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Application of Immersive Dietary Nursing Educational Games in Clinical Teaching of Gastroenterology

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Abstract: With the increasing demand for clinical teaching in gastroenterology, the traditional lecture-based teaching model presents challenges in dietary care training, including limited practical opportunities, insufficient student initiative, and insufficient clinical scenario simulation. To enhance students' practical skills and clinical thinking in dietary care, this study introduces an immersive educational game, combining real clinical cases with virtual interactive scenarios to achieve a close connection between theory and practice. An immersive dietary care educational game experiment is conducted among students enrolled in clinical practice in the Department of Gastroenterology. The experimental design includes case selection and processing, task design, standardized patient interaction, and the use of supplementary teaching tools, covering four core components: case analysis, nutritional risk assessment, personalized dietary plan design, and communication and interaction. After optimizing the process through a pilot experiment, a rating scale and questionnaire are used to collect student data on knowledge acquisition, operational skills, interactive experience, and satisfaction. The experiment shows that students generally rate the immersive dietary care educational game highly, with an average score of 4.56 out of 5, indicating that this teaching model receives positive feedback in terms of interactivity, fun, immersion, and learning motivation. Among them, "scene immersion" scores the highest, with an average of 4.75 points, indicating that the virtual clinical environment and situational case design can effectively enhance students' sense of involvement.

1. Introduction

In recent years, immersive teaching and virtual simulation technologies have been gradually applied in medical education, providing new approaches to addressing issues such as insufficient practical training, low student learning initiative, and insufficient clinical context experience. Through virtual cases, interactive tasks, and standardized patient simulations, students can conduct

multiple rounds of training in a safe and controlled environment, transforming theoretical knowledge into practical skills and improving their clinical judgment and communication abilities. Furthermore, incorporating evidence-based medicine concepts, students can conduct case analysis, nutritional assessment, and dietary plan design within immersive scenarios, achieving a complete learning process that closely follows clinical practice, posing questions, identifying evidence, evaluating quality, and guiding procedures. Based on this, this study aims to design and apply an immersive dietary nursing educational game in gastroenterology clinical teaching. By combining real-life cases with virtual interactive scenarios, the study explores its effectiveness in improving students' dietary nursing knowledge, practical skills, adaptability to clinical situations, and learning interest, thereby providing a practical basis for innovative clinical nursing education models.

This article first reviews the current research status and application bottlenecks of immersive education, virtual reality, and artificial intelligence in dietary nursing and medical education. It then details the design concept, experimental process, and implementation methods of an immersive dietary nursing educational game. Furthermore, the article presents experimental results in terms of student knowledge acquisition, operational skills, interactive experience, and learning motivation, and analyzes and discusses the teaching effects. Finally, based on the experimental findings, this article summarizes the application value of immersive education in gastroenterology clinical teaching and identifies research limitations and future development directions.

2. Related Works

In recent years, with the continuous development of health education and clinical nursing practice, the application of immersive technology, Virtual Reality (VR) , Augmented Reality (AR) and artificial intelligence in nutrition, dietary care and medical education has gradually attracted attention. Kalimuthu et al. developed an innovative course called STEM-ARNutri Edu, which integrates AR and comprehensive STEM (Science, Technology, Engineering, and Mathematics) education to address the common nutritional problems among Malaysian teenagers. The course is based on Kolb's experiential learning theory. Through eight virtual activities and three STEM projects, it guides students to actively learn in an immersive environment and improve their nutritional knowledge [1]. Davies et al. designed and evaluated the effectiveness of Aboriginal cultural immersion teaching for nutrition graduate students at an Australian university. Through questionnaire and interview analysis, it was found that students had significantly improved their knowledge of Aboriginal history, culture, diet and health ($p < 0.001$), and had a deeper understanding of the concept of holistic health [2]. Goldsmith et al. used immersive virtual reality (VR) to provide new experimental and therapeutic methods for nursing. Through expert interviews, four home care nurses participated in three rounds of discussions and identified more than 20 common situations and needs [3]. Norwitz et al. introduced the "Metabolic Health Immersive Medical Education" pilot project led by Harvard medical students, which involved experiential learning by wearing a continuous glucose monitor (CGM). The results showed that students had fun participating, improved their health behaviors, deepened their understanding of nutrition and metabolism, and believed that this experience would be helpful for future clinical practice [4]. Vaishali proposed the Immersive Health Education (IWE) method, using VR to create a real interactive learning environment to improve the effectiveness of health education. The knowledge retention rate increased by 25%; the exercise participation rate increased by 30%; the healthy diet improved by 20%; the stress level decreased by 80%, proving that VR technology can effectively promote health behavior changes [5]. Hoffman et al. evaluated the effect of VR simulation in community nursing continuing education. 67 registered nursing students completed pre-tests, VR simulations, and post-tests. The results showed that most students improved their grades and

believed that the simulation effectively improved their knowledge and skills and enhanced their confidence in learning [6]. Vaughan reviewed the application of VR and AR in the field of diabetes, covering three aspects: education, prevention, and treatment. VR is mainly aimed at doctors, adults, and children with diabetes, and can improve the effectiveness of training and health management [7]. Hoffman et al. evaluated the effect of virtual reality (VR) simulation in community nursing education. 100 nursing undergraduates completed pre-tests, VR simulations, post-tests, and evaluations. The results showed that students significantly improved their knowledge of social determinants of health and cultural competence [8]. Chang et al. explored the application of generative artificial intelligence (ChatGPT) in nursing and health education courses. The results showed that ChatGPT significantly improved students' critical thinking, problem-solving skills, and learning satisfaction, proving that it has application potential in nursing education design and can make up for the lack of interaction in traditional teaching [9]. Floríndez et al. collaborated with African American churches to develop a VR hypertension education project using a community participatory research method. The intervention plan was co-designed through the Delphi method and member feedback. The results showed that the participation of church members significantly optimized the course design and enhanced the acceptance of the project [10]. den Hamer-Jordaan et al. explored the key factors in dietary behavior intervention training for community nurses in the Netherlands. Interviews showed that factors affecting the effectiveness of interventions include nurses themselves (role identity, dietary knowledge and behavioral intervention skills), nurse-patient interaction (building trust, respecting autonomy, and personalized methods), and organizational cooperation and environment [11]. Although immersive technology, virtual reality, and artificial intelligence have shown positive effects in health education and nursing teaching, existing research has mostly focused on single technology applications, short-term interventions, or specific groups. There is a lack of systematic integration, long-term follow-up, and interdisciplinary collaborative empirical research, making it difficult to comprehensively guide clinical education practice.

3. Methods

3.1 Gastroenterology Theory and Evidence-Based Medicine Teaching

Modern gastrointestinal diagnosis relies primarily on gastroscopy and colonoscopy, and the description of lesion characteristics also relies on the analysis of endoscopic image features. Clinically, the Endovision System (ENDOVISION) allows for text editing, static and dynamic storage, and convenient access. The research group has used this system in clinical gastroenterology training, achieving positive results. Building on this experience, this study integrates this content into an immersive dietary care educational game for use in both clinical gastroenterology and dietary care teaching practices.

To meet the needs of long-term medical education, modern educational technologies must be applied to teaching design and processing. For example, Photoshop can be used to process massive amounts of images; Flash technology can be used to create animations; clinical data can be presented as PowerPoint presentations or online using Dreamweaver technology; linking technology can be used to connect diseases horizontally and vertically, facilitating comprehensive analysis and teaching of specific diseases.

Gastroenterology is a multidisciplinary field encompassing clinical epidemiology, gastroenterology, digestive endoscopy, and statistics. To better grasp the theories and methods of evidence-based gastroenterology, the teaching of basic theoretical knowledge must be integrated with clinical cases. Through practical training, students can shift from being taught "as if I'm required to learn" to "wanting to learn." During the teaching process, students are guided by clinical

practice through the development of basic knowledge, literature searches, research methodology evaluation, systematic reviews and meta-analyses, etiology research and evaluation, diagnostic testing and evaluation, and clinical efficacy and prognosis assessment. In practice, by providing topics closely related to clinical practice, students are encouraged to independently identify questions and relevant literature, following the principles of evidence-based medicine. This ensures a comprehensive process of "staying close to clinical practice, posing clinical questions, identifying clinical evidence, evaluating research quality, and guiding practice." In this teaching method, students can not only integrate basic knowledge, but also apply it to clinical and dietary care. This is a true quality education. It changes the "cramming" teaching method developed over the years from passive learning to active exploration, laying a solid evidence-based basis for future clinical and dietary care work.

In clinical practice, gastrointestinal disease cases are processed using an endoscopic image computer processing system (Endovision System), which allows text editing, static and dynamic storage, and convenient access. In this study, these images are embedded into the task module of an immersive dietary care educational game, enabling students to complete endoscopic image observation, case analysis, and dietary care assessment tasks within the game.

3.2 Immersive Dietary Care Teaching Scenario in the Metaverse

Narrative nursing instruction is an important method for cultivating nursing students' humanistic qualities. Through the insights, insights, and resonance presented by narrative themes, it stimulates students' understanding of the body and mind, their experience of illness and pain, and their attitudes toward death and life, thereby achieving the purpose of nursing humanistic education. International medical practice demonstrates that narrative is prevalent in clinical doctor-patient interactions, serving as a bridge for communication and treatment. Narrative nursing, which addresses the real-life experiences, cultural understandings, and disease status of patients and their family members, can significantly improve the nurse-patient relationship. Clinical nurses possess superior narrative skills and possess a high level of humanistic care.

Traditional narrative nursing instruction can be achieved through the sharing of parallel notes within nursing humanities courses, explaining narrative nursing topics, role-playing, interactive communication on online platforms, and the creation of a digital story. This process allows students to create diverse cultural scenarios and foster empathy. This allows them to fully empathize with the characters' psychology and understand the impact of diverse contexts on nursing. In this study, a metaverse scenario is integrated into an immersive dietary nursing educational game, enabling students to interact with simulated patients in a virtual environment and conduct dietary nursing assessments, interventions, and narrative nursing practice.

3.3 Dietary Nursing Practice

Practical skills training is also a crucial component of nutrition education. However, due to limitations in classroom conditions and class hours, practical instruction is relatively weak in many secondary vocational schools. Consequently, after completing nutrition classes, students often lack the knowledge to assess their own diets, let alone develop a scientific and balanced nutritional plan. During instruction, teachers should explain and evaluate common recipes or individual cases, based on practical situations, to develop a scientific and balanced dietary plan. Students can also be encouraged to analyze and evaluate their eating habits over a week to identify and address any shortcomings. Furthermore, conducting a community-wide nutrition survey can not only assess the nutritional status of the community population but also promote knowledge about proper nutrition and, when appropriate, provide nutritional interventions. This not only broadens students' horizons

but also cultivates their ability to apply nutritional theory to practical problems, achieving multiple goals at once. On this basis, through collaboration with the Centers for Disease Control and Prevention, food hygiene supervision agencies, and some hospitals, patients with chronic diseases such as diabetes and hypertension are interviewed to understand relevant nutritional intervention measures, enabling them to better apply nutritional knowledge to solve practical problems, thereby further improving their educational level. These practical tasks are also embedded in immersive dietary care education games, allowing students to complete dietary care assessment and intervention tasks within the game.

3.4 Simulating Clinical Dietary Care Scenarios

Simulating clinical nursing scenarios and interacting with "patients" reveals that clinical work never follows textbook scenarios. Real-life nursing practice presents numerous unexpected situations, requiring nurses to adapt to changing circumstances. This is particularly challenging for newly graduated interns and new nurses. Traditional secondary vocational nursing internships often utilize medical models or mannequins. These "patients" experience no emergencies and have no opportunity to interact with the "nurses." Students engage in simple communication and evaluation, setting their own conditions and assuming the "patients" accept them. If the IES immersive classroom teaching system can be introduced after students have mastered surgical procedures, creating a more realistic, clinical work environment, allowing "patients," "nurses," and "patients" to interact and respond to various emergencies, this not only helps students better adapt to their future work environments, but also strengthens their interpersonal skills, overall well-being, and adaptability, ultimately cultivating high-quality nursing talent for hospitals. This study integrates these simulated scenarios into an immersive dietary care educational game, allowing students to complete dietary care operations and emergency response tasks within the game.

3.5 Teaching Adapted to Clinical Development

Against the backdrop of rapid information development, medical knowledge is rapidly updated, but in actual teaching, it remains primarily confined to textbooks. Furthermore, with the continuous updating of equipment, practical teaching has gradually become detached from clinical reality, making it difficult for students to quickly integrate into clinical nursing. With an immersive classroom teaching system, there is no need to frequently replace instruments. Simply by resetting the virtual scene according to actual clinical conditions, nursing teaching can be easily integrated with real dietary nursing practice, allowing teaching to keep pace with clinical development. This study integrates this function into an immersive dietary nursing educational game, allowing teaching to closely align with dietary nursing and gastroenterology clinical practice and provide a gamified interactive experience.

4. Results and Discussion

4.1 Team Building and Role Division

This study assembles an interdisciplinary team consisting of two attending physicians in gastroenterology, a deputy chief nurse, two head nurses, two nurses, a nutritionist, and two faculty members with extensive clinical teaching experience. Team members have clear divisions of labor: the attending physician is responsible for selecting real-life nutritional risk cases and providing instruction on the medical content; the faculty is responsible for organizing and processing the cases based on student knowledge; the nutritionist and deputy chief nurse are responsible for designing

the cases as immersive game-like tasks; the head nurse is responsible for preparing the necessary game tools and overseeing each step of the experiment; the nurses serve as standardized patients, assisting students in completing the interactive sessions.

4.2 Teaching Process and Game Design

The experimental teaching process consists of four steps: First, the attending physician selects a total of eight real clinical cases, covering physical assessment, nutritional risk screening, dietary principles, and dietary care content for diseases such as ulcerative colitis, cirrhosis, gastritis, and peptic ulcers. Subsequently, the teacher organizes and processes the cases based on the students' knowledge structure, making them suitable for teaching and gamification. Next, the nutritionist and deputy head nurse transform the cases into immersive challenge tasks, including designing the question presentation method, the number of tasks, and the time limit for answering them. Finally, the head nurse prepares auxiliary tools such as task cards, answer sheets, food color cards, whiteboards, and pasteboards, and manages the entire game implementation process. Through this design, students complete case analysis, nutritional assessment, and dietary care tasks in an immersive dietary care educational game, achieving a fusion of theoretical knowledge and practical operations.

4.3 Process Optimization and Preliminary Experiments

Before the formal experiment, the team invites four students to participate in a pre-experiment, completing the entire immersive game process and collecting feedback from both students and teachers. By organizing and analyzing these feedback, the research team adjusts and optimizes the case presentation, task design, and the use of auxiliary tools to enhance the gaming experience and student interaction, making the experimental environment more realistic for clinical dietary nursing practice.

4.4 Experimental Results

The experimental indicators include students' mastery of dietary care knowledge, operational skills scores, interactive experience and learning motivation, as well as evaluation of teaching satisfaction and effectiveness, which are used to comprehensively evaluate the teaching effectiveness of immersive educational games.

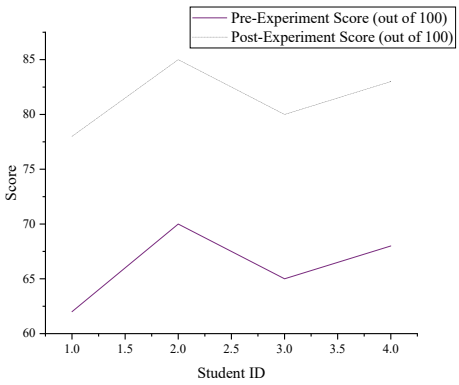

Figure 1. Students' knowledge of dietary care (comparison before and after the pilot experiment)

Note: The score is assessed comprehensively based on the students' performance in case analysis,

nutritional risk assessment and dietary plan design.

Figure 1 shows that students significantly improve their knowledge before and after participating in the immersive dietary care education game. Before the pilot study, students' average score is 66.3, indicating incomplete knowledge in areas such as case analysis, nutritional risk screening, and dietary plan design. After completing the immersive educational game, their average score increases to 81.5, an overall improvement of 22.9%. Individual improvements range from 21.4% to 25.8%, with relatively stable differences, demonstrating that this teaching model has good adaptability and facilitating effects across a wide range of students.

This result demonstrates that immersive dietary care educational games can effectively stimulate students' learning interest and independent inquiry, enabling them to actively apply theoretical knowledge to solve practical problems in real-world simulations, thereby promoting knowledge internalization and skill transfer. Compared to traditional teaching methods that rely primarily on lectures and demonstrations, this model, through an interactive and contextualized learning process, allows students to deepen their understanding and memory of the key aspects of dietary care in gastroenterology through experiential learning.

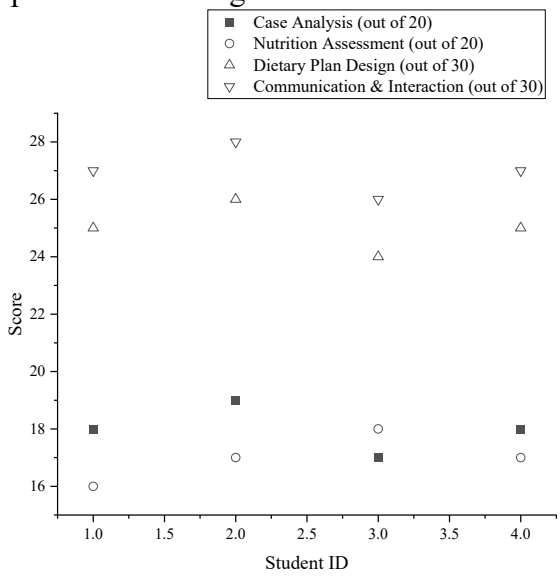

Figure 2. Students' dietary care skills scores (game task completion)

Note: Scores are determined by standardized patients and teachers based on a comprehensive assessment of students' performance in the immersive game.

As shown in Figure 2, students perform well overall in the immersive dietary care education game, with scores across all four core skill modules remaining high. On average, they score 18 and 17 points in the case analysis and nutritional assessment modules, respectively, demonstrating that students are able to accurately identify nutritional risk factors for gastrointestinal diseases and make preliminary assessments based on these factors. The average scores for the dietary plan design and communication and interaction modules are 25 and 27, respectively, demonstrating that students not only possess the ability to scientifically develop individualized dietary care plans but also effectively communicate and provide feedback to their patients.

The scoring sources show high consistency between standardized patient and teacher evaluations of students, indicating that students perform reliably and consistently in the contextual tasks. Analysis of individual performance reveals that scores for case analysis and nutritional assessment are slightly lower than for other components, primarily due to some students' limited understanding of disease-related nutritional metabolic mechanisms. However, scores for dietary plan design and

communication are generally high, reflecting the positive impact of the immersive teaching environment on students' practical skills and clinical thinking.

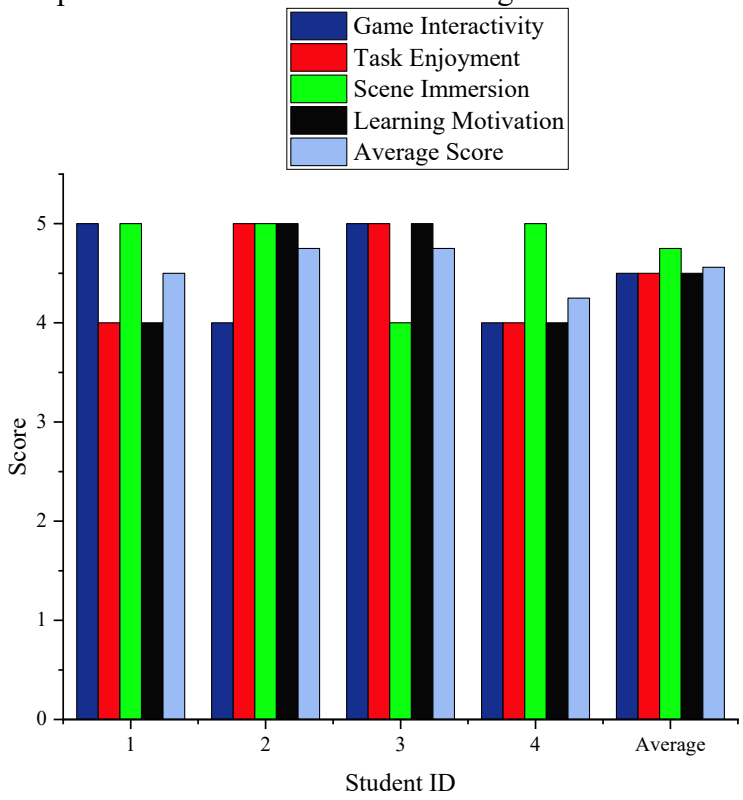

Figure 3. Student interactive experience and game participation (5-point scale)

Note: The questionnaire is used to collect students' evaluations of the interactivity, fun, immersion and learning motivation of the immersive dietary care education game, with 5 points being the highest score.

As shown in Figure 3, students generally give the immersive dietary nursing education game a high evaluation, with an average score of 4.56 out of 5. This indicates that the teaching model receives positive feedback in terms of interactivity, fun, immersion, and learning motivation. "Scenario immersion" scores the highest, with an average of 4.75 points, indicating that the virtual clinical environment and contextualized case design effectively enhance students' sense of immersion, enabling them to develop a near-realistic nursing experience through interaction with "simulated patients." "Game interactivity" and "Task fun" both score 4.5 points, indicating that students generally recognize the role of gamification in stimulating learning interest and promoting teamwork.

Furthermore, the "Learning Motivation" dimension scores 4.5 points, indicating that immersive learning not only increases immediate engagement but also, to a certain extent, stimulates students' intrinsic motivation for continued learning. Interviews reveal that students view the game-based teaching approach as "more challenging and immersive than traditional classroom instruction," and that it naturally generates a urge to learn within the task-driven environment, leading them to actively consult literature and explore disease mechanisms and nutritional principles while completing tasks. This shift from passive acceptance to active exploration demonstrates the positive impact of immersive learning on the psychological level of education.

Table 1. Student satisfaction and teaching effectiveness evaluation (5-point scale)

Evaluation Indicator	Very Dissatisfied (1)	Dissatisfied (2)	Neutral (3)	Satisfied (4)	Very Satisfied (5)	Average Score
Practicality of Teaching Content	0	0	1	2	1	4
Authenticity of Cases	0	0	0	3	1	4.25
Learning Effectiveness	0	0	1	2	1	4
Game Experience	0	0	0	2	2	4.5

Description: The post-experiment questionnaire is used to collect students' satisfaction with the immersive dietary care education game and their evaluation of the teaching effect.

The results of student satisfaction and teaching effectiveness evaluations indicate that the immersive dietary nursing educational game receives high overall recognition. The average scores for all four evaluation indicators are above 4.0, indicating that students are generally satisfied or very satisfied. "Game Experience" scores the highest (4.5), demonstrating that the immersive design effectively enhances student engagement and learning enjoyment. "Case Authenticity" (4.25) is second, reflecting the high degree of alignment between the teaching content and clinical scenarios, allowing students to experience the authenticity and professionalism of the situational tasks. In contrast, "Practicality of Teaching Content" and "Learning Effectiveness" scores slightly lower (both 4.0), indicating that while students recognize the value of the course, they still desire to further enhance the integration of knowledge and practical skills. Overall, the questionnaire results indicate that this teaching model performs well in terms of content design, contextualization, and learning experience, providing positive evidence for future promotion (see Table 1).

5. Conclusions

This study designs and implements an immersive dietary care educational game, combining real-life gastroenterology clinical cases, dietary care tasks, and virtual interactive scenarios, achieving a close integration of theoretical knowledge and practical application. Results show significant improvements in students' dietary care knowledge, practical skills, interactive experience, and learning motivation. The average knowledge score increases from 66.3 to 81.5; the average practical skill score reaches 87; scores for interactive experience and learning motivation are both above 4.5, indicating high student satisfaction. The data suggests that immersive instruction not only improves students' clinical thinking and practical skills but also enhances their autonomous learning and adaptability to situations, providing an effective and innovative approach for gastroenterology clinical teaching. However, this study has limitations. First, the sample size is relatively limited, and the generalizability of the results requires further verification. Second, the design of immersive games requires significant human and technical support, making widespread application in large-scale teaching in the short term difficult. Future research can be conducted on a larger student population, optimizing game design and teaching processes, and combining technologies such as virtual reality and artificial intelligence-assisted evaluation to further enhance the operability and effectiveness evaluation system of immersive dietary nursing education in clinical teaching.

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