

Research on the Application of Information-Based Flipped Classroom Teaching Model in Nursing Education of Rheumatology and Immunology Department

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Abstract: Objective: To explore the application effect of an information-based flipped classroom teaching model in nursing education of rheumatology and immunology, providing empirical evidence for optimizing specialized nursing education models. Methods: Eighty nursing students from the 2021 grade of Xi'an Medical University were selected as research subjects and randomly divided into an experimental group ($n = 40$) and a control group ($n = 40$) using a random number table method. The control group received traditional lecture-based teaching, while the experimental group underwent information-based flipped classroom teaching. The theoretical knowledge scores and practical operation assessment scores of the two groups were compared after teaching, and the teaching satisfaction of the experimental group students was evaluated through a questionnaire survey. Results: The theoretical knowledge score (85.60 ± 5.20) and practical operation score (88.30 ± 4.70) of the experimental group were significantly higher than those of the control group (76.20 ± 6.50) and (75.80 ± 5.90), respectively. The differences were statistically significant ($p < 0.05$). The satisfaction scores of all dimensions in the experimental group were significantly higher than those in the control group, and the differences were statistically significant ($p < 0.05$). Conclusion: The information-based flipped classroom teaching model can effectively improve the quality of nursing teaching in rheumatology and immunology, enhance students' knowledge mastery and practical abilities, and is worthy of promotion and application in clinical nursing teaching.

Keywords: Information-based teaching; Flipped classroom; Rheumatology and immunology; Nursing education; Teaching effectiveness

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1. Introduction

Rheumatic and immunological diseases are a group of autoimmune diseases primarily manifested by joint,

muscle, bone, and related soft tissue lesions, characterized by a protracted course, complex condition, and high disability rate ^[1]. Clinical nursing work not only requires nursing staff to have solid theoretical knowledge but also demands precise operational skills and good clinical decision-making abilities. However, the passive “teacher speaks, students listen” model in traditional nursing education suffers from issues such as a disconnect between theory and practice and low student engagement, making it difficult for nursing students to quickly adapt to the complex nursing scenarios in rheumatology and immunology departments after entering clinical practice ^[2]. With the deep integration of “Internet + Education”, flipped classrooms provide a new approach to address the shortcomings of traditional teaching by reconstructing the teaching process, placing knowledge transfer before class and focusing on knowledge internalization and skill development during class ^[3]. This study combines information technology with the flipped classroom model to construct a new teaching model suitable for rheumatology and immunology nursing education, aiming to improve teaching quality and provide practical references for cultivating high-quality specialized nursing talents.

2. Materials and methods

2.1. Participants

Eighty undergraduate nursing students from a medical school’s 2022 intake were selected. All were full-time students who had completed basic medical courses and an introduction to nursing studies, but had no clinical internship experience in rheumatology and immunology. They were randomly divided into an experimental group and a control group, with 40 students in each group. The average age of the experimental group was (20.32 ± 1.24) years, while that of the control group was (20.54 ± 1.12) years. There was no statistically significant difference in general information between the two groups ($p > 0.05$), making them comparable. This study was approved by the school’s ethics committee, and informed consent forms was signed by all participants.

2.2. Teaching methods

2.2.1. Control group

(1) Theoretical teaching

The teacher has conducted classroom lectures according to the textbook chapters (“Rheumatology and Immunology” chapter in “Internal Medicine Nursing”), with 4 class hours per week for a total of 8 weeks

(2) Practical teaching

2 simulation operation practices were arranged after class, with teacher demonstration followed by student group practice

(3) Assessment method

A closed-book theoretical examination was conducted and operational assessment at the end of the semester.

2.2.2. Experimental group

The implementation of the flipped classroom model in rheumatology and immunology nursing was divided into two major stages, the teaching preparation stage and the implementation stage. During the teaching preparation stage, a specialized teaching team was established, consisting of three associate chief nurses from the Department of Rheumatology and Immunology, each with over ten years of clinical experience, and two

nursing education experts, responsible for program design and resource development.

An information-based teaching platform was constructed by utilizing the school's "Smart Nursing Teaching System", which integrated micro-lecture videos, around 10–15 minutes each, six virtual simulation modules including joint care for rheumatoid arthritis, an online question bank containing 300 specialized questions, and interactive discussion forums. In addition, a learning guide, titled "Rheumatology and Immunology Nursing Flipped Classroom Learning Manual", was compiled based on the teaching syllabus to clarify learning objectives, key points, challenges, and milestone tasks for each chapter.

During the implementation stage, the learning process was divided into three phases. In the pre-class autonomous learning phase, with about 30% of total learning time, teachers released learning tasks via the platform three days in advance. Students engaged in self-directed study by watching micro-lecture videos, including Operational Norms for Skin Care in Systemic Lupus Erythematosus, reading electronic lesson plans, completing timed online tests with automated scoring, and posting questions on the discussion forum. Teachers monitored learning progress and identified common issues using platform analytics. The classroom interactive internalization phase is about 40% of total time and has adopted a "problem-orientation–case discussion–skill practice" approach. For instance, when teaching nursing care for rheumatoid arthritis, teachers first analyzed high-frequency errors from pre-class tests, then organized students into six-member groups to discuss virtual cases such as nursing plans for patients with joint deformities and morning stiffness, followed by standardized patient simulations to practice nursing operations under teacher supervision and feedback.

In the post-class consolidation and expansion phase with 30% of the total time, the platform generated personalized assignments based on pre-class weaknesses, enabling students to repeatedly practice operational skills using the virtual simulation system and participate in weekly online case discussions, where clinical nurses shared real patient cases to enhance clinical relevance and knowledge retention.

2.3. Observation indicators

2.3.1. Knowledge and skill evaluation

(1) Theoretical knowledge

A unified test paper (reliability 0.86, validity 0.82) was used, covering disease mechanisms, nursing measures, and more., with a full score of 100 points.

(2) Practical operation

"Positional nursing for patients with ankylosing spondylitis" was selected as the assessment item, using the OSCE scoring criteria (operational standardization 40%, communication ability 30%, emergency handling 30%). Three examiners who were blinded to the scoring give on-site scores, and the average score was taken.

2.3.2. Teaching satisfaction survey

A self-made questionnaire (Cronbach's $\alpha = 0.91$) was used, including three dimensions, including teaching resources (3 questions), teaching methods (4 questions), and learning effects (3 questions), with a total of 10 questions. The Likert 5-level scoring system (1 = very dissatisfied, 5 = very satisfied) was used, with a total score of 50 points. A score of ≥ 40 points was indicated high satisfaction.

2.4. Statistical methods

SPSS 26.0 software was used to analyze the data. Measurement data was expressed as mean $\pm$ standard

deviation ($\bar{x} \pm SD$), and independent sample t-tests were used for comparisons between groups. Count data were expressed as rates (%), and comparisons were made using the χ^2 test. $p < 0.05$ was considered statistically significant.

3. Results

3.1. Comparison of student performance between the two groups

The theoretical knowledge and practical operation scores of the experimental group are significantly higher than those of the control group, and the difference is statistically significant ($p < 0.05$). See **Table 1** for details.

Table 1. Comparison of assessment scores between the two groups of students ($\bar{x} \pm SD$, points)

Group	n	Theoretical knowledge	Practical skills
Experimental	40	85.60 $\pm$ 5.20	88.30 $\pm$ 4.70
Control	40	76.20 $\pm$ 6.50	75.80 $\pm$ 5.90
<i>t</i> -value		7.142	10.481
<i>p</i> -value		< 0.05	< 0.005

3.2. Student satisfaction in two groups

The satisfaction scores of the experimental group were significantly higher than those of the control group in all dimensions, and the difference was statistically significant ($p < 0.05$). See **Table 2** for details.

Table 2. Comparison of student satisfaction between two groups ($\bar{x} \pm SD$, score)

Group	n	Overall Satisfaction	Teaching Resources	Teaching Methods	Learning Outcomes
Experimental	40	42.52 $\pm$ 3.67	4.54 $\pm$ 0.55	4.33 $\pm$ 0.62	4.22 $\pm$ 0.76
Control	40	32.64 $\pm$ 4.15	3.23 $\pm$ 0.75	3.07 $\pm$ 0.88	2.95 $\pm$ 0.97
<i>t</i> -value		11.279	8.908	7.403	6.518
<i>p</i> -value		< 0.05	< 0.05	< 0.05	< 0.05

4. Discussion

Nursing care for rheumatic and immune diseases emphasizes “individualization” and “long-term management”. For example, patients with rheumatoid arthritis need to adjust their nursing plans based on joint mobility. Personalized assignments pushed by the information platform, such as nursing plan designs for different degrees of deformity has cultivated students’ clinical thinking. Real cases shared in online case discussions, such as “nursing care for the use of biological agents” and “flare-up period management of diseases”, compensate for the lag of textbook content behind clinical practice ^[4]. This study shows that the experimental group performed significantly better than the control group, confirming the advantages of flipped classrooms in specialized nursing education. From a cognitive psychology perspective, pre-class micro-courses reduce the difficulty of understanding abstract concepts through visual presentations, such as animated demonstrations of joint pathologies, while classroom case studies facilitate deep processing of knowledge through “clinical situation reproduction” ^[5]. The “trial-and-error” cycle provided by the virtual simulation system addresses the pain points of “fear of making mistakes and lack of opportunities” in traditional practical training, allowing students to

master operational skills in a safe environment ^[6].

Approximately 15% (6/40) of students reported low pre-class learning efficiency, mainly due to inadequate time management skills. The teaching team later adopted a “learning partner system” (grouping students based on complementary abilities) and a “task decomposition method” (breaking down large tasks into daily small goals), coupled with the platform’s timed reminder function, to increase the task completion rate from 78% to 95%. Initially, some micro-courses suffered from the problem of “focusing on knowledge while neglecting application”, such as only explaining pathological mechanisms without incorporating nursing scenarios. By inviting clinical nurses to participate in script design, practical content such as “morning care procedures for patients with morning stiffness” was added, and a resource update mechanism was established, including the revisions based on clinical guidelines every quarter, resulting in a 23% increase in the practicality score of resources ^[7]. The flipped classroom requires teachers to transition from being “lecturers” to “guiders”, but 80% of teachers initially struggled with “inappropriate intervention timing”. Through special training on “clinical case guidance skills” and establishing a teacher-student online interaction quality evaluation system, the effective classroom interaction duration increased from 35% to 68% ^[8].

This study found that combining the flipped classroom with PBL can further enhance the effectiveness: independent pre-class learning addresses “knowledge reserve” issues, while in-class PBL discussions focus on “clinical decision-making” abilities, forming a complementarity between the two ^[9]. For example, in teaching about systemic lupus erythematosus, students first grasp disease classification through micro-courses, and then engage in PBL discussions around “diet management controversies for patients with lupus nephritis”, which reinforces knowledge and cultivates critical thinking.

Besides significant improvements in theoretical knowledge and practical operation scores, the informatized flipped classroom also positively impacts students’ comprehensive abilities. During the independent pre-class learning stage, students need to independently plan their study time and filter important information, implicitly cultivating their self-learning ability and information literacy. The group discussion session in class requires students to actively express their views, listen to others’ opinions, and communicate effectively, greatly exercising their communication, collaboration, and teamwork skills. Taking rheumatology immunology’s common rheumatoid arthritis nursing teaching as an example, when discussing virtual cases in groups, students need to explore multiple aspects, including the pathophysiology, clinical manifestations, nursing assessment, and nursing measures of the disease. Students have different levels of understanding and mastery of knowledge points. During discussions, they complement and correct each other, which not only deepens their understanding of knowledge but also teaches them how to play their role in a team and solve problems together. Cultivating this ability is crucial for them to collaborate with other members of the healthcare team and complete nursing tasks when they enter clinical practice in the future. Meanwhile, when facing complex clinical cases and various unexpected situations, students need to use their knowledge to analyze, make judgments, and develop reasonable nursing plans. This enhances their clinical thinking and problem-solving abilities. For example, in a virtual scene dealing with positional nursing for patients with ankylosing spondylitis, students must consider factors like the patient’s pain level and joint movement restrictions. They must then choose an appropriate position and take corresponding nursing measures. This undoubtedly serves as a practical exercise for their clinical thinking and problem-solving skills.

Nursing students at different levels have varying knowledge reserves, learning abilities, and learning needs. Therefore, the application of the informatized flipped classroom needs to be appropriately adjusted according to the students’ levels to ensure teaching effectiveness. For undergraduate nursing students who already have

a certain foundation of medical knowledge and learning ability, the informatized flipped classroom can fully unleash their potential for independent learning. The teaching content can include more clinical case analyses and training in complex nursing skills, such as nursing for patients with rheumatic immune diseases combined with multiple organ damage. For college nursing students who have relatively shorter study durations and weaker basic medical knowledge reserves, it is necessary to reduce the difficulty of pre-class independent learning when applying the informatized flipped classroom. Micro-lecture videos should be more concise and focused on basic knowledge and operational skills. During classroom interaction, teachers should provide more guidance, and case discussions can start with simple cases, gradually increasing in difficulty. Meanwhile, during practical training, it is essential to increase the frequency of teacher demonstrations and guidance to ensure that students can master basic operational skills. For the continuing education of in-service nursing staff, the informatized flipped classroom offers unique advantages. Given the busy schedules and fragmented time of in-service nurses, the informatization platform allows them to flexibly arrange their learning according to their own time. The teaching content can be more focused on clinical advancements, new skills, and the handling of complex cases to meet their needs in practical work. Online case discussion sessions can invite senior clinical experts to share the latest clinical experiences and nursing methods, enabling in-service nurses to update their knowledge and improve their professional skills promptly.

With the continuous development of technology, the integration of informatized flipped classrooms with other emerging technologies has vast potential, which can further enhance the effectiveness of nursing education in rheumatology and immunology. Artificial intelligence technology can accurately analyze students' knowledge weaknesses based on their learning progress and test scores, pushing personalized learning resources and practice questions to achieve true individualized teaching. For instance, when the system detects that a student has deficiencies in medication nursing for rheumatoid arthritis, it can automatically push related micro-lecture videos, knowledge summaries, and practice questions to help the student targeted the learning process.

The incorporation of Virtual Reality (VR) technology can create more realistic clinical nursing scenarios for students. Through VR equipment, students can “enter” the rheumatology and immunology ward, interact with virtual patients, and simulate various nursing operations, such as performing skin care for patients with systemic lupus erythematosus or assisting patients with ankylosing spondylitis in changing positions. This immersive learning experience enables students to more intuitively experience the clinical nursing environment, improving their emergency response capabilities and operational proficiency. Big data technology can comprehensively analyze students' learning behaviors and outcomes, providing valuable reference information for the teaching team. By analyzing data such as students' online test scores, micro-lecture video viewing duration, and discussion forum participation, the teaching team can understand students' learning habits and difficulties, allowing timely adjustments to teaching plans and resources. At the same time, big data can also track and evaluate teaching effectiveness over the long term, providing data support for the continuous optimization of the information-based flipped classroom.

5. Conclusion

In summary, the information-based flipped classroom teaching model effectively improves the quality of nursing teaching in rheumatology and immunology through a closed-loop design of “precise pre-class guidance–in-depth internalization during class–personalized expansion after class”. This model balances knowledge transmission and ability cultivation, meets the needs of specialized nursing education, and is worthy

of promotion and application.

In the future, it is necessary to further optimize the dynamic resource update mechanism, explore the application of artificial intelligence technology in personalized learning recommendations, and conduct in-depth research on the integration of this model with other emerging technologies, continuously improve the teaching system, and contribute to cultivating more high-quality rheumatology and immunology nursing talents^[10].

Disclosure statement

The authors declare no conflict of interest.

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