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Effect of nursing simulation teaching information system based on HIS in comprehensive training course for senior nursing undergraduates: a randomized controlled trial

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Abstract

Background Advancements in information technology, have made hospital information systems (HIS) essential tools for clinical nursing. The integration of HIS into undergraduate nursing education is a growing expectation within healthcare institutions. To meet this demand, nursing educators have promoted the incorporation of HIS into curricula to foster educational innovation. In response, our research team developed the Nursing Simulation Teaching Information System (NSTIS) to facilitate nursing operations related to HIS. We designed a comprehensive training course for senior students to prepare them for clinical rotations, with case simulations as a central component. This study aimed to assess the effectiveness of NSTIS in the training course and refine both the system and teaching scheme based on student feedback.

Methods A total of 114 nursing students were assigned to either the experimental ($n=55$) or the control group ($n=59$), with only 114 students completing the intervention. Both groups worked on the same simulation case. The experimental group used the NSTIS to obtain complete medical records, whereas the control group used traditional Microsoft Word documents and printed materials. With informed consent from the participants, data were collected using a self-designed classroom teaching effect questionnaire and a case workshop scoring form.

Results The experimental group scored higher than the control group on the total scores of the self-designed teaching effect questionnaire, with significant differences observed in specific items related to teaching objective achievement and learning outcomes. Qualitative data indicated that the experimental group reported acquiring skills in HIS operation. Both groups recommended adjustments to the teaching structure to enrich the case study resources, while the control group expressed a desire for measures to enhance their learning motivation.

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Conclusion Integrating NSTIS into a comprehensive training course can help enhance the effectiveness of case simulations. Further improvements to the NSTIS and teaching strategies are necessary for effective teaching. Future research should explore whether the application of the NSTIS in comprehensive training courses can improve students' abilities and investigate how to integrate the NSTIS into other courses.

Trial registration Not applicable.

Keywords Hospital information systems, Nursing comprehensive training course, Scenario simulation, Nursing education, Teaching effect

Background

Advances in information and communication technology have transformed healthcare systems worldwide and have influenced nursing education. Nursing education must balance the current and future needs of the nursing workforce. Therefore, it must continually revise and enhance its curriculum framework [1]. Hospital information systems (HIS), which are among the most widely used health information technologies [2], are also known as electronic health records (EHR), electronic medical records (EMR), computer-based patient records (CBPR), and electronic health information management systems (EHIMS) [3]. As predicted, nurses increasingly depend on these systems for critical data, making them essential tools for managing clinical nursing and patient health information [4].

The literature indicates that most nursing students have limited opportunities to use HIS during clinical practice. Their understanding of the fundamental structure and functionality is predominantly primarily gained through observational experience during clinical rotations [5–7]. While it is essential for nursing students in clinical settings to learn about HIS, they are unfortunately not granted access to these systems [5]. Nursing educators must therefore, incorporate innovative teaching strategies to ensure that all students engage with contemporary healthcare technology to provide safe and high-quality patient care [5]. Integrating HIS into the nursing curricula is crucial for meeting the demands of the information age and supporting the comprehensive development of nursing students. George et al. [8] proposed that combining academic web-based EMR systems with simulations for skill reinforcement or case studies is a critical step in advancing nursing education and encouraged its introduction into the basic nursing curricula.

The United States, Canada, Singapore, the United Kingdom, and South Korea are the main countries that have integrated HIS into their nursing curricula [9]. The integration is primarily for simulated learning in classrooms for conceptual learning, skill labs for procedural training, and simulation wards for scenario-based training [10]. In these countries, HIS was primarily incorporated into the nursing curricula in three ways: collaboration with hospital institutions, purchasing HIS simulation software, and independent software development. Initially, collaboration with hospital institutions involved connecting laboratory computers to the HIS of the partnering hospitals [11]. Choi et al. [12] collaborated with a local Korean health system to create a mobile academic EMR system. They modified the existing HIS to a read-only mode and integrated external applications for nursing documentation, enabling students to practice safely and learn about of the HIS during clinical rotations. However, partnering with hospitals to access the HIS is often restricted due to patient safety and privacy concerns.

The development of dedicated academic HIS effectively addresses permission issues, allowing students to operate in a safe environment without compromising patient safety [7, 13]. In 2013, Kowitlawakul et al. [14] designed a software program called Electronic Health Record for Nurse Education (EHRNE), which simulates electronic health records to effectively retrieve and record data, primarily for teaching nursing documentation skills. The program was later upgraded to the Integrated Nursing Education System (iNES), a web-based platform that enhances data storage, enabling users to create and update records of patient progress, medication and evaluation, as well as create new cases [15]. Hong et al. [16] reformed a cloud-based HIS by adding a preset list of nursing diagnoses and a content list based on nursing procedures to meet the needs of undergraduate education. Based on the characteristics or prototypes of clinical HIS, these programs enable students to understand HIS and develop competencies in data retrieval and recording, serving as effective pedagogical examples for nursing education. However, the relevant systems currently developed focus mainly on recording nursing procedures and pay less attention to other aspects of HIS. Few studies have been conducted that can fully simulate the functions of each HIS module. Additionally, existing systems rarely divide cases into distinct clinical phases, such as pre-admission, pre-operation, and post-operation, nor do they simulate the patient hospitalization process in real-time.

To simulate HIS more authentically and comprehensively, our research team has been actively developing and refining a Nursing Simulation Teaching Information System (NSTIS) since 2018 [17]. The system has become

an important tool and support platform for the study of professional courses and case analysis training at our institution. Additionally, it has been granted two patents in China and has received support from five initiatives, including projects funded by the Ministry of Education, provincial-level programs, and the National College Students' Innovation and Entrepreneurship Training Program. Based on enterprise cloud management, the system comprises a user layer, a system management, a teaching platform, a nurse workstation, and other modules. The system functions as follows: (1) The nurse station module aligns with the HIS system configuration, enabling all HIS-related operations within the scope of the nurse's duties, such as medication administration, nursing assessments, and nursing documentation. (2) Complete medical records covering the entire hospitalization period were embedded in the system. The medical record timeline follows the simulation time in real-time, enabling high-simulation, multi-scenario, dynamic developmental simulations. (3) The system generates multiple copies of the same case by changing the patient's name and assigning them to each student to simulate responsible care. (4) The teaching auxiliary function module caters to teachers' needs, such as course scheduling, setting the case phase, and releasing tasks and learning resources. It also provides a platform for students to upload homework, self-assessments, and peer assessment. (5) The case management submodule in system management allows for the modification, updating, and addition of case resources. The specific module composition of the NSTIS is illustrated in Fig. 1. To integrate the NSTIS into case simulations, each bed in the nursing laboratory was equipped with a mobile nurse workstation and bedside information display.

To enhance students' use and understanding of the NSTIS, it was integrated into the case simulation of the comprehensive training course. The training course has assisted nursing students in better adapting to clinical rotation and enhancing their practical nursing skills, including basic and specialized nursing operations and case simulations. This course is typically conducted during the third year's second semester of a nursing program. Eight teachers from various course groups, including internal medicine nursing, surgical nursing, health assessment, and emergency and critical nursing, were involved in the case simulation section. Among them, three were senior clinical nurses qualified to undertake teaching tasks. Many institutions have incorporated comprehensive case simulations into their courses, primarily utilizing scenario-based simulation and Problem-Based Learning (PBL) teaching methods [18]. Students received primary details through Microsoft Word documents and printed case summaries. The NSTIS, used in comprehensive nursing training courses, is an innovative approach that integrates HIS-related tasks, such as medical order processing, into specific case simulations to train nursing students. This integration enhances the fidelity of

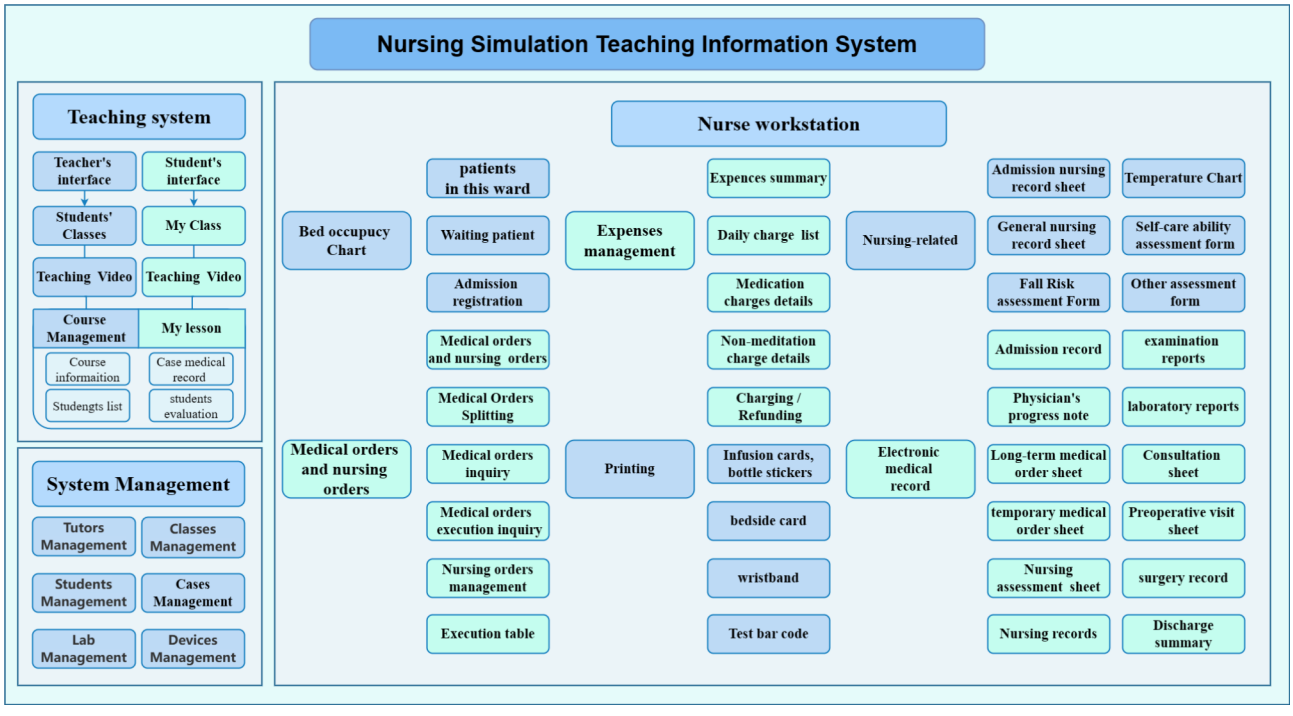

Fig. 1 The specific function module composition of NSTIS

simulated scenarios, making them more representative of actual clinical situations.

Methods

Objectives

To verify the effect of the NSTIS on the comprehensive nursing training course.

To investigate students' insights into the refinement of the NSTIS and teaching scheme.

Study design

A randomized controlled trial was conducted based on a COPD case simulation during comprehensive nursing training from April 2023 to June 2023.

Participants and randomization

Third-year undergraduate nursing students from the School of Nursing at a researcher-affiliated medical university were selected as the participants. The inclusion criteria required that participants be third-year undergraduate nursing students who agreed to participate in the study, excluding those who did not complete the intervention due to the COVID-19 pandemic or other unforeseen circumstances. A total of 119 third-year undergraduate nursing students were enrolled in the study. Participants were randomly divided into experimental ($n = 59$) and control ($n = 60$) groups. Due to epidemic prevention and control measures, 5 individuals were excluded, resulting in a final control group of 59 individuals and an experimental group of 55 individuals. Figure 2 shows the CONSORT flow diagram.

A double-blind design was employed, with both researchers and data analysts blinded to group allocation. The participating students were randomized into Groups 1 and 2 using a lottery method based on their student ID sequences. One researcher recorded the students' IDs and the corresponding group numbers on a list, that was submitted to the course instructor. A second researcher, blinded to the allocations, designated one group as the experimental group and informed the instructor of the course. The instructor supplemented the list with the intervention assignments, sealed it in an envelope, and stored it securely. Class schedules were arranged according to group assignments, and students were notified

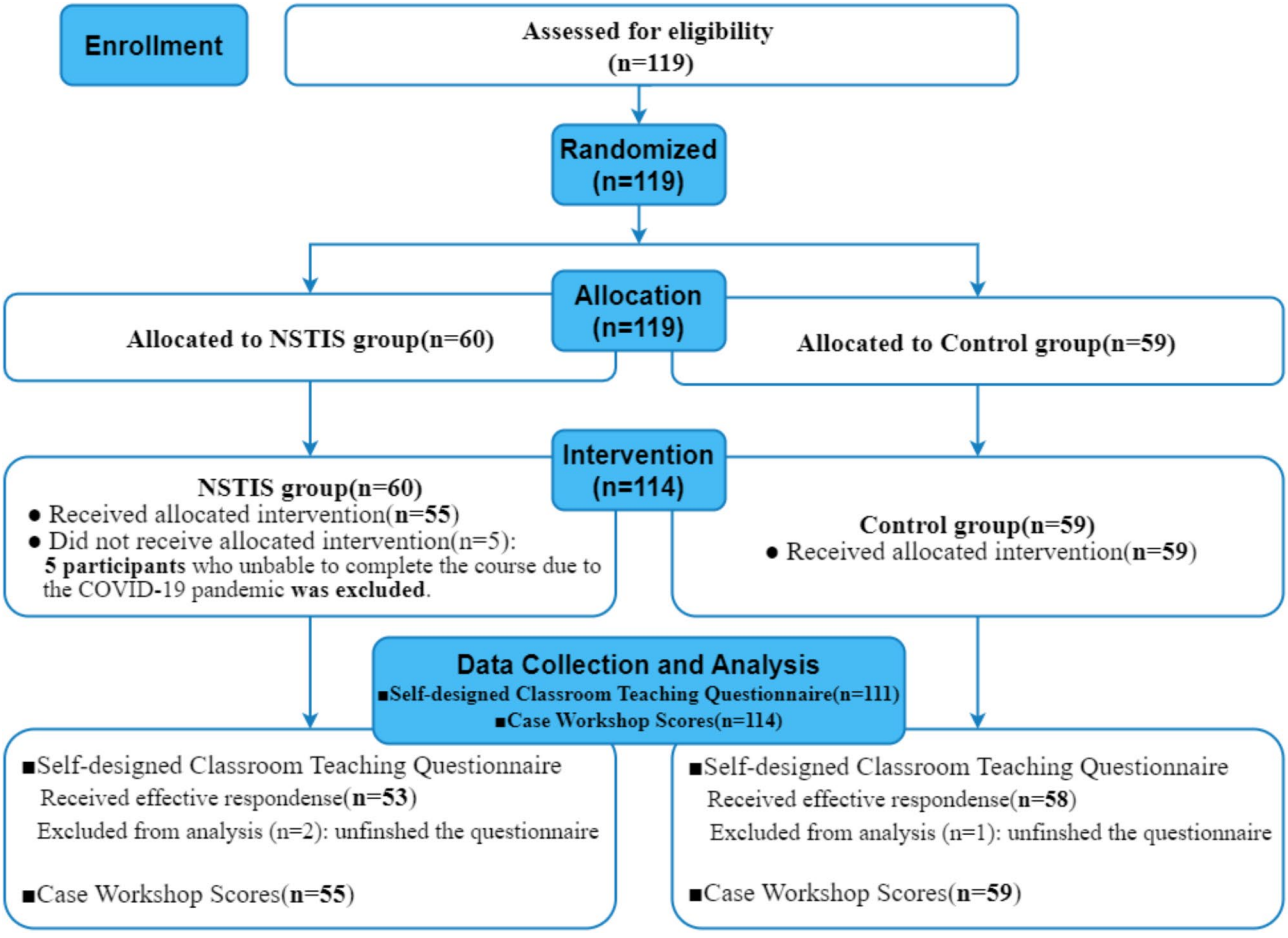

Fig. 2 The CONSORT flow diagram

of their class locations and times. The students were informed of their group assignments only after the intervention. Following data analysis, the instructor unsealed the envelope to reveal the group allocation.

Sample size

The sample size was determined using the formula for estimating means [19], with a significance level (α) of 0.05 and a target power of 0.90. Based on the findings of Baptista et al. [20], we used a mean difference of 4.49 with a standard deviation of 6.53. The resulting sample size was 34 participants per group, accounting for a 20% dropout rate, resulting in a total sample size of 86.

Intervention

Teaching scheme

The lesson consisted of a pre-class preparation task and three in-class modules, as illustrated in Fig. 3.

1) Pre-class tasks (relevant knowledge previously learned and assessed through other courses).

   a) Review the health history collection, focus assessment, key points of nursing, and health education related to COPD.
   b) Review the arterial blood gas analysis, atomization inhalation, respiratory function exercises, chest percussion for sputum clearance, and sputum specimen collection.

2) Practical Training Sessions.

   a) Module 1: Admission assessment and health education (50 min) based on the admission case scenario.

      i) Admission focus assessment: core symptom inquiry and completion of respiratory specialty assessment scales (COPD, and dyspnea quantification scales).
      ii) Admission health education: Introduction to the hospital environment, symptom relief methods, sample collection methods, nutritional and lifestyle guidance.

   b) Module 2: Executing medical orders and complete report interpretation (40 min) based on the case scenario on Day 1.

      i) Perform arterial blood gas analysis procedures and interpret the results of the blood gas analysis report.

   c) Module 3: Chest Percussion (30 min).

      i) Simulation Scenario: Nurses receive orders to administer atomization inhalation to the patient; upon assessment, it is discovered that the patient has difficulty expectorating sputum, necessitating the chest percussion for sputum clearance.

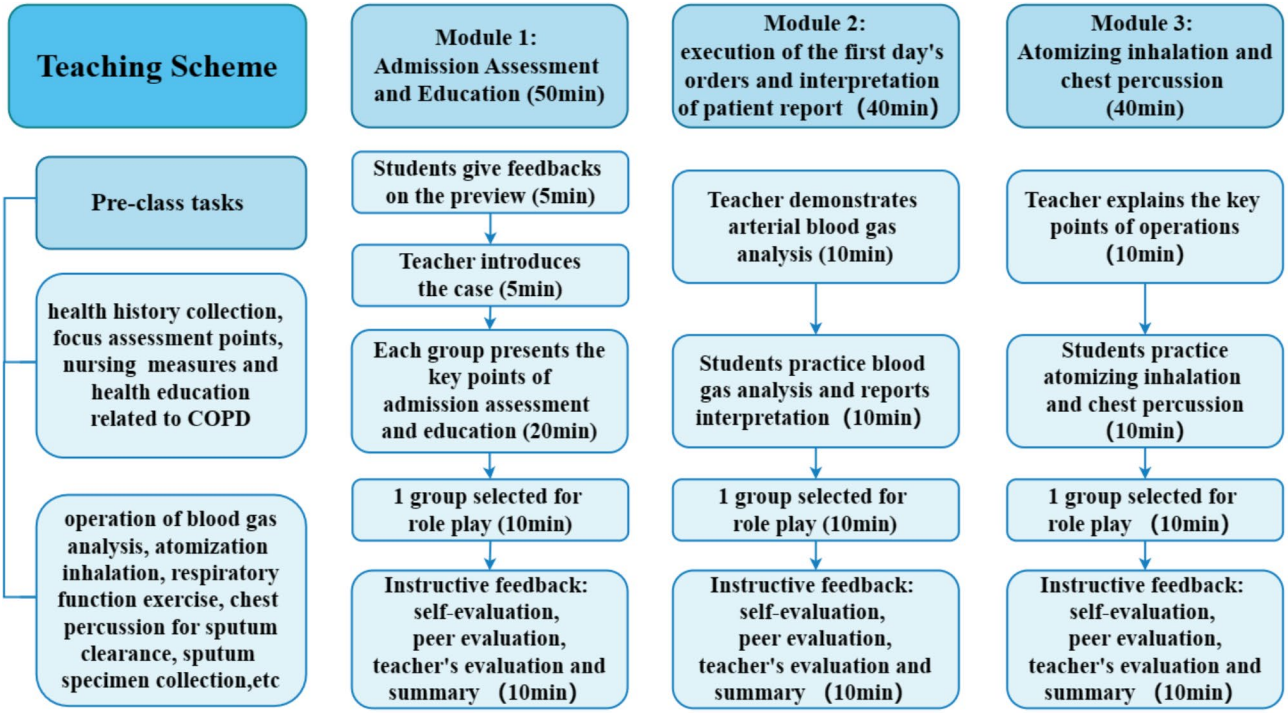

Fig. 3 Teaching scheme

3) Feedback and evaluation session.

After each module simulation, the students, guided by the teacher, engaged in reflective discussions on the simulation process and complete a self-assessment or peer assessment on a guided feedback form.

The experimental group

The experimental group adopted the NSTIS to conduct scenario-based simulation teaching integrated with PBL. Students in the experimental group completed the related pre-class tasks by reviewing EMR in the system and professional textbooks. During class, students used the system to perform assessment tasks, manage orders through the system modules, and carry out nursing procedures as required.

The control group

The control group used traditional printed materials to conduct scenario-based simulation teaching integrated with PBL. Students in the control group completed the related pre-class tasks using Microsoft Word versions of case summaries and professional textbooks and completed the simulation tasks through printed assessment sheets and orders during class.

The two intervention groups were divided into three classes and taught in separate laboratories. Each class conducted situational exercises in groups of 2–3 people. The nursing simulation teaching system guidance and case simulation teaching were conducted by professional teachers who received standardized training. Three teachers taught the control group in the morning and the experimental group in the afternoon to prevent the teaching experience of the experimental group from interfering with that of the control group.

Data collection tools

Self-designed classroom teaching effect questionnaire

The self-designed questionnaire included six aspects: (1) Basic characteristics including sex and birth date. (2) Satisfaction evaluation with five items was assessed using a 5-point Likert scale, where scores from 1 to 5 represented "strongly disagree," "disagree," "neutral," "agree," and "strongly agree," respectively. (3) Achievement of teaching objectives with nine items rated on a 5-point Likert scale, with scores ranging from 1 to 5 indicating "not met," "partially met," "moderately met," "largely met," and "fully met." (4) Learning outcomes were assessed using five items scored on a 5-point Likert scale, where ratings of 1 to 5 signify "ineffective," "slightly effective," "moderately effective," "quite effective," and "very effective," respectively. (5) Suggestions for additional course content with six items rated on a 5-point Likert scale, with 1 to 5 representing "strongly disagree," "disagree," "neutral," "agree," and "strongly agree." (6) Open-ended questions for main learning gains and suggestions aimed at capturing insights beyond the closed-ended items. The detailed descriptions and distributions of each item are presented in Table 2. The overall Cronbach's α coefficient for the closed-ended items was 0.918, with individual section Cronbach's α coefficients of 0.945, 0.920, 0.921, and 0.791 respectively. The closed-ended section was evaluated by three experts in the relevant field, and the S-CVI was 0.987. The closed-ended questions showed good internal consistency and content validity.

Case workshop scores

The case workshop scores were evaluated by the instructional faculty based on group performance during case training, including nursing assessment, health education, skill operation, cooperation, and communication skills, with three points awarded for each. Additionally, individual student participation and group performance were recorded, which may have resulted in bonus points or deductions based on group scores. The students' total scores did not exceed 15 points.

Data collection and analysis

The two groups completed related questionnaires after class, which were collected by researchers who were not involved in the teaching. All responses were submitted anonymously, and confidentiality was maintained. Teachers were absent when the surveys were distributed to prevent evaluation bias from their presence. The researchers responsible for data collection labeled the original data for group comparisons during the data analysis.

SPSS 24.0 (IBM Corp., Armonk, NY, USA) was used to analyze quantitative data. Descriptive data are presented as numbers, percentages, means, and standard deviations. Sex composition was assessed using the chi-square tests. Age, scores on the self-developed classroom teaching effect questionnaires, and case workshop scores exhibited a skewed distribution; the Mann–Whitney U test was used to compare the differences between the two groups. The significance level was set at $\alpha = 0.05$. NVivo 12 Plus was used to analyze the gains and suggestions gathered from open-ended questions. The researchers analyzed the data by group number while remaining blind to the students' assignments in the experimental or control group.

Ethical consideration

This study was approved by the Southern Medical University Biomedical Ethics Committee (Approval [2023] No.6). Written informed consent was obtained from all the participating students.

Result

Quantitative data analysis

Baseline characteristics

A total of 114 classroom teaching questionnaires were distributed, of which 111 were returned, (53 from the experimental group and 58 from the control group). Among the valid questionnaires, there were 19 male and 92 female participants, with a mean age of 21.55 ± 0.97 years. No significant differences in age or sex were observed between the groups (Table 1).

Self-designed classroom teaching questionnaire scores

Table 2 shows that the experimental group scored significantly higher than the control group on the self-designed classroom teaching questionnaire ($p < 0.05$). Significant differences were observed in the total scores of the achievement of teaching objectives and three specific items: "Familiarity with the nursing measures for the patient," "Mastering COPD-related admission focus assessment," and "Mastering COPD-related admission health education," with the experimental group demonstrating higher achievement levels ($p < 0.05$). Regarding learning outcomes, the experimental group showed significantly higher scores for "Enhancing learning interest" and "Satisfying the need for relevant case information" ($p < 0.05$).

Case workshop scores

A total of 114 participants completed the intervention and received case workshop scores, with 59 in the control group and 55 in the experimental group. The control group had an average score of 12.80 ± 1.23 points, while the experimental group scored 12.84 ± 0.92 points. The difference in the case workshop scores between the two groups was not statistically significant (Z = -0.036, $p = 0.971$).

Qualitative data analysis

Students' gains in classroom teaching questionnaire

Textual data analysis resulted in 183 coded nodes, with both groups identifying four main themes and nine subthemes each. As shown in Table 3, both groups reported gains in the following areas: "Consolidation and expansion of knowledge," "Acquisition of clinical skills," "Positive emotional engagement in simulation," and "Development of clinical thinking." Compared to the control group, the experimental group emphasized the benefit of "HIS operational skills" in terms of clinical skills. Regarding emotional experiences in the classroom, the experimental group noted that their learning approach deepened their learning impressions and enhanced their sense of clinical immersion in the simulation environment, whereas the control group's immersion was mainly derived from role-playing exercises.

Students' suggestions in classroom teaching questionnaire

Classroom suggestions comprise 58 nodes. The experimental group, with 25 nodes, identified four main themes and five subthemes, while the control group, with 33 nodes, identified four main themes and four subthemes. As seen in Table 4, both groups suggested adjustments to the teaching structure, with the majority of students expressing that the teaching content was extensive and that insufficient time was allocated to each component of the course. They emphasized the need to extend the duration of skill practice and group discussion. Under the theme of adjusting the teaching structure, the experimental group recommended the inclusion of more case scenario elements, specifically more opportunities for role simulation, while the control group focused more on individual skills and expressed a desire for increased explanations of skill operations. Additionally, both groups suggested enriching the resources related to the case, with a higher demand from the control group. The experimental group suggested proposed further improvement to the NSTIS and the expansion of pre-class tasks. Meanwhile, the control group expressed a desire for various measures to stimulate learning engagement, such as promoting group discussions and competition and increasing interaction.

Discussions

Our results indicated that the NSTIS group scored higher in self-evaluations of classroom teaching effectiveness than the control group. This finding suggests that the NSTIS may play a constructive role in enhancing simulation-based learning outcomes, primarily by facilitating nursing students' acquisition of relevant knowledge

Table 1 Basic characteristics of the two groups of students

Variable		Experimental		Control		Test value Z	*p*-Value
		$\bar{X}$	SD	$\bar{X}$	SD		
age		21.62	1.11	21.48	0.82	-0.375	0.708
Variable		**Experimental**		**Control**		**Test value χ^2**	***p*-Value**
		n	**%**	***n***	**%**		
Sex	male	6	11.3	13	22.4	2.402	0.121
	female	47	88.7	45	77.6		
	total	53	100	58	100		

Table 2 Comparison of classroom teaching effect questionnaire scores between two groups

	Item	score($\bar{x} \pm SD$)		Test value *Z*	*p* value
		Experimental (*n* = 53)	Control (*n* = 58)		
Total Score		107.94 ± 11.05	103.78 ± 9.67	-2.260	0.024*
Total score of satisfaction evaluation		23.00 ± 2.31	22.74 ± 2.35	-0.569	0.569
Satisfaction evaluation	Satisfying with this course	4.62 ± 0.49	4.55 ± 0.50	-0.754	0.451
	Significant overall gains	4.68 ± 0.47	4.55 ± 0.54	-1.248	0.212
	Reasonable organization of teaching	4.51 ± 0.61	4.53 ± 0.50	-0.054	0.957
	Appropriate arrangement of teaching format	4.57 ± 0.50	4.50 ± 0.50	-0.693	0.488
	Teaching methods suitable for the course content	4.62 ± 0.49	4.60 ± 0.53	-0.091	0.927
Total score of the achievement of teaching objectives		40.45 ± 5.50	38.91 ± 4.44	-2.293	0.022*
The achievement of teaching objectives	Familiarity with the patient's condition;	4.40 ± 0.86	4.24 ± 0.66	-1.793	0.073
	Familiarity with the main treatment measures for the patient	4.30 ± 0.87	4.09 ± 0.78	-1.790	0.073
	Familiarity with the nursing measures for the patient	4.47 ± 0.75	4.24 ± 0.68	-2.110	0.035*
	Mastering COPD related admission focus assessment	4.57 ± 0.69	4.29 ± 0.68	-2.447	0.014*
	Mastering COPD related admission health education;	4.66 ± 052	4.38 ± 0.67	-2.287	0.022*
	Mastering the operation of arterial blood gas analysis	4.60 ± 0.60	4.48 ± 0.76	-0.799	0.424
	Mastering the interpretation of blood gas analysis report	4.40 ± 0.84	4.40 ± 0.56	-0.819	0.413
	Acknowledging the characteristics of inhalers in patients with COPD	4.36 ± 0.98	4.24 ± 0.66	-1.754	0.079
	Mastering the assessment and chest percussion for sputum clearance	4.70 ± 0.58	4.55 ± 0.50	-1.936	0.053
Total score of learning outcome		22.38 ± 2.74	21.53 ± 2.80	-1.600	0.110
Learning outcome	Enhancing learning interest	4.51 ± 0.64	4.29 ± 0.56	-2.160	0.031*
	Increasing the sense of clinical simulation	4.26 ± 0.74	4.24 ± 0.66	-0.316	0.752
	Satisfying the need for relevant case information	4.47 ± 0.61	4.19 ± 0.63	-2.383	0.017*
	Deepening learning impression by combining theory and practice	4.58 ± 0.54	4.40 ± 0.65	-1.499	0.134
	Helping to develop clinical thinking	4.55 ± 0.67	4.41 ± 0.65	-1.291	0.197
Total score of course suggestion		22.11 ± 3.79	20.59 ± 3.89	-1.864	0.062
Course suggestion	Suggestion to add pre-class learning tasks	3.38 ± 1.04	3.00 ± 0.96	-1.870	0.061
	Suggestion to add pre-class quizzes (as a part of course grades)	3.11 ± 1.03	2.78 ± 1.03	-1.506	0.132
	Suggestion to increased interaction and discussion in the classroom	4.04 ± 0.81	3.86 ± 0.87	-1.220	0.222
	Suggestion to add more case scenarios and simulated tasks	3.94 ± 0.91	3.78 ± 0.96	-0.958	0.338
	Suggestion to add after-class assignments (as a part of course grades)	3.08 ± 1.00	2.86 ± 1.00	-0.952	0.341
	Suggestion to observe real COPD cases after class	4.57 ± 0.54	4.31 ± 0.82	-1.503	0.133

* $p<0.05$

and clinical competencies. Consistent with our findings, Romero-Collado et al. [21] demonstrated that using EMR for simulations can help students acquire knowledge and skills related to health prevention and promotion. The pedagogical advantages of NSTIS in simulation-based learning may be attributed to its effectiveness in optimizing health information collection and utilization, both of which are essential components of nursing case simulations. Kaplan and Korkmaz [6] noted, that EMR-based training in educational settings could enhances nursing students' data collection capabilities and care quality. Primarily, the NSTIS enables students to interact with authentic patient records rather than simplified synthetic records, which better addresses their clinical documentation requirements. Similarly, Elliott et al. [22] stated that students prefer accessing actual patient clinical records through EMR and acknowledge the higher quality of case information provided by these systems. Such authentic interactions may facilitate the integration of theoretical knowledge with clinical practice during case simulations, potentially contributing to students' mastery and application of their knowledge. Additionally, the thorough use of the NSTIS during the simulation process may help students link different nursing procedures and foster positive perceptions of nursing processes [23], enabling them to systematically grasp the entire simulation activity and deepen their mastery of the knowledge and skills required. Therefore, utilizing an academic HIS can enhance the effectiveness of simulation education It is recommended that nursing simulation activities, along with simulations in other medical disciplines, provide students with access to academic HIS whenever possible.

Table 3 Students' gains in both groups

Group	Theme/Subtheme	Excerpts	Statement (%)
Experimental group	Consolidation and expansion of knowledge	"Consolidated the previously learned knowledge, such as lip breathing, abdominal breathing, effective cough, tapping the back and so on.""Understood the admission process of COPD patients.""Learned about jet atomizers.""Learned a lot of clinical knowledge."	26.83
	Acquisition of clinical skills		51.22
	(i)Focus patient assessment	"More familiar with key content of the COPD focus assessment."	
	(ii) Health education delivery	"Mastered the content of COPD health education."	
	(iii)Nursing Procedural skills	"Learned the operation of arterial blood collection.""Mastered effective cough and chest tapping methods."	
	(iv)Interpretation of diagnostic reports	"More fully interpreted the blood gas analysis report."	
	(v)HIS operational skills	"Learned medical order handling and execution form signing from admission to Day 1."	
	Positive emotional engagement in simulation		18.29
	(i) Self-awareness of shortcomings	"Known the limitations in terms of knowledge.""Realized that I need to learn a lot in the future career"	
	(ii) Deepening of learning impressions	"Through practice, I became more familiar with the teaching content and remembered it more deeply."	
		"Obtained a deeper understanding of COPD."	
	(iii) Promotion of team cooperation	"There was a lot of interaction in the learning process of this class, and the communication and cooperation with the group members increased."	
	(iv) Enhancement of clinical immersion	"It was close to clinical, could further feel the clinical environment.""I felt clinically immersed...."	
	Development of clinical thinking	"This case analysis helped me know how to approach similar issues in clinical practice."	3.66
		"Practiced the clinical thinking."	
Control group	Consolidation and expansion of knowledge	"The assessment of patients with COPD and the focus and content of health education were reviewed again."	29.7
		"Understood the clinical atomization related technologies"	
	Acquisition of clinical skills		54.46
	(i) Focus patient assessment	"Learned more about the focus assessment of patients with COPD."	
	(ii) Health education delivery	"Helped master some of the main health education content."	
	(iii) Nursing Procedural skills	"Learned arterial blood collection techniques and key points.""Mastered effective coughing techniques, expectoration, and the correct methods for sputum clearance."	
	(iv) Interpretation of diagnostic reports	"Learned how to analyze arterial blood gas reports."	
	(v) Nurse-patient communication skills	"Assessment during the clinical course... It was very important to communicate with patients."	
		"Learned to communicate effectively with patients."	
	Positive emotional engagement in simulation		9.9
	(i) Self-awareness of shortcomings	"Have recognized my own shortcomings, I would strengthen the review of the theoretical knowledge after class."	
	(ii) Promotion of team cooperation	"Team cooperation was very good."	
	(iii) Enhancement of role immersion	"Role-playing enhanced immersion and fostered a deeper understanding."	
		"It created a closer connection to clinical practice, thereby integrating knowledge with clinical application more effectively."	
	(iv) Increased confidence in clinical rotation	"I felt more confident about my internship."	
	Development of clinical thinking	"Helped me develop clinical thinking."	5.94
		"Had a deeper understanding of how to approach patients in clinical settings and the ways to effectively support them."	

Table 4 Students' suggestions in both group

Group	Theme/Subtheme	Excerpts	Statement (%)
Experimental group	Improving the NSTIS	"The digital teaching system can be improved."	4.35
	Exposure to real cases in hospital	"Go to a real clinical environment for internship and practical observation."	13.04
	Enrichment of case-related resources	"I hope there are some images of the real situation as positive teaching materials."	13.04
	Adjustment of teaching structure		69.57
	(i)Optimization of overall class schedule	"Too much content, can be divided into classes.""Reduce teaching content or increase classroom time.""Increase time for feedback and assessment of student learning progress"	
	(ii)Addition of case scenarios	"Wish for more role play……." "Desire for more scenarios, so that the immersion could be stronger."	
	(iii)Expansion of pre-class tasks	"Increase pre-class assignments to promote familiarity with cases."	
	(iv)Extension of discussion time	"I wish there was more (time for)discussion."	
	(v)Increase in skill practice time	"Time is a little tight and the operation time is not enough."	
Control group	Exposure to real cases in hospital	"I hope to manage real COPD cases in clinical practice."	18.18
	Enhancement of learning motivation	"To restrain the apathetic group, improve the efficiency of group learning." "Hope to have more interaction with students." "It is suggested to have more group discussions and group competition."	18.18
	Enrichment of case-related resources	"Some case videos can be added to the class." "It is suggested that more clinical knowledge should be expanded." "Teachers can show various instruments (for atomization)."	24.24
	Adjustment of teaching structure		39.39
	(i)Optimization of overall class schedule	"There is too much teaching content and not enough time." "To extend the class hours."	
	(ii)Addition of skill operation explanations	"Hope for more explanations of skill operations."	
	(iii)Increase in skill practice time	"Add more time to practice nursing skill."	
	(iv)Extension of discussion time	"To extend the discussion time." "The class discussion was not enough, and the presentation would be rushed."	

Our findings suggest that NSTIS may enhance simulation learning experiences through three key aspects: stimulating interest in learning, deepening learning impressions, and fostering clinical immersion. This observation aligns with the research conducted by Williamson and Muckle [24], in which nursing students reported that HIS-related technologies significantly improved their educational experiences. Compared to traditional case summaries, the advantages of NSTIS in enhancing simulation experiences primarily lie in its alignment with electronic information processing in clinical settings and its provision of authentic clinical medical records. These strengths help replicate the nursing workflow in actual clinical practice, elevating nursing students' simulation experience from "role immersion" achieved through role-playing to "clinical immersion." Relevant studies have also shown that using academic HIS can significantly enhance the realism of simulations, facilitate students' immersion in the simulated experience [16, 25], and improve their perception of simulation effectiveness [26]. Additionally, the navigation and documentation features of the NSTIS optimize students' efficiency in accessing and managing patient information [27], enabling them to focus more effectively on completing nursing simulation tasks based on case scenario requirements. These factors may contribute to a more profound and lasting impression of the learning experience itself. Furthermore, as an innovative teaching tool offering case resources beyond traditional textbooks, the NSTIS adopts an electronic information-processing approach that aligns with the learning preferences of digitally native nursing students. This may enable the NSTIS to capture students' interests and stimulate their learning motivation effectively. This perspective was indirectly supported by feedback from the control group, which suggested implementing measures to enhance learning motivation and improve the learning experience.

The results indicated that NSTIS did not significantly improve workshop scores. This outcome may be attributed to two factors. First, simulation learning is inherently highly engaging and interactive, allowing students to achieve baseline scores through active participation in discussions and teamwork. Second, even after training, nursing students' proficiency in operating the NSTIS remained insufficient, which may have limited its effectiveness during the nursing simulation process and hindered significant improvements in their scores. This finding suggests that future efforts to promote the

application of the NSTIS should focus on enhancing training in system operations to improve student proficiency, thereby realizing its potential.

Our research suggests that NSTIS may help nursing students develop competencies in HIS operations. While a subtheme emerged reflecting the acquisition of "HIS operational skills," it is noteworthy that relatively few students provided this feedback. This suggests that the majority of nursing students lack a sufficient understanding of the importance of HIS operational skills. Most graduates require additional training to utilize these systems proficiently upon entering clinical practice, and they often feel overwhelmed during this process [5, 6, 28–30]. Incorporating academic HIS into simulation training in undergraduate education is an effective strategy to bridge this gap and address the associated challenges [31, 32]. Although our research did not objectively measure HIS operational competence, student feedback indicated that using the NSTIS in simulations has the potential to satisfy training needs related to HIS and cultivate nursing students' HIS-related skills. Simulations create immersive learning by integrating theory with clinical practice and embedding HIS into authentic case scenarios [21]. This approach surpasses traditional didactic methods by enhancing context-specific knowledge retention and operational skill development through experiential learning. Supported by the NSTIS, it offers risk-free, repeatable practice environments [32], enabling students to refine their HIS competencies to meet information-age demands, ultimately improving their preparedness for clinical placements and future employment.

While the adopted pedagogical reform framework and NSTIS demonstrate promising outcomes, certain refinements are still necessary to optimize student satisfaction. Both groups reported that compressed time allocations constrained opportunities for in-depth discussions and skill rehabilitation sessions. Future pedagogical practices should prioritize optimizing instructional sequencing to reallocate temporal resources to more valuable educational activities. By fully utilizing the educational assistance module within the NSTIS, we propose further development of the NSTIS into an integrated resource platform. This platform systematically consolidates extensive learning materials, such as clinical case libraries and skill demonstration videos, to meet the personalized learning needs of students while potentially addressing the issue of limited classroom time. For example, by prerecording instructional videos and uploading them to this module as pre-class learning tasks, instructors can focus on delivering key content during lectures, thereby allocating more time to simulations and providing instructive feedback.

Overall, integrating the NSTIS into comprehensive training course reform appears to be a feasible approach with the potential for broader application. Initially, the research team raised concerns that incorporating an information system might introduce additional challenges, such as maintaining traditional scenario-based simulation teaching while managing the increased classroom complexity arising from system operation. However, our practice suggests that the teaching reform approach implemented in this study can address these concerns and result in positive overall teaching outcomes. Additionally, it provides students with the opportunity to engage in HIS, which is typically not feasible in traditional classrooms. Although these results are promising, further research and validation are required to fully assess the reform's long-term effectiveness and scalability.

Study limitations

This study was conducted at a single university with a specific cohort of nursing students and was based on data collected after one lesson using a single case. Consequently, nursing students may have had insufficient exposure to the intervention, which could have introduced bias into the data. This study used a self-developed questionnaire to assess the teaching effect and did not employ standardized scales to objectively measure the teaching effect of the system on nursing students' critical thinking, clinical reasoning abilities, and other nursing competencies.

Conclusions

The application of the NSTIS based on the HIS, in the comprehensive training course, enhances the case simulation effect, enabling nursing students to master information systems and related clinical skills before their internships. This method offers a deeper learning experience and greater immersion in clinical scenarios than traditional teaching, facilitating a smoother transition from theory to practice and improving information processing in clinical settings. The integration of such systems addresses nursing students' needs for clinical case information and enhance the quality of nursing education. Academic HIS, such as NSTIS, can be integrated into other simulation activities and courses within both undergraduate and postgraduate nursing education programs.

However, this study has some limitations, including data collection based only on one teaching case, insufficient consideration of the impact on critical thinking and other related nursing competencies, and a lack of exploration of teaching experiences and feedback from the teacher cohort. Future research should address these limitations and identify the shortcomings of the system raised by nursing students to refine the course structure and the NSTIS. Further optimization of the research design will involve incorporating multiple teaching cases

and utilizing authoritative scales to investigate the system's impact on nursing students' competencies and simulation outcomes. Further studies should expand the application of this system to other courses to validate its effectiveness and facilitate better integration of HIS into undergraduate nursing education.

Abbreviations

CBPR	Computer-Based Patient Records
COPD	Chronic Obstructive Pulmonary Disease
EHIMS	Electronic Health Information Management Systems
EHR	Electronic Health Records
EHRNE	Electronic Health Record for Nurse Education
EMR	Electronic Medical Records
HIS	Hospital Information Systems
iNES	Integrated Nursing Education System
NSTIS	Nursing Simulation Teaching Information System
PBL	Problem-Based Learning

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Author contributions
YS C: Formal analysis, Writing and revising original manuscript; RX F: Formal analysis, Writing and revising original manuscript; MN L: Data collection, Writing original manuscript; Y Y: Data collection, Prepare figures for the manuscript; H L: Methodology, Project administration, Investigation; WZ: Methodology, Project administration, Investigation; Y Z: Conceptualization, Methodology, Reviewing and editing the manuscript; CL L: Supervision, Conceptualization, Final approval of the version to be submitted. All authors read and approved the final manuscript.

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Data availability
The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study adhered to the Helsinki Declaration and granted ethical approval from Southern Medical University Biomedical Ethics Committee (Approval [2023] No.6). Informed consent was obtained from all the participating students. All methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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