simulation and AI humanoid are widely used in the teaching and evaluation of surgical nursing, emergency nursing and other disciplines as they create an online classroom that is always available for the students where repeated training is introduced to train their clinical thinking, an environment is created for their practices and learning with higher reality, efficiency and safety, and potential medical disputes in learning and practices are well eliminated without compromising the interests of the patients; this new IT teaching method allows the students to better practice the theories, solves the shortage of resources in practice teaching, and helps the medical students to develop complete clinical thinking better and faster.

3. Exploration of a Teaching Mode Combining Virtual Simulation and AI Humanoid

3.1. Course Selection and the Establishment of Teaching Procedures and Processes

First, the medical platform for virtual simulation practice shall be used for courses in which practical operation is hard for students or for courses for which the plat form provides better cost-efficiency and safety than traditional teaching methods. Second, the course process shall be designed to respect teaching principles, focus on the operational experience and meet the basic requirements of the practice.

3.2. A Combination of Old and New Styles, a Reform of the Learning Mode

The lecturer-led tradition (Li, Ye, Wu et al., 2022) is reserved where the lecturer is responsible for setting the learning goals, contents and experimental procedures; and the students, under the instructions of the lecturer, learn and practice with the help of the virtual simulation teaching platform and AI humanoid. The platform records the mistakes and defects of each student in their operation, gives specific suggestions for their improvement and continuously interacts with them to form an interaction-feedback learning mode. Compared with the traditional learning relying on mainly the lecturer, virtual medical teaching gives more play to the students and could better solve the shortage of lecturers.

3.3. The Establishment of a Teaching Effect Assessment System

Make the final evaluation a combination of various evaluation methods and focus on formative evaluation. Establish a formative evaluation system considering the overall teaching effect, including: the students' theoretical examination results (case analysis), multi-stage skill evaluation, lecturers' comments, problem analyzing and solving ability, active learning and teamwork, clinical thinking, etc.

4. Prospect of Teaching Model Combining Virtual Simulation and AI Humanoid

Unlike other disciplines, medical education is limited by medical ethics, doc-

tor-patient disputes and concerns in humanistic care and other aspects, and the mountain of theoretical learning tasks and fixed clinical practices (Li, 2022) further reduce the possibility of medical and nursing students to practice their skills and repeat the operations in a good experimental environment before their clinical internship. The combination of virtual simulation and AI humanoid for medical teaching, fortunately, provides a comprehensive practice platform integrating medical teaching, practice, examination, training and other functions, which enables both learning in fragmented time and remote learning of the students, breaks the limitation of time and space in traditional practical teaching, reduces the risk of secondary injury to medical staff and patients in potentially dangerous environment, and solves the lack of clinical patients and the unsatisfying bedside teaching effect. The promotion of this teaching mode could help medical and nursing students to improve their abilities to better deal with complicated clinical conditions and grow into senior talents with comprehensive and applied skills required in this new era.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Chen, L., Zhu, K. J., Wen, X., & Hao, F. (2021). Observation on the Application Effect of Humanistic Nursing in the Shock Stage of Massive Burn. *Contemporary Medicine, 27,* 185-187.

Lei, A. H., Lu, C. X., Chen, C. Q., Zeng, T. B., & Li, R. H. (2018). Experience of the Application of Virtual Simulation in Experimental Teaching of Medical Immunology. *Think Tank Era, 155,* 247-248.

Li, J. R. (2022). Thinking on the Application of Virtual Simulation in Medical Practice in Open Education. *Study of Science and Engineering at RTVU, 291,* 61-64+78.

Li, Y., Ye, H., Wu, S. et al. (2022). Mixed Reality and Haptic-Based Dental Simulator for Tooth Preparation: Research, Development, and Preliminary Evaluation. *JMIR Serious Games, 10,* e30653. https://doi.org/10.2196/30653

Li, Y., Ye, H., Ye, F. et al. (2021). The Current Situation and Future Prospects of Simulators in Dental Education. *Journal of Medical Internet Research, 23,* e23635. https://doi.org/10.2196/23635

Lu, D. D., Sun, Y. J., Huang, H. X., & He, Y. (2022). Study on the Factors Influencing Medical Lecturers' Willingness to Apply Virtual Simulation. *Journal of Nanjing Medical University (Social Sciences Edition), 22,* 311-316.

Qin, Y., Yang, S. L., Deng, Z. Y., Li, L. Q., Deng, Y. F., Li, Y. F., & Luo, Q. Y. (2021). Construction and Application of Virtual Simulation-Based Training Platform for First Aid Thinking against Chest Injury. *China Medical Education Technology, 35,* 583-587.

Vergara, D., Antón-Sancho, Á., Extremera, J. et al. (2021). Assessment of Virtual Reality as a Didactic Resource in Higher Education. *Sustainability, 13,* 12730. https://doi.org/10.3390/su132212730

Xiong, T. Q., Wu, H. H., & Liang, J. Y. (2022). Evaluation of the Application of Virtual Simulation in Experimental Teaching of Human Anatomy as a Part of Clinical Medicine. *Chinese Journal of Anatomy, 45,* 387-389.