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Analysis of the Application Effect of Group Cooperative Learning Combined with Flipped Classroom in Standardized Training of Resident Physicians

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Abstract: Objective: To explore the application effect of group cooperative learning combined with flipped classroom in standardized training of emergency surgery resident physicians. Methods: 95 resident physicians undergoing emergency surgery standardized training in our hospital were randomly divided into an experimental group (46, group cooperative learning + flipped classroom) and a control group (49, traditional teaching). The training period was 2 months. Results: The graduation assessment scores of the experimental group were higher than those of the control group ($P < 0.05$). The improvement in critical thinking ability and self-learning ability was better than that of the control group ($P < 0.05$). The response rate of "yes" to all items of course teaching satisfaction was significantly higher than that of the control group ($P < 0.05$). The satisfaction scores for training teachers were higher than those of the control group ($P < 0.05$). Conclusion: The teaching model of group cooperative learning combined with flipped classroom, through reconstructing the learning process and activating interactive participation, can significantly improve the clinical operation and theoretical foundation of emergency surgery standardized training students. It also cultivates core professional qualities such as critical thinking, self-learning, and team collaboration, providing a feasible paradigm for integrated medical education in this discipline.

Keywords: Emergency surgery; Neurology; Standardized training; Group cooperative learning; Flipped classroom

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1. Introduction

With the accelerated process of social development and the deepening of population aging, the prevalence of neurological diseases, cerebrovascular accidents, trauma among the elderly, and acute abdominal diseases is increasing. Emergency surgery is the most common place for surgical emergencies, requiring doctors to have calm thinking, accurate judgment, skilled technique, rapid response, tacit teamwork, and continuous learning

ability. This allows them to make correct responses at the first moment of receiving patients and apply skilled techniques to address the emergencies that patients present with [1]. Compared to the comprehensive emergency treatment in emergency surgery, neurology focuses more on the pathogenesis, diagnosis, prevention, and treatment of neurological diseases such as headache, cerebral infarction, epilepsy, meningitis, and dementia [2].

Standardized training for resident physicians is currently the core content of medical student training in teaching hospitals [3]. Previous studies have found that the cooperative learning method emphasizes student-centeredness and group activities as the basic form. Through teaching strategies such as case studies and member sharing, it is beneficial to promote the development of students' communication skills and innovative thinking skills, and improve learning effects [4]. In addition, the flipped classroom is also a teaching model that subverts the traditional teaching process. This model shifts from the traditional teaching model to students mastering basic knowledge through independent learning before class, interactive discussions, and practical applications in class. It emphasizes more on students' active learning and the guiding role of teachers, thereby improving teaching effectiveness [5].

Therefore, integrating both methods and applying them simultaneously to the standardized training of resident physicians in emergency surgery, through exploring new teaching design models, aims to enhance the learning effects and interest of trainee residents. This provides practical references for optimizing medical education models.

2. Materials and methods

2.1. General information

Ninety-five resident physicians undergoing emergency surgical training at our hospital from January 2024 to January 2025 were selected as the subjects of this study. All trainees were postgraduate students, and the training duration was two months. The trainees were randomly divided into two groups using a random number table method, and the general information of the two groups was comparable ($P > 0.05$). See **Table 1** for details.

Table 1. Comparison of general information between the two groups

Group	Number of participants	Gender (Male/Female, n)	Age (Years)
Control group	49	40/9	20–23 (21.75 ± 1.04)
Experimental group	46	37/9	20–23 (21.55 ± 1.23)
t/χ^2	/	0.022	0.858
P-value	/	0.882	0.393

2.2. Teaching methods

2.2.1. Control group

The traditional training method was adopted. Trainees participated in practical training in groups of 6–7, with one instructor per group. A total of 8 instructors were needed. The training consisted of 8 hours of clinical practice per day, 4–5 days a week. Upon completion of the rotation, trainees underwent an exit assessment.

2.2.2. Experimental group

Cooperative group learning combined with a flipped classroom approach was used:

(1) Grouping Design: Based on the principle of "intra-group heterogeneity and inter-group homogeneity",

trainees were divided into groups of 5 (with one group having 6 trainees due to the total number of trainees). Groups were formed considering learning abilities and gender, and each group elected a group leader with strong communication and learning abilities. Each group was assigned an instructor for guidance throughout the process.

(2) Independent Pre-class Learning: Instructors developed a learning plan based on training requirements, clarifying learning objectives such as disease diagnosis and treatment, image interpretation, etc. Patient information, audio-visual courses, micro-courses, literature, and other materials were pushed through an online platform. Trainees worked in groups, using the Think-Pair-Share method, where 2–3 trainees would first independently consider questions, then exchange views and share within the group. The group leader would summarize the list of issues to be resolved.

(3) Clinical Practice and Collaboration: During the 4-hour clinical practice session on the training day, students will focus on the pre-class question list and specifically complete patient inquiries, physical examinations, image reading, and surgical operations. Instructors provide real-time guidance and fill in any omissions. In practice, the student group achievement division method is adopted, tasks are assigned to group members, and after mastering the tasks, students share within the group to achieve team collaboration and knowledge complementation.

(4) Discussion and Feedback Reinforcement: After daily clinical practice, the group discusses disease diagnosis, differential diagnosis, and treatment plans. A representative is elected to report in the WeChat group, and teachers provide feedback. Centralized explanations are given for common questions, and classroom tests are used to understand learning effects and dynamically adjust teaching. Weekly jigsaw activities are conducted, where each group deeply studies different modules and then cross-shares, broadening knowledge breadth.

(5) Assessment and Summary Optimization: After the training, a theoretical written test and operational spot check are conducted, and individual and group average scores are calculated to comprehensively evaluate learning effectiveness. Each group sends a representative to share learning gains, difficulties, and suggestions. All participants evaluate, teachers summarize and comment, and propose improvement measures to continuously optimize training quality.

2.3. Observation indicators

(1) Graduation assessment scores: Including basic theoretical knowledge and clinical diagnosis and treatment abilities. Basic theoretical knowledge is assessed through a written test, while clinical diagnosis and treatment abilities are evaluated using the Mini-Clinical Evaluation Exercise (MiniCEX) scale [6], with a total score of 63 and each item scored from 1 to 9.

(2) Critical thinking ability and self-learning ability: Critical thinking ability was assessed using the California Critical Thinking Disposition Inventory-Chinese version (CTDI-CV) [7]. The total score of this inventory is 420 points. Scores below 210 suggest a negative disposition towards critical thinking, scores between 201–280 indicate an ambiguous disposition, scores of 280 and above indicate a positive disposition, and scores of 350 and above suggest a strong disposition towards critical thinking. Self-learning ability was evaluated based on three dimensions: self-management ability, information ability, and cooperation ability. The total score of the scale was set at 140 points, with higher scores indicating stronger self-learning ability.

(3) Students' evaluation of course teaching: A questionnaire survey was conducted to assess students'

satisfaction with the teaching model. The questionnaire consisted of 9 questions, and students were required to answer with "yes" or "no" based on the implemented teaching model. This allowed for comprehensive feedback and evaluation of the teaching model from the students.

(4) Evaluation of student satisfaction with trainers: A questionnaire developed by the training center was used to evaluate student satisfaction with trainers. Each item was rated on a Likert scale of 1 to 5, ranging from "very dissatisfied" to "very satisfied". Higher scores indicated higher levels of satisfaction.

2.4. Statistical methods

Data were analyzed using SPSS 21.0 software package. Count data were analyzed using chi-square test or exact probability method, while measurement data were analyzed using *t*-test. A *P*-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of final assessment scores between the two groups

The experimental group had higher final assessment scores than the control group ($P < 0.05$), as shown in **Table 2**.

Table 2. Final assessment scores after teaching in the two groups (mean ± SD, points)

Group	Theoretical knowledge	Clinical Competency						
		Physical Exam skills	Clinical judgment	Communication skills	Medical interview skills	Organizational efficiency	Humanistic care	Overall performance
Control group ($n = 49$)	80.16 ± 6.04	7.61 ± 1.07	6.30 ± 0.80	7.68 ± 0.66	6.24 ± 0.28	6.91 ± 0.64	7.49 ± 0.68	8.54 ± 0.42
Experimental group ($n = 46$)	88.09 ± 5.42	8.09 ± 0.81	8.41 ± 0.42	7.91 ± 0.46	8.05 ± 0.34	8.02 ± 0.71	8.02 ± 0.97	7.05 ± 0.34
t-value	6.720	2.453	15.941	2.114	28.396	8.013	3.099	18.931
P-value	< 0.001	0.016	< 0.001	0.037	< 0.001	< 0.001	0.003	< 0.001

3.2. Comparison of critical thinking skills and self-learning ability scores between the two groups of students after teaching

After teaching, the experimental group had higher scores for critical thinking skills and self-learning ability than the control group ($P < 0.05$), as shown in **Table 3**.

Table 3. Scores for critical thinking skills and self-learning ability of the two groups after teaching (mean ± SD, points)

Group	Critical thinking skills total score	Self-directed learning ability total score
Control group ($n = 49$)	254.13 ± 16.81	81.64 ± 8.01
Experimental group ($n = 46$)	321.44 ± 19.21	100.27 ± 10.37
t-value	18.203	9.834
P-value	< 0.001	< 0.001

3.3. Comparison of course teaching evaluations between the two groups of students after teaching

The course evaluations of the experimental group were significantly better than those of the control group ($P < 0.05$), as shown in **Table 4**.

Table 4. Course teaching evaluations of the two groups after teaching (*n*)

Item	Control group (*n* = 49)		Experimental group (*n* = 46)		χ^2	P-value
	Yes	No	Yes	No		
Improved learning motivation	15	34	31	15	12.851	< 0.001
Enhanced perceptual understanding of theoretical knowledge	18	31	27	19	4.59	0.032
Deepened knowledge, comprehension and retention	21	28	30	16	4.771	0.029
Bridged theory-clinical practice gap	22	27	40	6	18.513	< 0.001
Enhanced clinical problem analysis ability	20	29	31	15	6.739	0.009
Effective utilization of school resources	15	34	30	16	11.397	< 0.001
Improved self-learning ability	17	32	38	8	22.346	< 0.001
Developed summarization and presentation skills	16	33	32	14	12.932	< 0.001
Cultivated critical thinking skills	19	30	31	15	7.793	0.005

3.4. Comparison of satisfaction scores for training teachers between the two groups of students

After teaching, the experimental group had higher satisfaction scores for the training teachers than the control group ($P < 0.05$), as shown in **Table 5**.

Table 5. Satisfaction scores for training teachers of the two groups (mean ± SD, points)

Group	Satisfaction score
Control group (*n* = 49)	2.59 ± 0.67
Experimental group (*n* = 46)	4.07 ± 0.51
t-value	14.998
P-value	< 0.001

4. Discussion

Compared to other departments, emergency surgery often faces patients with complex, urgent, and rapidly changing conditions, such as shock, coma, poisoning, cardiac arrest, etc. Some patients may even have complex situations like unknown medical history or suicidal tendencies. Characterized by timeliness, complexity, and heavy workload, this department requires physicians to have quick decision-making, damage control, and multidisciplinary collaboration skills [8]. Therefore, emergency surgery residents not only need professional clinical practice abilities but also require keen observation skills regarding patients' vital signs, facial expressions, and other aspects.

The traditional medical education model, with teachers as the mainstay and classroom teaching as the core, adopts a one-way knowledge indoctrination approach. Although this model enables students to form a basic understanding of disease diagnosis and treatment processes, it also has significant limitations. On one hand, it ignores the cultivation of cognitive and discriminatory abilities regarding the nature of diseases; on the other hand, this model tends to inhibit students' initiative in learning, seriously affecting the cultivation of scientific clinical thinking skills and being unfavorable for clinical practice [9]. In recent years, teaching based on flipped classrooms has emerged and developed rapidly. The flipped classroom utilizes online teaching, allowing students to self-study the more boring theoretical knowledge that teachers explain in class ahead of time. It emphasizes student-centeredness, gives students sufficient self-study time, provides personalized guidance based on differences in students' abilities, and stimulates student engagement. At the same time, specific teachers are selected to guide and evaluate teaching outcomes [10]. The cooperative learning model in small groups can enhance doctors' interest and enthusiasm for learning, improve interpersonal communication skills and teamwork spirit. The supervising teachers urge group members to learn step by step according to monthly and weekly study plans, repeatedly train skill items, improve the effect of standardized training, and also feel the importance and care from the collective, stimulating enthusiasm for upward mobility [11]. Cooperative learning in small groups also fosters the habit of critical thinking among clinicians. They constantly discover others' strengths in learning from each other, compete within and between groups, learn from each other's strengths, and enhance team collaboration skills. Especially in the treatment of severely injured patients, group learning can train their team collaboration skills and tacit understanding. In the currently popular trauma treatment model, it is recommended to have a clear division of roles between the team leader and team members, with each performing their respective duties and collaborating. A review and summary analysis should be conducted for every successfully treated case of severe multiple trauma (**Figure 1**). Especially for failed cases, problems should be identified and repeatedly practiced.

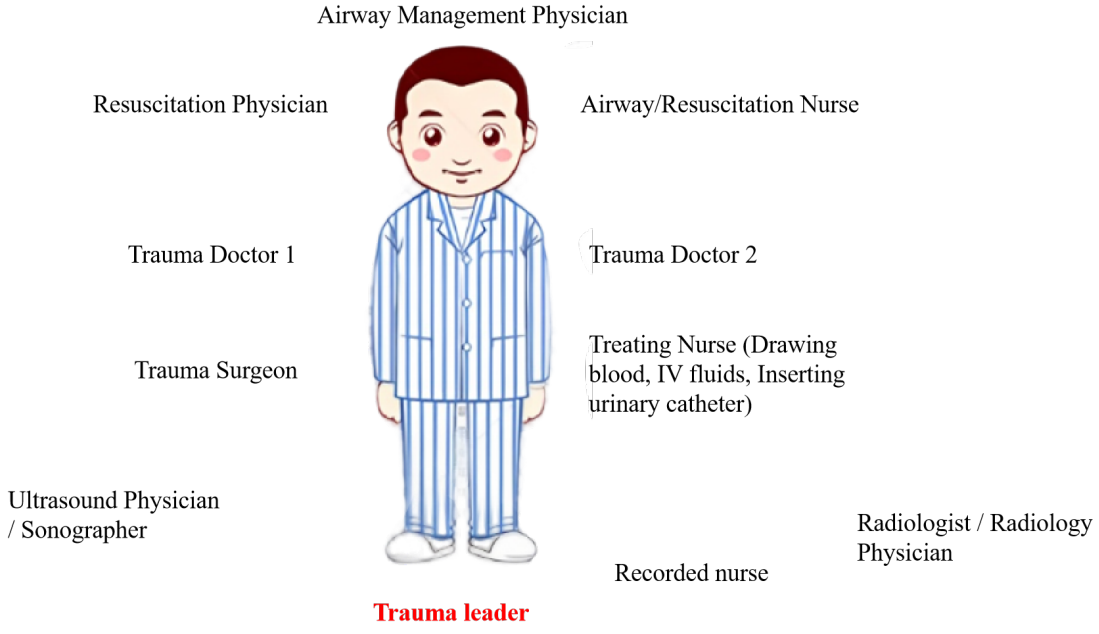

Figure 1. Schematic diagram of medical staff positions in a trauma resuscitation unit.

This study adopted a teaching method combining group cooperative learning with the flipped classroom. After two months of training, the evaluation results showed that the graduation assessment scores of the

experimental group were higher than those of the control group ($P < 0.05$). This suggests that the flipped classroom freed up class time through pre-class knowledge transfer, enabling teachers to focus on complex case analysis and clinical thinking training. Structured group cooperation provided students with frequent opportunities to simulate clinical decision-making, strengthening the rapid judgment and system management skills required for the diagnosis and treatment of neurological diseases. The scores for critical thinking ability and self-learning ability after teaching were higher than those of the control group ($P < 0.05$). The reason for this is that the flipped classroom required students to independently plan their learning progress, screen and integrate information, while the collision of viewpoints and analysis of evidence in group cooperation directly exercised critical thinking traits such as seeking truth and open thinking. Additionally, the scores for post-teaching critical thinking ability and self-learning ability were higher than those of the control group. The experimental group's evaluation of the course and satisfaction with the trainers were significantly better than those of the control group ($P < 0.05$). The knowledge system of neurology is complex and abstract, and the practical operation requirements of emergency surgery, especially for severely traumatized patients, require team assistance for treatment. The combination of group cooperation and flipped classroom transformed obscure neurological disease diagnosis and treatment into operable and experiential learning tasks through diversified forms such as case discussions and role-playing. This not only enhanced the depth of knowledge retention but also strengthened problem-solving abilities in clinical situations.

5. Conclusion

In summary, the teaching model combining group cooperative learning with the flipped classroom can significantly improve the clinical skills and theoretical foundation of emergency surgery trainees by reconstructing the learning process and activating interactive participation. It also cultivates core professional qualities such as critical thinking, self-learning, and team collaboration, providing a feasible paradigm for integrated medical education in this discipline.

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Disclosure statement

The author declares no conflict of interest.

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