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Assessment of the effectiveness of "conceive, design, implement, and operate-based" flipped classroom approach to laparoscopic nursing training

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Abstract

This study investigated the effectiveness of a flipped classroom approach based on the CDIO (Conceive, Design, Implement, Operate) framework in training newly recruited gynecologic operating room nurses in laparoscopic nursing. A total of 74 nurses were randomly assigned to either a control group receiving traditional instruction or an observation group receiving CDIO-based flipped classroom teaching. Key learning outcomes were compared between the two groups, including performance in laparoscopic surgery assistance, procedural proficiency, theoretical knowledge, critical thinking, self-directed learning, and teaching satisfaction. Results showed that while both groups improved after training, the observation group outperformed the control group in all measured areas ($P < 0.05$). Nurses in the flipped classroom group showed better understanding of endoscopy, more accurate instrument handling, and greater gains in theoretical knowledge. They also demonstrated significantly improved critical thinking and independent learning skills, along with higher satisfaction with the teaching experience. These findings suggest that integrating the CDIO framework with a flipped classroom model can significantly enhance the clinical competence and learning engagement of new gynecologic OR nurses, making it a more effective alternative to traditional teaching methods. *(Afr J Reprod Health 2026; 30 [4]: 94-104).*

Keywords: Flipped Classroom; Critical Thinking Ability; CDIO Concept; Gynecologic Operating Room; Teaching Satisfaction; Independent Learning Ability

Résumé

Cette étude a examiné l'efficacité d'une approche de classe renversée basée sur le cadre CDIO (concevoir, concevoir, mettre en œuvre, opérer) dans la formation d'infirmières gynécologiques nouvellement recrutées en salle d'opération en soins laparospiques. Au total, 74 infirmières et infirmiers ont été affectés de façon aléatoire soit à un groupe témoin recevant un enseignement traditionnel, soit à un groupe d'observation recevant un enseignement en classe renversé basé sur le cdio. Les principaux résultats d'apprentissage ont été comparés entre les deux groupes, y compris la performance en chirurgie laparoscopique, la compétence procédurale, les connaissances théoriques, la pensée critique, l'apprentissage autodirigé et la satisfaction dans l'enseignement. Les résultats ont montré que, bien que les deux groupes se soient améliorés après la formation, le groupe d'observation a surpassé le groupe témoin dans toutes les zones mesurées ($P < 0,05$). Les infirmières du groupe de classe retourné ont montré une meilleure compréhension de l'endoscopie, une manipulation des instruments plus précise et de meilleurs gains en connaissances théoriques. Ils ont également démontré une amélioration significative de la pensée critique et des compétences d'apprentissage autonome, ainsi qu'une plus grande satisfaction à l'égard de l'expérience d'enseignement. Ces résultats suggèrent que l'intégration du cadre de CDIO à un modèle de salle de classe renversera considérablement les compétences cliniques et l'engagement d'apprentissage des nouvelles infirmières et infirmiers gynécologiques, ce qui en fait une alternative plus efficace aux méthodes d'enseignement traditionnelles. *(Afr J Reprod Health 2026; 30 [4]: 94-104).*

Mots-clés: classe retournée; Capacité de pensée critique; Concept CDIO; Salle d'opération gynécologique; La Satisfaction de l'enseignement; Capacité d'apprentissage autonome

Introduction

The gynecological operating room is a place in the hospital dedicated to gynecological surgery, involving the surgical treatment of several female reproductive systems.[1] Laparoscopic nursing teaching in gynecological operating room is an important part of medical education, and its

teaching directly affects the professional skills and clinical thinking ability of nursing staff.[2] Firstly, the traditional teaching mode pays too much attention to the teaching of theoretical knowledge, neglects the cultivation of practical operation skills, and lacks a systematic training program, which makes the nursing staff lack the necessary preparation and coping ability when facing different types of luminal surgery.[3] Secondly, traditional teaching mostly adopts face-to-face lectures and lacks diversified teaching methods. This approach is likely to make new nurses feel bored, have low motivation for learning, and make it difficult for them to effectively master complex luminal surgery nursing skills.[4-5] The CDIO concept is a student-centered educational model that emphasizes the cultivation of students' practical ability and innovative thinking through the four phases of conceptualization, design, implementation, and operation, and is now widely used in nursing training and teaching reform.[6] Flipped classroom, as an innovative teaching model, subverts the traditional teacher-centered lecture-based education and gives the initiative of learning to students, enabling them to improve their clinical decision-making ability and preparation for professional practice through independent learning, discussion, and practice.[7] At present, there is a lack of research reports on the use of flipped classroom based on the concept of CDIO in the teaching of laparoscopic nursing in gynecological operating rooms. Therefore, 74 new nurses in the gynecologic operating room of the hospital were selected for this study, aiming to provide some scientific basis for improving the nursing competence of new nurses in the gynecologic operating room.

Methods

Participantssociodemographic characteristics

74 new gynecological operating room nurses in Shanghai General Hospital from April 2022 to March 2024 were selected and divided into an observation group (*n*=37) and a control group (*n*=37) by random number table method. As shown in Table 1, the sociodemographic information of the two groups was comparable (P＞0.05).This study was approved by the Ethics Committee of Shanghai General Hospital (KYLL202106-03).

The inclusion criteria included the following: Voluntary participation in all teaching courses and signed informed consent; Internship new nurses; Age ≥18 years old; All were females. The exclusion criteria:New nurses with less than a university degree; Teaching teachers from outside hospitals for training and advanced training;Those with abnormal communication, reading, and comprehension skills;Those who were not qualified to teach; and Those who could not participate in the entire nursing teaching.

Teaching methods

The instructors all had clinical and teaching experience, had been working in the gynecological operating room for at least 5 years, and had bachelor's degrees or higher degrees, and they all underwent unified training before teaching.

The assessment contents, internship teaching materials and contents of the two groups were similar.

The control group adopted the traditional teaching method In the 1st week of teaching, Wednesday to Friday and Monday to Tuesday were centralized operation training and theory lectures respectively. In the 2nd to 6th weeks of teaching, the instructor led the new nurses in the gynecological operating room to teach the nursing of laparoscopic surgery. Each batch of new nurses was required to complete 9 cases of laparoscopic surgery coorperation. In the 6th week, evaluation and assessment were completed 2 days before leaving the gynecology department.

The observation group received the flipped classroom teaching method based on the concept of CDIO The teaching program in the 1st week was consistent with the control group. Teaching weeks 2 to 6 received the flipped classroom teaching method based on CDIO concepts.

Establishment of teaching team

The teaching team included one Head nurse, five instructors and one CDIO nursing expert. The Head nurse organized the study of CDIO standards and specific operational methods for at least 20 credit hours. The experts answered and solved difficult theoretical problems in a timely manner.

Table 1: Comparison of general information of the two groups ($\bar{x} \pm s$, n)

Groups	N	Age (years)	Married	Education level	
				College	Bachelor's Degree
Control group	37	23.41±3.27	20	12	25
Observation group	37	23.02±3.45	23	10	27
t/ χ^2		0.499	0.500	0.259	
P value		0.619	0.480	0.611	

The teaching team formulated the teaching program and teaching objectives in accordance with the requirements of the internship syllabus and the Guidelines for Nursing Practice in the Operating Room.Formulation of teaching objectives

With reference to the teaching characteristics of gynecological operating room nursing, CDIO personnel training syllabus and standards, and internship training syllabus, the teaching team formulated 3 teaching objectives, including quality objectives, ability objectives and knowledge objectives.Formulation of teaching program

The teaching program was formulated on a weekly basis according to the number of surgical cases to be completed by the new nurses and the sequence of learning of specialized procedures, as shown in Table 2.Definition of Nursing Responsibilities and Scope of Practice.The roles of the novice nurses were those of the scrub nurse and circulating nurse within the surgical team. All their instructional and practical activities were strictly confined to nursing responsibilities and did not involve any surgical decision-making or primary operative techniques. The specific nursing tasks are detailed as follows: Scrub Nurse Responsibilities: Primarily responsible for the management and passing of surgical instruments. The tasks include, but are not limited to: Pre-operative: Checking, inspecting, and arranging the laparoscopic instrument tray.Intra-operative:Accurately and aseptically passing specialized laparoscopic instruments (e.g., dissecting forceps, needle holders, electrocautery hooks); correctly connecting laparoscopic equipment lines (e.g., fiber optic light cable, camera cord, insufflation tube); cleaning and maintaining the clarity of the laparoscope lens. Post-operative: Participating in the initial count of instruments and their post-procedure processing. Circulating Nurse Responsibilities: Primarily responsible for overall coordination in the operating room and patient care. The tasks include, but are not limited to:Pre-operative: Checking the functionality and activating the laparoscopic equipment (imaging system, light source, insufflator); assisting in positioning the patient; participating in the surgical safety checklist (time-out).Intra-operative: Supplying sterile items as required; managing the operating room environment; documenting nursing records; responding to emergent situations.Post-operative: Assisting with wound dressing and transporting the patient.

Teaching implementation

As an example, the steps involved in the participation of new nurses in the cooperation of laparoscopic surgery were shown in Table 3

Observation indicators

Assessment of laparoscopic surgery cooperation results

Laparoscopic cognitive ability (score 0~100), accuracy of laparoscopic installation and accuracy of instrument delivery were assessed by the Laparoscopic Nursing Cooperative Test Outcome Questionnaire developed by our hospital after teaching.

Operational and theoretical scores

The operation achievement and theory achievement of the new nurses were assessed before and after the teaching using the hospital's own questionnaire respectively, including 4 operation assessments of contactless glove wearing, surgical hand disinfection, supine position placement, and putting on and taking off sterile surgical gowns, with a score of 0~100, and the higher score represents the better performance.

Table 2: Teaching program

Procedure	Educational objective	Educational content	Teaching methods	Evaluation of Teaching	Phase
Conceive	Objective 1： To acquire knowledge related to the specialty. Objective 2 ： To foster independent learning skills.	Part I: Prior to teaching, the lead instructor summarized the difficulties and key professional-related skills involved in laparoscopic surgical cooperation case and distributed the relevant micro-lesson videos through the DingTalk platform. Part 2: The new nurse independently searched the relevant literatures according to the difficulties of the case, and initially conceptualized the surgical cooperation plan.	Method 1 ： Case Teaching Method. Method 2： Problem-Based Learning (PBL) Teaching Method	Part I： Theory Assessment； Part II： Classroom Reporting； Part III： Self-directed Learning Assessment and Critical Thinking Assessment	8
Design	Objective 1: To develop professional systems thinking; Objective 2: To enhance communication and teamwork skills; Objective 3: To enhance critical thinking skills.	Part 1: New nurses freely combined into unit groups according to the characteristics of the composition of the surgical team members. Part 2: The instructor guided the new nurses to design the nursing typical operation cooperation program according to the 3 periods. Part 3: Team members discussed and perfected the nursing cooperation program for laparoscopic surgery.	Method 1： Group Teaching Method； Method 2： Participatory teaching		4
Operationalization	Objective 1: To exercise the basic skills of specialized practice. Objective 2: To foster a caring spirit. Objective 3: To develop emergency response and coordination skills.	Part 1: the instructor guided the new nurses to design a relatively perfect nursing cooperation program according to their ideas, and implemented role-playing and scenario simulation in small groups to further find out the deficiencies of the surgical cooperation design program; Part 2: The instructor led the new nurse in actively participating in endoscopic surgery in the operating room, deepening their understanding of the procedures through practice.	Method 1： Scenario simulation method Method 2 ： Role-playing method Method 3: Specific surgical cooperation	Part I： Operational Skills Assessment. Part II： Satisfaction Assessment.	24

Realization	Objective 1： To establish proper professional values and responsibilities. Objective 2： To develop problem solving and identification skills	Part 1: New nurses were assessed on their professional skills and relevant theories after the specific operation of the practice program Part 2: After the assessment, the new nurses would conduct a multimedia report and teacher's comment as a group.	Project Reporting	Project Mutual Evaluation and Critique	4

Table 3: Teaching and learning implementation program-example of new nurses' involvement in laparoscopic surgery collaboration

Overall orientation	Procedure
Conceive	1) Script design Based on the theoretical and practical operations involved in laparoscopic surgery, the video contains at least 1 question for the new nurse to contemplate. 2）Recording video program The video should restore the actual scene of gynecologic laparoscopic surgery as much as possible, and the instructor's speech should highlight the important and difficult points, be full of enthusiasm, and the language should be easy to understand. Nine micro-videos were recorded, including placement in surgical position, use of instruments and equipment, cognitive skills related to laparoscopy, accuracy of instrument delivery, surgical safety verification, donning and doffing of sterile gloves and gowns, surgical instrument inventory, laparoscopic mounting skills, and sterilization of surgical hands. 3）Uploading to the web After the video was recorded, it was sent to the operating room nurses group on the DingTalk platform. 2 days before teaching, the instructor should send nursing difficulties and key points (e.g. how to avoid postoperative complications? How to relieve patients' preoperative worries and anxiety?), videos on use, unloading and installation of laparoscopes, typical cases of laparoscopic surgery and other reference materials) in the WeChat group. Based on the case study, the new nurse consulted relevant materials, reviewed micro-lecture videos, and drafted preliminary surgical assistance steps. She completed the self-directed learning task by checking in via the WeChat group and submitted her proposed nursing assistance plan (Monday, within 8 academic hours).
Design	New nurses formed groups based on the primary composition of the surgical team members, including anesthesiologists, instrument nurses, surgeons, and circulating nurses (Tuesday mornings, within 4 credit hours). Each cohort of new nurses was divided into 2 groups, and each group introduced a team leader who was responsible for assigning and coordinating tasks among members. The lead instructor nursing designed 2 major nursing cooperation work projects (in three time periods, i.e., preoperative - intraoperative - postoperative). The circulating nurse's work section was project 1, covering preoperative operating room preparation and 1-day preoperative visit; the instrumentation nurse's work section was project 2, covering sterile gowning and preparation of surgical instrument items. In the process of designing the project, the team leader assigned the team members to create, present and modify the project, and sorted out the related knowledge points. Under the guidance of the instructor, team members integrated relevant professional knowledge into the design proposal and drafted their group's project implementation plan.
Operational ization	According to the conceptualization and design plan, implement the scenario simulation training (within 4 credit hours, Tuesday afternoon). Under the guidance of the instructor, members of the group would play the roles of circulating nurses, surgeons, etc., and carry out the simulation of

	surgical cooperation (including simulation of the layout of instruments, instrument preparation drills, instrument operation drills, etc.). Through different roles, the members looked for their own deficiencies, and at the same time, the instructor gave encouragement to the new nurses who did not operate in a standardized way, and assessed the operating skills after completing the simulation training. In their respective specialized operating rooms, the new nurses of each group completed the cooperation work of the laparoscopic surgery. At the end of the operation, the instructors instructed the new nurses to tell their experiences and thoughts about the cooperation in the operation, and answered the questions and difficulties in the nursing cooperation work.
Realization	Taking the group as a unit, the new nurses presented the results of the surgical procedure program in multimedia form on Friday afternoon, and put forward the difficulties and ideas of the group for the reference, discussion and learning of other groups. After the report was completed, the teaching teacher timely commented and analyzed the strengths and weaknesses of each group's cooperation process, in order to improve the new nurses' understanding of the teaching content. After the realization of the program, the lead teacher should evaluate the teaching quality and further optimize the course design and video content.

Critical thinking ability

The critical thinking ability of new nurses was evaluated before and after teaching through the Critical Thinking Ability Scale[8], covering 7 dimensions, such as analytical ability, etc., with each dimension covering 10 items, 1~6 points for each item, with a score value of 70~420 points, and the score value is positively proportional to the critical thinking ability. The Cronbach's alpha coefficient of the scale is 0.90.

The autonomous learning ability of new nurses was assessed before and after the teaching intervention using the Autonomous Learning Ability Measurement Scale. This scale consists of 30 items across four dimensions, including learning motivation. Each item is scored on a 5-point Likert scale, ranging from 1 to 5 points. The score is positively proportional to independent learning ability. The Cronbach's alpha coefficient of this scale is 0.822.

Teaching satisfaction. After teaching, the hospital's self-made questionnaire was used to survey the new nurses' satisfaction with the teaching method, covering five striking points such as whether the teaching method stimulates learning interest, and the scores of <70, 70~90, and >90 were recorded as unsatisfactory, comparatively satisfactory, and very satisfactory, respectively. The sum of the percentage of more satisfied and very satisfied is the teaching satisfaction.

Statistical methods

The data of this study were analyzed by SPSS25.0 software. n (%) was used to represent the count data, χ^2 test; ($\bar{x} \pm s$) was used to represent the measurement data, t-test. $P < 0.05$ was considered a statistically significant difference

Ethical consideration

This study was approved by the Ethics Committee of Shanghai General Hospital (KYLL202106-03).

Results

Evaluation of the outcome of the cooperation of laparoscopic surgery

Compared with the control group, the observation group demonstrated comprehensive advantages after instruction:

Endoscopic cognitive ability scores were significantly higher (93.3±2.4 vs 88.2±2.1), and both endoscope placement accuracy (100.0% vs 54.1%) and instrument pass accuracy (97.3% vs 67.6%) were significantly superior to the control group. All differences were statistically significant ($P < 0.001$), as shown in Table 4.

Comparison of operational and theoretical scores between the two groups

Following the training, the operation scores and theory scores of the two groups were elevated compared with those before teaching ($P < 0.05$), and the observation group was higher than the control group ($P < 0.05$), as shown in Table 5.

Table 4: Comparison of the effectiveness of the two groups in terms of cooperation in laparoscopic surgery [$\bar{x} \pm s$, *n* (%)]

Groups	N	Laparoscopic Cognitive Ability (scores)	Accuracy of laparoscopic installation	Accuracy of instrument delivery
Control group	37	88.2±2.1	20（54.1）	25（67.6）
Observation group	37	93.3±2.4	37（100.0）	36（97.3）
t/ χ^2		9.700	22.070	11.291
P-value		0.001	0.001	0.001

Table 5: Comparison of operational and theoretical scores in the two groups ($\bar{x} \pm s$, scores)

Groups	N	Operation scores		Theory scores	
		before teaching	After teaching	before teaching	After teaching
Control group	37	52.43±5.79	82.07±4.27*	56.08±5.73	84.25±4.16*
Observation group	37	53.56±5.25	94.32±2.39*	56.77±5.31	95.48±2.02*
t		0.879	15.228	0.537	14.771
P-value		0.382	0.001	0.593	0.001

Note: *$P < 0.05$ compared to pre-instruction cohort

Table 6: Comparison of critical thinking skills between the two groups ($\bar{x} \pm s$, scores)

Groups	N	Critical thinking skills	
		Before teaching	After teaching
Control group	37	215.03±23.57	252.38±26.79*
Observation group	37	217.84±22.45	292.47±29.86*
t		0.525	6.079
P-value		0.601	0.001

Note: *$P < 0.05$ compared to pre-instruction cohort

Table 7: Comparison of independent learning skills between the two groups ($\bar{x} \pm s$, scores)

Groups	N	Independent learning skills	
		before teaching	After teaching
Control group	37	82.34±8.72	102.42±7.38*
Observation group	37	81.21±8.19	126.20±6.49*
t		0.575	14.718
P-value		0.567	0.001

Note: *$P < 0.05$ compared to pre-instruction cohort

Table 8: Comparison of Teaching Satisfaction [*n* (%)]

Groups	N	Highly satisfied	Comparatively satisfied	Dissatisfied	Overall Instructional Satisfaction
Control group	37	18（48.65）	11（29.73）	8（21.62）	29（78.38）
Observation group	37	26（70.27）	10（27.03）	1（2.70）	36（97.30）
χ^2					6.198
P value					0.028

Comparison of critical thinking skills between the two groups

Following the training, both groups of nurses demonstrated a significant improvement in critical thinking scores compared to pre-training levels ($P < 0.05$). Compared to the control group, the observation group exhibited a greater increase in scores post-training, with the difference being statistically significant ($P < 0.001$), as shown in Table 6.

Comparison of independent learning skills between the two groups

Following the training, both groups of nurses demonstrated a significant improvement in self-directed learning ability scores compared to pre-training levels ($P < 0.05$). The observation group achieved significantly higher post-training scores than the control group, with the difference being statistically significant ($P < 0.001$), as shown in Table 7.

Assessment of teaching satisfaction

The teaching satisfaction evaluation results revealed that the teaching satisfaction rate in the observation group (97.30%) was significantly higher than that in the control group (78.38%), with the difference being statistically significant ($P = 0.028$), as shown in Table 8.

Discussion

Effects of cooperation in laparoscopic surgery

Laparoscopic techniques are minimally invasive surgical technique that enters the interior of the human body through tiny incisions or natural cavities for examination, diagnosis, and treatment, and this technique is widely used in a number of medical fields, including thorax, gastrointestinal, gynecological, urological oncology, and breast surgery, etc.[10]. Currently, classroom lectures are still the mainstay of traditional teaching methods; however, the teaching content of gynecologic operating rooms faces certain challenges under the constraints of teaching time. The traditional teaching method is teacher-centered, mainly through lectures and textbooks to impart knowledge, this way to a certain extent limits the development of students' independent learning and practical ability, and there are some drawbacks of this teaching mode mode, such as the dull teaching atmosphere and lack of vitality, which reduces the students' professional interest and innovation ability, and makes the effect of new nurses' cooperation with the laparoscopic surgery significantly lower[11]. The results of this study showed that the observation group's laparoscopic cognitive ability, accuracy of laparoscopic installation, and accuracy of instrument delivery were higher than those of the control group, suggesting that the flipped classroom teaching method based on the CDIO concept can improve the effect of new nurses' laparoscopic surgical cooperation in gynecological operating rooms. Reasons: The flipped classroom mode based on the CDIO concept combines teaching content with practical operation, so that students can initially understand the operation steps and theoretical knowledge of laparoscopic surgery by watching microcourse videos before class, and consolidate and apply the knowledge they have mastered beforehand through practical operation in the classroom, which can promote new nurses to better understand and memorize the relevant knowledge and skills of laparoscopic surgery.

Improvement of operation performance and theory performance

Studies[12-13] have shown that the key points of nursing operations in gynecological operating rooms are mainly focused on preoperative preparation, intraoperative cooperation and postoperative care. For example, preoperative gastric tube insertion, indwelling urinary catheter, arterial blood gas analysis, intravenous indwelling needle infusion and other operations are key links in nursing, and these operations require nurses to have a high degree of professional skills and experience. In addition, the placement of body position in gynecological surgery is also an important nursing difficulty, which is directly related to the safety and effect of surgery. Conventional filler education method has obvious defects and deficiencies in teaching nursing in gynecological operating room. First of all, this teaching method relies too much on the teacher's

lectures and neglects the students' active learning and the cultivation of practical ability. Students tend to passively accept knowledge and lack the process of independent exploration, which leads to a lack of in-depth understanding of knowledge and difficulty in applying theoretical knowledge to practical operation. Secondly, the education method is tasteless, which will reduce students' learning initiative and enthusiasm. In addition, this teaching mode cannot effectively solve the problem of disconnection between theory and practice, which makes it difficult for students to cope with complex nursing tasks in actual work. In this study, the theory scores and operation scores of the observation group were higher than those of the control group after teaching, indicating that the flipped classroom teaching method based on the concept of CDIO can improve the theory scores and operation scores of laparoscopic surgery nurses. The flipped classroom teaching method based on the concept of CDIO reverses the traditional teaching method, allowing new nurses to study independently before class, search for relevant information, conceptualize the answers to the questions assigned by the instructor, refer to the microclass video, and initially conceptualize the steps to cooperate with the laparoscopic surgery. And the leading teacher answered the questions and solved the difficulties of the new nurses, and in the subsequent actual operation, the theory guided the practice and deepened the new nurses' memory of the theoretical knowledge. The flipped classroom teaching method based on the concept of CDIO can continuously deepen the new nurses' mastery of theoretical knowledge, thus improving the theoretical performance of the new nurses. In addition, according to the design and conceptualization of the program, scenario simulation training, including simulation of instrument layout, instrument preparation exercises, instrument operation exercises, etc. During actual surgical procedures, new nurses gradually became familiar with and mastered the key considerations for surgical assistance. After the operation, the instructor provides targeted answers to the difficult points in nursing cooperation, thus improving the new nurses' operation performance.

Improvement of critical thinking skills and independent learning ability

In this study, the critical thinking ability and independent learning ability of the observation group after teaching were higher than those of the control group. Research analysis: the flipped classroom teaching method based on the concept of CDIO emphasizes students' learning and application of knowledge in practical operation, adjusts the teaching classroom mode, takes new nurses as the main body of the teaching classroom, and the leading teacher guided the new nurses to consult relevant information and conceptualize the answers to the difficult questions before teaching, and provided answers during class sessions, identified issues through scenario simulations, and guided new nurses to enhance their learning capabilities through self-directed study.[14-15]. In the design step, under the guidance of the instructor, the group designed its own surgical cooperation work section with reference to the operation steps of laparoscopic surgery, and its critical thinking ability was enhanced in the team discussion. In the operation step, in practice, new nurses continue to master the theory and skill knowledge, in the specific nursing work, according to the patient's individual situation, assessment of possible complications, and give the corresponding preventive measures, so that the new nurses do not need to memorize the operating procedures of the laparoscopic surgery, to help the new nurses in the “design” and “implementation” of nursing care, It helps new nurses in “designing” and “implementing” nursing operations to organically combine the relevant teaching contents, and to continuously improve various nursing abilities in this interactive and participatory operation step. In the conceptualization step, before teaching, the instructor throws the difficult problems of laparoscopic surgery to the new nurses until they search for relevant literature and information, think about the answers to the questions, and improve their independent learning ability. In the hands-on teaching phase, let the new nurses learn to check the surgical method and surgical site, clear intraoperative nursing points and operation steps,

let them understand that each link is an important factor in the success of the operation, so as to improve their critical thinking ability. The results of a study have shown[16] that a CDIO-based IT education curriculum model could stimulate students' self-directed learning abilities, similar to the results of this study. Previous studies[17] confirmed that the CDIO teaching model oriented to the development of students' higher-order thinking skills can improve their critical thinking skills.

Improvement of teaching satisfaction

In this study, the teaching satisfaction of the observation group (97.30%) was higher than that of the control group (78.38%), suggesting that the flipped classroom teaching method based on the CDIO concept can improve the teaching satisfaction of new nurses. The reasons for this are: the flipped classroom model encourages students to learn independently outside the classroom, which helps new nurses develop self-directed learning ability; the CDIO concept emphasizes 'learning by doing', which involves acquiring theoretical knowledge through practical operations and project-based practice practice. s. This teaching mode allows new nurses to apply the skills and knowledge they have learned in a model or real-life nursing care, so as to better understand and master nursing skills. This close integration of theory and practice improves new nurses' ability to understand and apply the teaching content, which in turn enhances their satisfaction with teaching; in the flipped classroom, students need to communicate and collaborate frequently with their classmates and teachers, which not only improves their communication skills, but also enhances their ability to work as a team. This interaction helps to establish a favorable learning atmosphere and makes students feel more satisfied[18-19]. Previous studies[6] have confirmed that the CDIO-based teaching model can stimulate the independent learning ability of nursing interns,
promote the organic combination of theory and practice, improve their ability to comprehensively apply theoretical knowledge in analysing and solving practical problems, and increase teaching satisfaction. The findings were similar to those of this study.

Conclusion

In conclusion, the flipped classroom teaching method based on the CDIO concept could improve the effect of new nurses' cooperation in laparoscopic surgery in the gynecological operating room, the operation performance, the theory performance, the independent learning ability, the teaching satisfaction and the critical thinking ability.This study has several limitations. First, as a single-center study with a relatively small sample size, the generalizability of our findings needs to be verified through future multi-center studies with larger samples. Second, the study primarily assessed short-term teaching outcomes; the long-term impact of this model on the post competency of new nurses requires further longitudinal observation.Future research should focus on the following directions: (1) exploring the application of this teaching model in training for other specialized fields (e.g., robotic surgery, emergency nursing); (2) employing mixed-methods research to gain an in-depth understanding of the key factors influencing teaching effectiveness and the authentic experiences of both instructors and nurses; and (3) establishing a long-term evaluation mechanism to assess the sustained benefits of the teaching model on nurses' professional development, thereby providing more robust evidence for nursing education reform

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Contribution of authors

Shao Qingqin:Conceptualization, Methodology, Investigation, Data Curation, Writing – Original Draft.Zhou Keyi: Supervision, Project Administration, Validation, Writing – Review & Editing.Both authors contributed to the study design, interpretation of results, and final approval of the manuscript**.**

Conflicting of interests

The authors declare no competing interests.

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