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The teaching design and implementation of “Intravenous Therapy” in “Fundamental Nursing”

<https://doi.org/10.1515/gme-2024-0026>

Received December 2, 2024; accepted March 9, 2025;

published online May 22, 2025

Abstract

Objectives: As a core course in nursing education, “Fundamental Nursing” needs to align with the development trends of modern nursing education and cultivate patient-centered clinical decision-making abilities. Currently, there are problems in the teaching of intravenous therapy, such as insufficient understanding of its historical evolution, unclear technological evolution, and lack of integration of humanistic care. Taking the “Intravenous Therapy” chapter as an example, this paper constructs a “history-case-flipped” three-element integrated teaching model, aiming to improve students’ knowledge, skills, and professional values.

Methods: Based on Bloom’s Taxonomy of Educational Objectives, hierarchical goals are set across three dimensions: cognitive, affective, and psychomotor. The teaching content has been restructured into three major modules: historical evolution, core issues, and technological innovation, covering core knowledge points such as the development history of intravenous therapy, infection control, selection of infusion fluids, and speed control. A coupled model of flipped classroom and case-based learning are adopted. A progressive teaching process is designed: pre-class autonomous learning, in-class case discussion, and post-class reflection and practice. Multiple interactive forms, such as group discussions and scenario simulations, are combined to stimulate students’ learning initiative.

Results: Before class, digital resources (micro-lecture videos, literature) guide students in sorting out the technological development context. During class, evidence-based analysis and group collaboration focus on clinical cases, such as contraindications for lower limb venous puncture. After class, knowledge application is deepened through multi-media presentation and scientific

research training. The evaluation system integrates process-based and formative assessments, including online tests, class participation, group work, and reflection reports, to comprehensively measure students’ overall competence.

Conclusions: This study constructs a “history-case-flipped” three-element integrated teaching model. It systematically optimizes the instructional design and implementation path of the “Intravenous Therapy” chapter in *Basic Nursing Science*. Teaching practice demonstrates that this model effectively integrates the historical context, core issues, and cutting-edge progress of intravenous therapy techniques. As a result, it significantly enhances students’ knowledge mastery, improves their clinical decision-making abilities, and fosters their professional values.

Keywords: fundamental nursing; intravenous therapy; flipped classroom; case method of instruction

Introduction

“Fundamental Nursing” plays a central role in the curriculum system of nursing majors and plays a crucial role in shaping students’ clinical skills and professionalism [1]. Under the framework of “New Medical Science” construction, the “Fundamental Nursing” course should actively respond to the Healthy China strategy and the development trends of the medical and health care industry. It focuses on cultivating students’ clinical thinking and innovative practical abilities, thereby enhancing their capabilities to tackle complex medical challenges [2]. This study aims to demonstrate how to design teaching activities based on expected learning outcomes. Using the “Intravenous Therapy” chapter in the “Fundamental Nursing” course as a case study, we will elaborate on the specific principles and strategies adopted in the implementation of these teaching designs.

Intravenous therapy is a medical procedure which involves the direct infusion of sterile solutions and medications into the veins. In fundamental nursing textbooks, the chapter on intravenous therapy typically covers how to establish venous access, monitor the infusion process, and manage the situation after the infusion is completed [3]. With the advancement of technology, intravenous therapy

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has evolved from simple fluid replenishment to a diverse range of treatment methods, including the infusion of complex chemotherapy drugs [4]. The application of infusion devices has also expanded from traditional intravenous injections using scalp needles to advanced techniques such as intraosseous infusion [5, 6]. Infusion monitoring technology has evolved from simple droplet rate control with smart infusion pumps to advanced systems that can automatically adjust the infusion rate based on the patient's physiological parameters, as well as intelligent infusion systems that respond to changes in the patient's activity level [7–9].

As one of the core skills in nursing practice, intravenous therapy requires practitioners to master puncture techniques precisely and possess clinical decision-making abilities. This encompasses comprehensive qualities such as the rational selection of puncture sites, protection of vascular access, and prevention of complications, which are essential to ensure patient safety and treatment efficacy [10, 11]. In recent years, innovative educational models like blended learning and flipped classrooms have emerged in nursing education. Zhang et al. [2] confirmed that blended learning significantly enhances nursing students' classroom participation and knowledge retention rate. The research by Wang et al. [12] highlighted the effectiveness of flipped classrooms in fostering critical thinking among nursing students. However, current teaching models still have notable deficiencies in cultivating specialized skills, including intravenous therapy. Specifically, issues include a lack of understanding of its historical evolution, an unclear technological evolutionary context, and insufficient integration of humanistic care elements.

This study introduces a novel “history-case-flipped” three-element integrated teaching model and applies it in the “Intravenous Therapy” unit of *Basic Nursing Science*. The specific implementation paths are as follows. (1) Historical dimension: systematically outline the developmental context of intravenous therapy technology, with a focus on key milestone events such as the establishment of aseptic techniques and the evolution of infusion devices, and guiding students to explore the scientific logic behind technological innovations. (2) Teaching innovation: reconstruct the teaching process using the flipped classroom model, creating a three-stage progressive teaching system, that is, pre-class self-learning with micro-lectures (theoretical foundation), in-class exploration and discussion (application of knowledge), and post-class reflection and consolidation (skill enhancement). (3) Case integration: design progressive case tasks based on real-world clinical

situations to strengthen patient-centered clinical decision-making abilities.

The teaching practice selected fourth-year undergraduate students from the School of Nursing at Shanghai University of Traditional Chinese Medicine as research subjects ($n=40$). All subjects were full-time second-year nursing students. This chapter was implemented in the first semester of the second academic year. Each class lasted 40 min, and a total of three classes were arranged. It should be noted that the sample group has characteristics in common: they all come from the same institution, pursue the same nursing direction, follow the same curriculum, and have a balanced knowledge base. This setup better reflects the general cognitive level of nursing students at this stage of training.

Teaching design and implementation

Identification of learning objectives

This chapter's design adopts Bloom's Taxonomy of Educational Objectives as its framework for establishing learning goals [11]. Bloom's Taxonomy categorizes learning objectives into three domains: cognitive, affective, and psychomotor, emphasizing the holistic development of knowledge, skills, and attitudes [13]. By utilizing this classification system, the course can systematically enhance students' learning outcomes to a better extent (Figure 1).

The course design, focusing on the history of intravenous therapy, establishes objectives across three core areas.

First, cognitive domain. By guiding students to answer related questions, this course uses historical failures in intravenous therapy as a teaching entry point, thereby stimulating their reflection and exploration of the underlying causes of these failures. The teaching process focuses on helping students master three core knowledge points – reducing infection risks, making appropriate choices of

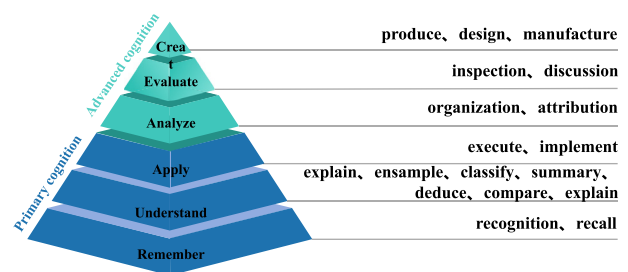


Figure 1: Design principles for teaching “Fundamental Nursing”.

infusion fluids, and accurately controlling infusion rates. The goal is to bridge the gap between theory and practice so that students can effectively apply theoretical knowledge to clinical practice.

Second, affective domain. This course will explore the evolution of standardized practices in intravenous therapy, emphasizing their crucial role in protecting patient rights and ensuring safe infusions during invasive treatments. Our primary objectives are threefold: successful puncture, vascular protection, and safe retention. By focusing on these goals, we aim to make students aware of the critical roles these goals play in improving the quality of patient care. Additionally, students are encouraged to deeply reflect on the foundational principles of intravenous therapy, adopting a patient-centered approach that prioritizes both effective treatment outcomes and high levels of patient satisfaction throughout their experience. This approach underscores the importance of humanistic care in nursing and highlights the significance of considering patients' perspectives during medical procedures.

Third, psychomotor domain. This course aims to enhance students' operational skills and clinical decision-making abilities. It provides a detailed introduction to current intravenous infusion techniques, such as scalp needles, peripherally inserted central catheters (PICC), central venous catheters (CVC), implantable venous access ports (PORT), and intraosseous infusion (IO). We will explore the principles of application and appropriate scenarios for these techniques in which they are applicable to ensure that students understand their characteristics and operational requirements. The course will employ case analysis to guide students in considering specific patient circumstances, including age, severity of illness, treatment plan, psychological state, and social needs. This approach helps determine the most suitable intravenous infusion method for each patient.

Adhering to the aforementioned principles, we have established the following learning objectives for nursing students concerning the history of intravenous therapy. These objectives range from simple to complex and cover three dimensions of knowledge, skills, and emotion.

At the end of this chapter, the students should advance their understanding of intravenous therapy at three different levels.

- a) **Knowledge level:** students should be able to accurately state the different types of intravenous therapy techniques and demonstrate mastery of the fundamental knowledge of intravenous therapy and its indications.
- b) **Skills level:** students should be able to select the appropriate method of intravenous infusion based on

ethical principles and the comprehensive situation of the patient.

- c) **Emotion level:** students should integrate the study of intravenous therapy history with their personal professional values and nursing philosophy to develop a concept of patient-centered nursing practice. When providing intravenous therapy, they should demonstrate compassion and professional care.

Remodeling of teaching content

The traditional teaching content of intravenous therapy includes infusion sites, commonly used infusion methods, how to establish intravenous access, common infusion reactions, and their preventive measures. To better adapt to modern nursing education's requirements, this chapter innovatively restructures the teaching content to guide students in developing systematic thinking as well as to deepen their understanding and recognition of intravenous infusion techniques. The pedagogical focus of each section is presented in Figure 2.

The nascent era of intravenous infusion

The evolution of intravenous infusion has spanned a protracted period from theoretical conception to practical implementation, with key points including:

- 1) **The 17th-century establishment of theory:** William Harvey's theory of blood circulation provided the theoretical underpinnings for the development of intravenous infusion.
- 2) **The 18th-century innovation by Thomas Latta:** During a cholera outbreak, Thomas Latta pioneered the use of intravenous infusion to treat dehydrated patients. Despite a high failure rate, this marked the beginning of clinical use of intravenous infusion.
- 3) **The 19th-century adoption of aseptic techniques:** Joseph Lister's introduction of aseptic techniques markedly decreased the incidence of infection related to infusions [14], facilitating the transition of intravenous infusion from experimental stage to clinical practice.

These historical developments illustrate the progression of intravenous infusion technology and reflect the spirit of scientific pioneers who were brave enough to challenge established norms and pursue the truth. This spirit is valuable for students to learn from and emulate, contributing to the development of their critical thinking and sense of professional responsibility.

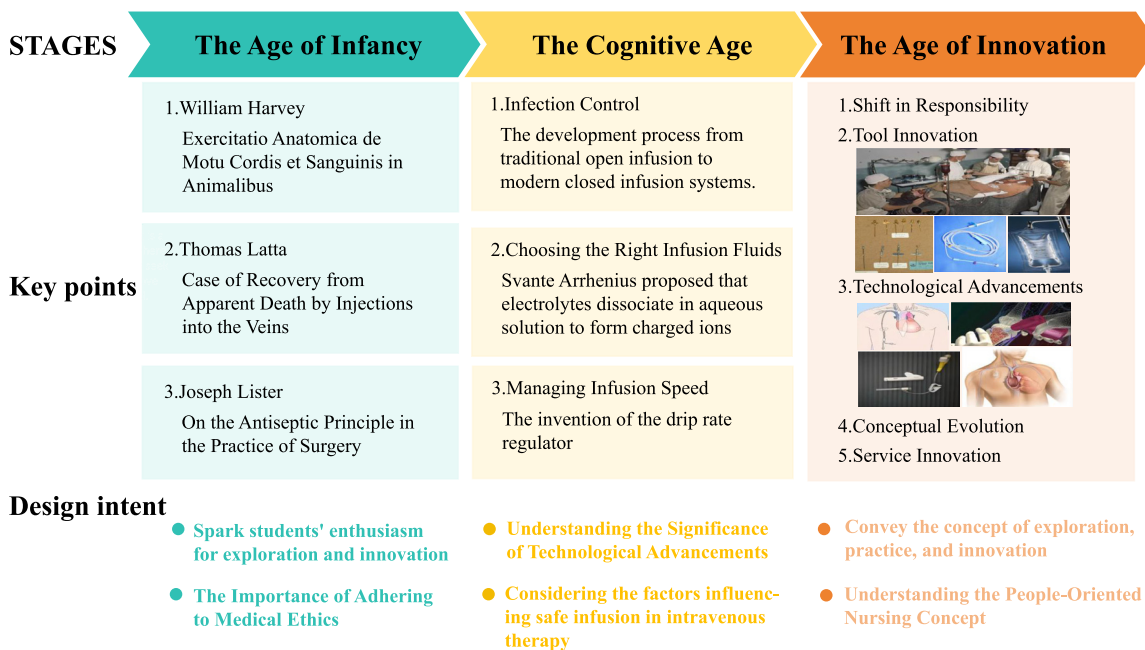


Figure 2: The teaching contents of “Intravenous Therapy”.

The cognitive era of intravenous infusion

The course intensively examines the solutions to three pivotal issues in intravenous therapy:

- 1) **Infection control:** The transition from conventional open infusion systems to contemporary closed systems highlights the importance of aseptic techniques.
- 2) **Choosing the right infusion fluids:** Arrhenius' theory on electrolytes resolved the compositional challenges of infused fluids, laying a vital theoretical groundwork for the evolution of intravenous infusion.
- 3) **Managing infusion speed:** During the mid-20th century, enhancements in infusion apparatuses, especially the development of rate-regulating devices, facilitated accurate control over infusion rates. Moreover, the emergence of modern intelligent infusion pumps, employing digital technology for dynamic rate modulation, has substantially minimized manual errors and patient discomfort [15].

Students, by studying these topics, will gain an understanding of the implications of technological improvements and cultivate a focus on patient safety.

The innovative era of intravenous infusion

The innovative era of intravenous infusion has experienced revolutionary changes in five key aspects: responsibility, tools, technology, concepts, and services.

- 1) **Shift in responsibility:** This section explores the extensive application of intravenous infusion in wartime rescue during World War II and the shift of infusion responsibilities from doctors to nurses, which facilitated the establishment of the subspecialty of intravenous therapy.
- 2) **Tools innovation:** The evolution of infusion tools, including the introduction of disposable infusion tubing, scalp needles, and polyurethane catheters, has propelled the standardization and advancement of intravenous therapy.
- 3) **Technological advancements:** Modern infusion technologies such as PICC, CVC, PORT, and IO have broadened the applications and supportive roles of intravenous infusion in treatment.
- 4) **Conceptual evolution:** The adoption of guidelines by the Infusion Nurses Society (INS) and national industry standards has underscored the importance of standardized practices, focusing on the objectives of successful puncture, vessel protection, and secure catheter dwell.
- 5) **Service innovation:** The nursing approach to intravenous infusion services has evolved to prioritize patient comfort, compassionate care, and effective communication, reflecting a patient-centered philosophy.

This revision provides a structured overview of the revolutionary changes in the era of intravenous infusion,

highlighting the significant developments in each area and their impact on modern nursing practice.

Other cutting-edge teaching content

In implementing this course, we integrate the latest cutting-edge research findings in intravenous therapy. This ensures that our content remains up-to-date and practical. Our goal is to foster an integrated approach to organ systems thinking within nursing education. Additionally, we aim to enhance students' clinical reasoning abilities. To achieve these objectives, we have adopted case-based learning as a key teaching strategy.

We have developed a comprehensive case study which integrates the background of the disease, clinical challenges, and the application of modern technology. This case is designed to closely mimic real-life clinical scenarios. Through this case, we seek to deepen students' understanding of the complexities involved in intravenous therapy. Furthermore, it aims to significantly improve their capacity to analyze and resolve clinical issues effectively.

Case description:

A 46-year-old female patient underwent bilateral mastectomy for breast cancer one month ago and had been recovering well postoperatively. During her hospitalization, intracranial tumors were detected through head CT and MRI examinations. On the fifth day after admission, she underwent frontal craniotomy for tumor resection under general anesthesia. Postoperatively, she was admitted to a specialized intensive care unit (ICU) for treatment; this included anti-inflammatory, hemostatic, anti-hypertensive, analgesic, anti-epileptic and nutritional support therapies. On the day of the surgery, an indwelling needle was placed in her right ankle for intravenous therapy.

On the first postoperative day, the patient was transferred from the ICU to the neurosurgery ward for continued treatment. During the bedside handover with the ICU, the responsible nurse noticed that due to the patient's bilateral mastectomy one month ago, it was not advisable to perform intravenous infusion in the upper limbs. Therefore, the responsible nurse immediately notified the intravenous therapy specialist nurse for a bedside assessment and consultation. Following a detailed evaluation, the specialist nurse effectively communicated with the attending physician, the patient, and the family. An infusion port was successfully placed in the operating room for infusion therapy. Additionally, the specialist nurse provided specific instructions to the patient: apply Hirudoid to the right lower limb, elevate the limb, drink plenty of water, and engage in appropriate limb function exercises to promote recovery.

Questions:

- 1) Why can't breast cancer patients undergo dual lower limb venipuncture after surgery?
- 2) What are the options for intravenous therapy following breast surgery in patients with a concurrent intracranial lesion?

Teaching model and methods

To achieve the predefined learning objectives for this chapter, a pedagogical approach that combines the "flipped classroom" model with case-based learning will be adopted to form a closed-loop learning system of "question-oriented teaching–collaborative construction–clinical migration". A series of questions will be designed before, during, and after the class. These questions are intended to guide students in self-directed learning, while teachers will provide corresponding teaching resources to support this process.

Before class

The teaching team established a digital resource library on the course platform, providing three types of learning material. (1) Video content: this video is approximately 10-min long. It combines historical video materials and clinical real-life scenes to systematically explain the technological development trajectory of intravenous infusion. The content ranges from experimental attempts in the early 17th century to modern standardized applications. (2) Literature: there are two pieces of literature, each taking about 10 min to read. These cover the latest content of "Nursing Technical Operation Standards for Intravenous Therapy" and group standards. (3) Extended materials on WeChat official account: key milestone events are presented using timeline visualization technology.

Seven days before the course implementation, the teaching team releases a modular learning task package with the following requirements. (1) video learning: identify key nodes of technological development and understand the context and its impact on related fields based on the time clues in the video; (2) literature study: during the study of the literature, carefully mark at least three evidence-based justifications and understand the scientific nature and credibility of the viewpoints; (3) preview report: summarize the inspiration from studying the video and literature with no less than 200 Chinese characters.

During self-study, the instructor presents the following two questions to students:

- 1) Why did human attempts to administer intravenous fluids fail in the 17th century?

- 2) What are the primary challenges and issues currently associated with intravenous infusion technology?

The intent of the question design is justified as follows. These two questions prompt students to review the knowledge of physiology and pathophysiology, and introduce the three core issues of intravenous therapy, stimulating students' thinking about the progress and future trends of intravenous therapy.

In class

During the in-class teaching process, the theoretical teaching session is carried out first, which lasts approximately 30 min. The teacher systematically expounds on the relevant theoretical knowledge. Subsequently, the group discussion stage begins. The students are divided into 10 groups, with 4 students in each group. They conduct evidence-based analysis on the clinical case of "contraindications for adult lower leg venous puncture," and the discussion time is 15 min. After the group discussion, each group is required to present and exchange their findings. Each group's presentation time is about 3 min, focusing on demonstrating the degree of literature support for the decision-making basis and the evaluation of clinical applicability assessment.

Following the presentations, the instructor concludes by further posing two questions to encourage continued learning and reflection:

- 1) What key historical events have propelled the development of intravenous therapy technology?
- 2) How does the progress of intelligent intravenous therapy technology impact clinical nursing practices?

The intent of the question design is justified as follows. The first question aims to help students deeply understand the critical moments in the history of intravenous therapy technology. It emphasizes that its application results from both technological innovation and the synergy between scientific research and clinical practice. The second question prompts students to consider how advanced medical technologies, such as infusion robots, could transform future nursing roles by enhancing efficiency and safety. This reflection may also ignite their interest in the evolving field of nursing.

After class

After class, the instructor poses the following two questions and require students to complete multi-media presentations of their learning outcomes. For students keen on

intravenous therapy, they may also engage in scientific research training in an alternative setting.

- 1) Analyze potential complications that may arise during intravenous infusion, focusing on infection control, drug compatibility, and infusion rate. Additionally, provide specific case analyses or solutions to address these issues.
- 2) Discuss the differences in applying intravenous infusion techniques across various clinical settings. For instance, how do the strategies and considerations for intravenous infusion vary between emergency departments, cardiology, pediatrics, and ICU? Additionally, please incorporate specific clinical cases to illustrate your understanding and analysis of these differences.

The intent of the question design is justified as follows. The first question aims to encourage students to analyze potential complications that may arise during intravenous infusion and their preventive measures, by integrating theoretical knowledge with practical scenarios. This fosters their analytical and application skills. The second question explores strategies and considerations for intravenous infusion across different departments, aiming to improve students' clinical reasoning and equip them with the abilities to make informed decisions in diverse clinical contexts.

Teaching and learning evaluations

To evaluate the attainment of learning objectives for this chapter, a multi-dimensional evaluation method is utilized, including various assessment forms before, during, and after class. The evaluation process integrates formative and summative assessments to comprehensively understand students' integrated development in knowledge, skills, and attitude (Table 1).

The goal of the pre-class online test and in-class quiz is to assess students' immediate understanding of the

Table 1: Assessment diagram for "Intravenous Therapy" learning.

Process stage	Assessments	Points (100 in total)
Pre-class	Online unit test	10
	Online resource learning	10
	Pre-study report	10
In-class	Real-time quiz	20
	Group discussion (participation, interaction, and quality of discussion)	30
After-class	Outcome presentation (logic, scientific rigor, standardization, and aesthetics)	20

content learned. Teachers will check whether students have completed the pre-class assignments on time. These assignments include watching instructional videos, reading literature, and writing a pre-study report. The report should summarize the key points and questions of the pre-study content. This helps teachers assess students' engagement before class. During group discussions, teachers will observe each group's discussion situation. They will consider participation, interaction, and the quality of the discussion. This allows them to evaluate students' learning attitude and state. When students present their learning outcomes through multi-media, teachers can evaluate the content of the presentation. They can point out strengths and areas for improvement.

Students' achievement and feedback

Through a comprehensive analysis of teaching effectiveness evaluation questionnaires and classroom observation data, we found remarkable results in enhancing students' professional capabilities. The questionnaire data showed that over 90 % of the 40 learners approved the course's effectiveness. Notably, "problem-solving ability" and "teamwork ability" saw significant improvements, both achieving a 97.5 % approval rate. However, "critical thinking ability" and "cultivation of learning interest" had approval rates of 90.0 % and 92.5 % (Table 2). This indicates that the case-based blended teaching model significantly promotes applied capabilities development. Nonetheless, cultivating higher-order thinking skills may necessitate a more systematic training design.

During the teaching interaction process, teachers utilized both online and offline channels. They closely monitored students' learning performance. Data shows that the participation rate of students in both forms of discussion reached 100 %. Guided by teaching cases, students actively

raised various questions related to intravenous therapy and deeply explored corresponding solutions. By analyzing students' post-class reflections, we found that 97.5 % of them showed characteristics of in-depth knowledge construction. In the reflection texts, professional terms such as "clinical decision-making" (n=32) and "risk assessment" (n=28) appeared frequently, which fully indicates that the real teaching situation has effectively promoted the internalization of the professional discourse system. However, 12.5 % of the reflection reports still remained at the level of operational process description, which means that the systematicity of clinical thinking of individual students still needs to be further improved.

Through qualitative analysis, two key findings emerged. Firstly, the historical context-based teaching method proved highly effective, with 82.5 % of students mentioned in their reflection reports that referencing the history of intravenous therapy development helped them establish a comprehensive knowledge and cognitive framework, thereby significantly enhancing their understanding of professional concepts. Secondly, role-playing significantly boosted students' professional awareness, with 35 % of the students actively reflected on the transformation in their professional awareness post-teaching, with remarks such as "shifting from mere technical execution to holistic nursing thought processes" being notably indicative. However, feedback distribution on critical thinking was unevenly distributed. It accounted for 67.5 % in the case-discussion segment but only 22.5 % in the self-learning module. This discrepancy highlights the need for curriculum adjustments, specifically emphasizing the enhancement of critical thinking skills within the self-learning component.

Discussion

In the curriculum system of *Basic Nursing Science*, the knowledge of each chapter is intertwined and closely related. Especially, the chapter of "Intravenous Therapy" has numerous connections with other chapters such as "Nursing Assessment," "Disinfection and Isolation Techniques," and "Drug Therapy." However, in the current teaching of the "Intravenous Therapy" chapter of the basic nursing curriculum, despite its detailed explanations of technical operations, there are still areas that need optimization. Firstly, the breadth of content needs to be expanded urgently. The coverage of emerging intravenous infusion technologies is relatively limited. The latest industry guidelines and cutting-edge research results

Table 2: Hierarchical analysis of the training effects on core competencies in "Intravenous Therapy" teaching.

Ability dimension	Approval rate, %
Applied practice ability	97.5
Team collaboration ability	97.5
Self-learning ability	95.0
Teaching satisfaction	95.0–97.5
Critical thinking	90.0
Learning interest	92.5

are not closely integrated. Consequently, students find it difficult to comprehensively understand the latest developments in the field of intravenous therapy. For example, intraosseous infusion, a method that establishes vascular access quickly, safely, and effectively, providing new ideas for intravenous therapy, has not been widely incorporated into the teaching content [16]. Secondly, the synergy between this chapter and other nursing-related courses is insufficient, students spend a significant amount of effort when studying the “Fundamental Nursing” course. Later, when they study other nursing professional courses, they need to repeatedly review relevant basic knowledge points. This fragmented learning mode disrupts the cultivation of clinical nursing thinking and is not conducive to building a systematic and coherent knowledge framework for students.

In view of this, strengthening the integration of knowledge among various chapters in the teaching process is of great significance. The instructional design of this chapter emphasizes integrating knowledge from different chapters. It serves as a good example for integrating themes with other nursing courses. For instance, in the chapter of “Nursing Assessment,” the key points of assessing patients receiving intravenous therapy can be explained in depth, so that students can understand the importance of comprehensive assessment in formulating intravenous therapy plans. It can also deepen their understanding of the holistic and systematic nursing assessment. In the chapter of “Disinfection and Isolation,” using infection-prevention measures during intravenous therapy as examples can strengthen students’ awareness of aseptic operation principles. This can further consolidate the application of disinfection and isolation knowledge in nursing practice. Additionally, the chapter of “Basic Knowledge of Medication” is closely related to the “Intravenous Therapy” chapter. In teaching, content such as the selection of intravenous infusion drugs, compatibility contraindications, and the impact of infusion speed on drug efficacy can be explained. This allows students to understand the crucial role of intravenous therapy in drug treatment and how to ensure the safety and effectiveness of intravenous medication.

In clinical practice, students can directly apply the knowledge and skills gained from this instructional design. For example, based on the development context and core issues of intravenous therapy technology, they can consider and formulate infusion plans for different patients. These plans focus on reducing infections, selecting appropriate infusion fluids, and precisely controlling the infusion speed. The study of new tools and technologies enables students

to quickly adapt to and proficiently use devices such as intelligent infusion pumps and needle-free infusion connectors in clinical settings. This improves the efficiency and quality of nursing work. In advanced nursing courses, the content of this instructional design can be further expanded as a foundation. For instance, in the “Critical Care Nursing” course, students can explore more complex and precise infusion plans for critically ill patients. They also learn how to handle complications, based on their understanding of intravenous therapy techniques and concepts. In the “Nursing Management” course, discussions can be held on effectively managing and continuously improving the quality of intravenous therapy in clinical nursing units. This is done in conjunction with the concept of total quality control. Thus, a complete nursing education system is constructed, ranging from basic to advanced levels and from theory to practice.

The diverse teaching methods adopted in this instructional design offer a certain degree of flexibility and scalability, suitable for classes of varying sizes and different healthcare education environments. For larger classes, during the theoretical teaching session, modern multi-media teaching equipment such as large-scale projection screens and online live-streaming platforms can be utilized. This ensures the efficiency and comprehensiveness of knowledge transfer. In case discussions and group collaborations, a group-based approach is employed. Each group selects a team leader responsible for organization and coordination. Meanwhile, the teacher circulates to provide guidance, ensuring that every group can fully engage in discussions and receive appropriate instructions. During the achievement-presentation session, an online platform is used. Students upload their presentation works, and all students conduct online peer-evaluations. This not only saves time but also enhances participation and interaction among students. This teaching model is equally effective in different healthcare education environments, including clinical practice settings and campus classrooms. In clinical practice settings, case discussions can be conducted using real-life cases. This allows students to gain a deeper understanding of theoretical knowledge in practical contexts. Additionally, group collaborations can focus on solving actual clinical problems, further bridging the gap between theory and practice.

Limitations

This study still has certain limitations. The sample size is relatively small ($n=40$). This may limit the generalizability of the results. Using self-reported data from students

can introduce subjective biases. The single-group design lacks a control group, which limits the rigor of causal inferences. For future research, it is necessary to expand the sample size and include diverse student groups to verify the external validity. Future studies should adopt a randomized controlled trial design to compare the differences between the traditional teaching model and this model. Additionally, objective assessments like practical exams and standardized tests should be introduced to enhance the scientific nature of the research.

Conclusions

The innovation of this study lies in the in-depth integration of historical evolution, clinical cases, and flipped classrooms. It offers a practical example of curricular integration for nursing education. The findings provide empirical support for intravenous therapy teaching and suggest a reference approach for teaching reform in other core nursing skills. In the future, we can further explore the application of this model in complex clinical scenarios, such as critical care nursing and geriatric nursing. By incorporating intelligent teaching tools, we can optimize the cultivation of critical thinking in the autonomous learning module. This will promote the continuous development of nursing education towards the cultivation of higher-order abilities.

Acknowledgments: I am deeply grateful to Professor Dai for his patient guidance and meticulous instruction throughout the entire course design process. His professional insights and valuable suggestions have greatly enriched my course content. These contributions helped me overcome numerous challenges.

Research ethics: The local Institutional Review Board deemed the study exempt from review.

Informed consent: Not applicable.

Author contributions: The authors has accepted responsibility for the entire content of this manuscript and approved its submission.

Use of Large Language Models, AI and Machine Learning

Tools: The research data constitute regular teaching evaluation materials, and the aggregated results preclude any possibility of tracing back to individual student information; The entire manuscript was manually authored by human authors.

Conflict of interest: The author states no conflict of interest.

Research funding: None declared.

Data availability: Not applicable.

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