

Application of the HSEI-LBL and HSEI-RC Dual-Platform Model in Clinical Clerkship Teaching of Emergency Medicine

Haibin Wang¹, Wentong Zhu², Yuncheng Li², Bingbin He³, Jianfei Huang³, Jiahua Yang³, Wenshan Zeng³, Zhiwei Liu^{2*}, Zhiwen Chu^{3*}

¹Department of Emergency Medicine, Huizhou Sixth People's Hospital, Huizhou, China

²Teaching and Research Section of Internal Medicine, Huizhou Sixth People's Hospital, Huizhou, China

³Department of Science and Education, Huizhou Sixth People's Hospital, Huizhou, China

Email: *843517495@qq.com, *yxychuzhiwen@163.com

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Abstract

Objective: To compare the differences in learning outcomes between the single-platform model using only HSEI-LBL (Hui Science-Education Integration with Lecture-Based Learning) and the dual-platform model HSEI-RC (Hui Science-Education Integration with Rain Classroom) during internal medicine rotations for clinical interns, and to explore the impact of Rain Classroom on the effectiveness of clinical clerkship teaching. **Methods:** A randomized cohort study was conducted to evaluate the 2019-grade clinical interns rotating in the emergency department at our hospital in 2024. The study compared the learning outcomes between a dual-platform teaching model (Rain Classroom APP + HSEI platform) and a dual-platform model (HSEI-LBL platform alone). Academic performance indicators, including admission and discharge examination scores, Direct Observation of Procedural Skills (DOPS), and Mini-Clinical Evaluation Exercise (Mini-CEX) scores, were analyzed. Statistical analysis was performed using SPSS software and the Ridit analysis to assess the differences between the two groups. **Results:** There were no statistically significant differences between the two groups regarding age, admission examination scores, or gender ratio. However, a statistically significant difference was observed in the discharge theoretical examination scores after one month of rotation ($t = -3.063$, $P < 0.01$). Regarding DOPS assessment, the HSEI-RC group achieved significantly higher scores than the HSEI-LBL group ($\bar{R} = 0.686$, 95% CI: 0.631 - 0.741). Similarly, for the Mini-CEX assessment, the HSEI-RC group scored significantly higher than the control group ($\bar{R} = 0.707$, 95% CI: 0.658 - 0.756). **Conclusion:** Compared with the HSEI-LBL model, the HSEI-RC model significantly improved the final theoretical examination scores, as well as the

DOPS and Mini-CEX assessment scores, among interns rotating in emergency medicine. The theoretical scores, DOPS rating levels, and Mini-CEX rating levels in the latter group were all superior to those in the former. Therefore, the HSEI-RC teaching model is worthy of promotion and application in the clinical teaching of interns across other medical specialties.

Keywords

Rain Classroom, HSEI, LBL, Emergency Medicine, Clinical Teaching

1. Introduction

Traditional clinical medicine teaching has primarily relied on pedagogies such as Lecture-Based Learning (LBL). Although face-to-face interaction between teachers and students fosters intimate communication in the classroom, the limited instructional hours often result in a “cramming” mode of education. Consequently, this leads to low classroom engagement, passive knowledge reception, and a lack of student motivation, initiative, and interactivity. The traditional model is not conducive to students’ comprehensive mastery of internal medicine knowledge and operational skills. The advent of the “Internet+” era has presented both significant opportunities and challenges for medical education. Novel teaching modalities—such as Massive Open Online Courses (MOOCs), micro-lectures, and flipped classrooms—have continuously challenged conventional pedagogical paradigms. In 2016, Tsinghua University launched “Rain Classroom,” an intelligent teaching tool designed to facilitate its extensive application in campus education and spearhead a “classroom revolution” [1].

Rain Classroom is a mobile-compatible platform that facilitates real-time interaction between teachers and students, offering a promising yet under-researched tool for immediate instruction. This teaching modality has demonstrated significant superiority over traditional methods in improving histology examination scores, learning experiences, and student satisfaction [2]. The integration of Rain Classroom with other teaching modalities has been shown to significantly enhance students’ learning motivation and initiative [3].

This study established a novel teaching model based on the HSEI-RC (Hui Science-Education Integration with Rain Classroom) dual-platform system. Grounded in the enhancement of core competencies—including operational skills and critical thinking—this approach refines the professional teaching process, transforms classroom dynamics, and promotes the high-quality implementation of instructional activities.

2. Subjects and Methods

2.1. Study Subjects

“HSEI” is a relatively mature teaching platform that has been widely adopted in

multiple teaching hospitals. It is a comprehensive clinical teaching system based on a WeChat mini-program, integrating admission education, practical skills training, discharge theoretical examinations, theoretical training, case discussions, teaching rounds, and attendance management for clinical interns. In the control group, clinical teaching was conducted using the traditional Lecture-Based Learning approach. The theoretical training was conducted in an offline mode. The control group received the traditional teaching model, while the experimental group was taught using the Rain Classroom model. Traditional Lecture-Based Learning (LBL) is the most enduring and widely applied teaching model in the history of education. At its core, it is “teacher-centered,” where instructors systematically impart knowledge and demonstrate principles to students through coherent oral language. The greatest advantages of this model lie in its efficiency and systematicity, enabling students to build a complete knowledge framework in a short period, which is particularly suitable for the introduction of new knowledge. However, LBL is essentially a one-way transmission of information. Students are often in a passive state of reception, lacking interaction and critical thinking, which can easily lead to a disconnect between theory and practice. Therefore, in modern teaching, it is frequently employed as a foundational approach in combination with other methods [4] [5]. To this end, we propose the concept of “HSEI-LBL”.

In contrast, the HSEI-RC model builds upon the HSEI system by implementing a novel blended teaching model that deeply integrates online and offline resources. This approach completely breaks the time and space limitations of traditional clinical teaching, reconstructing the process into a three-stage closed loop of “pre-class, in-class, and post-class.”

Pre-class: Instructors publish preview tasks, such as micro-lectures and case materials, allowing students to study autonomously during fragmented time and provide feedback on difficult points.

In-class: Features like real-time quizzes and “danmu” (bullet-screen) interactions are utilized to conduct heuristic and interactive teaching, combined with Case-Based Learning (CBL), Problem-Based Learning (PBL), and practical drills.

Post-class: Extended materials and assignments are pushed to students, and online questions and answers are provided to consolidate clinical reasoning and achieve knowledge internalization.

Both groups were matched for rotation duration and faculty allocation, and were assessed using identical evaluation protocols. Upon completion of the emergency medicine rotation, outcomes including discharge theoretical examination scores, Direct Observation of Procedural Skills (DOPS), and Mini-Clinical Evaluation Exercise (Mini-CEX) results were compared between the two groups to evaluate the learning effectiveness of the dual-platform model versus the single-platform model. The content of the admission and discharge theoretical examinations was based on the 3rd edition of Emergency Medicine (published by People’s Medical Publishing House, 2024), which serves as the standard undergraduate text-

book. Each exam consisted of 40 single-choice questions and 10 multiple-choice questions, with a total score of 100 points. All participating clinical interns took the exact same exam paper for each assessment; however, the questions in the admission exam differed from those in the discharge exam. Exclusion criteria were applied as follows: 1) Students who failed to complete the rotation; 2) Those who experienced major adverse events or severe illness during the internship; 3) Those who did not complete learning tasks according to the teaching plan; and 4) Those who committed academic misconduct (cheating) during assessments.

A total of 101 clinical interns (Grade 2019) rotating in the Department of Emergency Medicine in 2024 were selected and assigned identification numbers. Participants were randomly allocated into the experimental group and the control group using a random number table. First, the students were sequentially numbered from 001 to 101 based on their student IDs. Microsoft Excel was then used to randomly shuffle these 101 numbers. The first 51 numbers were labeled A01-A51, and the remaining 50 were labeled B01-B50. Based on their initial numbers, the students were assigned to either the HSEI-RC group (Group A) or the HSEI-LBL group (Group B). The control group received instruction via the HSEI-LBL platform alone, while the experimental group underwent a novel teaching intervention combining the HSEI-RC platform.

Ultimately, 50 students were enrolled in the HSEI-LBL group and 51 in the HSEI-RC group. This study was approved by the Hospital Ethics Committee (Ethical Approval Number: KYJY2026-LY052).

2.2. Study Methods

2.2.1. Control Group Curriculum Design

Preliminary baseline assessments were conducted prior to the rotation. Subsequently, based on the standardized clinical internship syllabus, a teaching plan for the emergency medicine rotation was formulated. Instruction was delivered via the HSEI platform, encompassing small-group lectures, theoretical teaching, case discussions, and clinical skills training (focusing primarily on cardiopulmonary resuscitation). Discharge theoretical examinations were administered upon completion of the rotation. Given that Direct Observation of Procedural Skills (DOPS) and Mini-Clinical Evaluation Exercise (Mini-CEX) are critical assessment tools for clinical medical students, these metrics were integrated into the evaluation system to assess students' clinical competence.

2.2.2. Observation Group Curriculum Design

The curriculum content was identical to the control group; however, the HSEI-RC model (HSEI + Rain Classroom APP) was utilized. Instructors received unified training on the use of Rain Classroom. Prior to class, instructors prepared lessons and uploaded learning materials (micro-videos, courseware, etc.) to the Rain Classroom APP, requiring students to preview. During class, students searched for literature and engaged in group discussions to formulate answers, submitting responses via the Rain Classroom platform. Instructors monitored response sta-

tistics in real-time, provided timely feedback, and guided students to preview materials for subsequent sessions. After one month of internship, data regarding baseline assessment scores, discharge theoretical examination scores, DOPS, and Mini-CEX results were aggregated for both groups. For the DOPS assessment, endotracheal intubation on a medical mannequin is used as the procedural test. The core focus is to evaluate the trainee's standardization and proficiency in performing a specific clinical skill. Implementation Details: 1) Preparation: Initiation & Case: The selected procedure must align with training requirements. Informed consent from the patient and family should be simulated in advance. Personnel & Duration: The session requires one assessor, one trainee, and a medical mannequin (simulator). The entire process typically takes 20 to 30 minutes. 2) Procedure: Briefing (Demonstration Room): The instructor clearly outlines the operational objectives, requirements, and precautions for the assessment. Observation Phase (Demonstration Room, approx. 10 - 20 mins): The instructor follows the "triangular positioning principle" (positioned to simultaneously observe the trainee's actions and the patient/simulator). Strict adherence to the "three no's principle" during observation: no prompting, no coaching, and no evaluation. The instructor should only intervene or halt the procedure if the trainee performs a dangerous maneuver or makes a critical error that threatens patient safety. Debriefing & Feedback (Demonstration Room, approx. 5 - 10 mins): The trainee briefly presents the procedure and post-operative management rationale. The instructor then provides scoring and immediate feedback. 3) Assessment Domains: These cover indications and anatomical understanding, informed consent, technical skills, communication skills, humanistic care, and post-procedure management. The scoring criteria were defined as follows: DOPS: 1 - 2 points: Below expectations; 3 points: Near expectations; 4 - 6 points: Meets or exceeds expectations [6].

Mini-CEX Core Focus: To assess the trainee's comprehensive clinical competence during patient encounters (covering history taking, physical examination, clinical reasoning, and humanistic qualities). Initiation & Case: Select common or typical emergency cases that meet the training guidelines. Informed consent from the patient must be obtained in advance. Personnel & Duration: Conducted by one assessor and one trainee with a real patient. The total duration is controlled within 20 to 30 minutes. 1) Procedure: Briefing (Demonstration Room): Clearly define the assessment objectives for the patient encounter. 2) Observation Phase (Emergency Outpatient Department, approx. 10 - 20 mins): The instructor directly observes the entire process of the trainee encountering the real patient, including history taking and physical examination. Strictly adhere to the "triangular positioning principle" and the "three no's principle" (no prompting, no coaching, no evaluation), intervening only when medical safety risks arise. Debriefing & Feedback (Demonstration Room, approx. 5 - 10 mins): The trainee presents the medical history, diagnostic reasoning, and treatment plan. The instructor provides targeted guidance using the FED feedback model (Feedback, Encourage-

ment, and Direction for improvement). 3) Assessment Domains & Scoring: Assessment Domains: Includes 7 core items: Medical Interviewing, Physical Examination, Communication Skills, Clinical Judgment (diagnosis and treatment plan), Organization/Efficiency, Humanism/Professionalism, and Overall Clinical Competence [7]. Mini-CEX: 1 - 3 points: Unsatisfactory; 4 - 6 points: Satisfactory; 7 - 9 points: Outstanding. All participants were fully informed about the study procedures and provided written informed consent.

3. Statistical Analysis

Data were analyzed using SPSS Statistics version 26. Measurement data (theoretical examination scores) were expressed as mean $\pm$ standard deviation ($\bar{x} \pm s$). Data conforming to the normal distribution were analyzed using the independent samples t-test, with $P < 0.05$ indicating statistical significance. Non-normally distributed data were analyzed using the rank-sum test, with $P < 0.05$ considered significant. DOPS and Mini-CEX scores represent ordered categorical data; therefore, Ridit analysis was performed. In this analysis, a Ridit value > 0.5 indicated that the experimental group was superior to the control group, < 0.5 indicated inferiority, and $= 0.5$ indicated no difference.

4. Results

4.1. General Characteristics of the Data

1) There were no statistically significant differences between the two groups regarding baseline admission scores ($t = 0.672$, $P = 0.5$), age ($t = 1.064$, $P = 0.29$), or gender ($\chi^2 = 0.005$, $P = 0.941$) (Table 1).

2) After one month of internship, the differences between the two groups were compared across three assessment modalities: discharge theoretical examination, DOPS, and Mini-CEX. The results revealed a statistically significant difference in discharge theoretical examination scores between the two groups ($t = -3.063$, $P < 0.01$) (Figure 1, Table 1).

The DOPS and Mini-CEX are ordinal categorical data. We used the Ridit analysis method for statistical analysis, and the results are as follows (Table 2, Table 3):

Table 1. Comparison of general characteristics and discharge theoretical examination scores between the two groups.

	HSEI-LBL Group	HSEI-RC Group	t/χ	P
Pre-rotation theoretical score	67.60 $\pm$ 11.84	66.04 $\pm$ 11.49	0.672	0.50
Discharge theoretical score	70.00 $\pm$ 12.86	77.22 $\pm$ 10.74	-3.063	<0.01
Age	22.04 $\pm$ 0.45	21.96 $\pm$ 0.28	1.064	0.29
Sex (Male/Female)	34/16	32/19	0.005	0.941

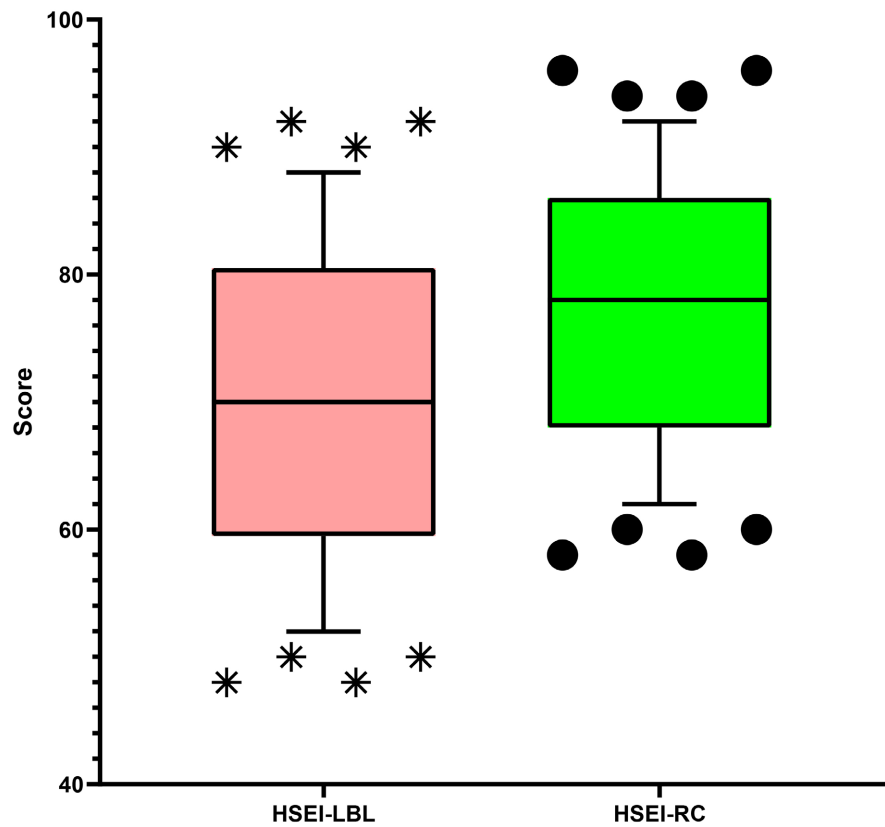


Figure 1. Comparison of theoretical examination results between the two groups at the end of rotation.

Table 2. DOPS (direct observation of procedural skills) score distribution.

Score	HSEI-LBL Group	HSEI-RC Group
1	6	2
2	6	2
3	9	2
4	11	11
5	10	18
6	8	16
Total	50	51

Table 3. Mini-CEX (mini-clinical evaluation exercise) score distribution.

Score	HSEI-LBL Group	HSEI-RC Group
1	3	0
2	4	0
3	5	0

Continued

4	6	1
5	7	5
6	8	13
7	7	15
8	6	12
9	4	5
Total	50	51

4.2. DOPS Score Ridit Analysis

Using the HSEI-LBL group as the reference group, the Ridit values were calculated as follows:

$$\text{Rank 1: } R_1 = (0 + 0.5 \times 6)/50 = 0.060$$

$$\text{Rank 2: } R_2 = (6 + 0.5 \times 6)/50 = 0.180$$

$$\text{Rank 3: } R_3 = (12 + 0.5 \times 9)/50 = 0.330$$

$$\text{Rank 4: } R_4 = (21 + 0.5 \times 11)/50 = 0.530$$

$$\text{Rank 5: } R_5 = (32 + 0.5 \times 10)/50 = 0.740$$

$$\text{Rank 6: } R_6 = (42 + 0.5 \times 8)/50 = 0.920$$

The mean Ridit value for the HSEI-RC group was:

$$\bar{R} = (2 \times 0.060 + 2 \times 0.180 + 2 \times 0.330 + 11 \times 0.530 + 18 \times 0.740 + 16 \times 0.920)/51 = 0.686, 95\% \text{ CI} = [0.631, 0.741]$$

4.3. Mini-CEX Score Ridit Analysis

Using the HSEI-LBL group as the reference group, the Ridit values were calculated as follows:

$$\text{Rank 1: } R_1 = (0 + 0.5 \times 3)/50 = 0.030$$

$$\text{Rank 2: } R_2 = (3 + 0.5 \times 4)/50 = 0.100$$

$$\text{Rank 3: } R_3 = (7 + 0.5 \times 5)/50 = 0.190$$

$$\text{Rank 4: } R_4 = (12 + 0.5 \times 6)/50 = 0.300$$

$$\text{Rank 5: } R_5 = (18 + 0.5 \times 7)/50 = 0.430$$

$$\text{Rank 6: } R_6 = (25 + 0.5 \times 8)/50 = 0.580$$

$$\text{Rank 7: } R_7 = (33 + 0.5 \times 7)/50 = 0.730$$

$$\text{Rank 8: } R_8 = (40 + 0.5 \times 6)/50 = 0.860$$

$$\text{Rank 9: } R_9 = (46 + 0.5 \times 4)/50 = 0.960$$

The mean Ridit value for the HSEI-RC group was:

$$\bar{R} = (0 \times 0.030 + 0 \times 0.100 + 0 \times 0.190 + 1 \times 0.300 + 5 \times 0.430 + 13 \times 0.580 + 15 \times 0.730 + 12 \times 0.860 + 5 \times 0.960)/51 = 0.707, 95\% \text{ CI} = [0.658, 0.756]$$

DOPS Assessment: The HSEI-RC group achieved significantly higher DOPS scores than the HSEI group ($\bar{R} = 0.686$, 95% CI: 0.631 - 0.741) (**Figure 2**).

Mini-CEX Assessment: The HSEI-RC group achieved significantly higher Mini-CEX scores than the HSEI-LBL group ($\bar{R} = 0.707$, 95% CI: 0.658 - 0.756) (**Figure 3**).

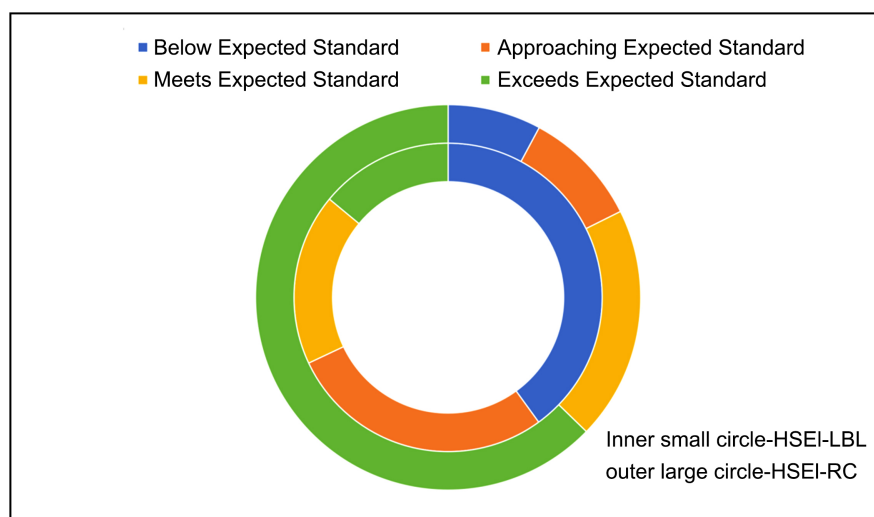


Figure 2. Comparison of DOPS score differences between the two groups.

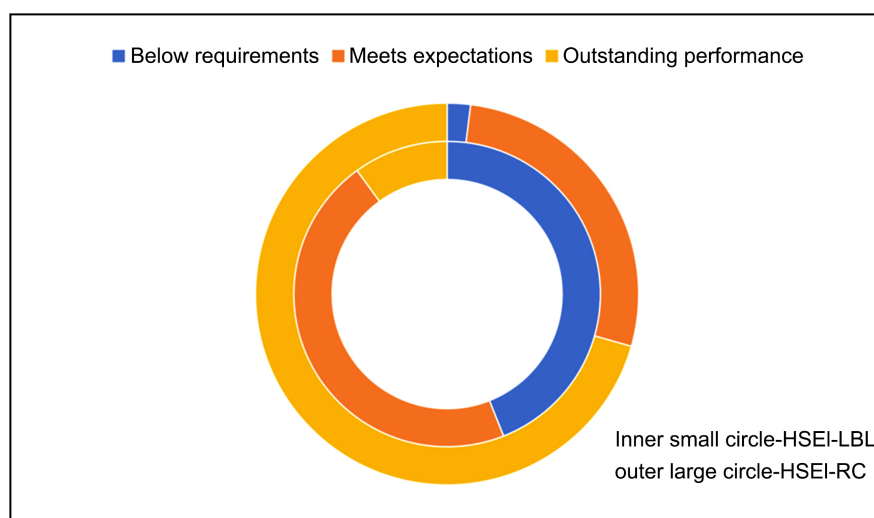


Figure 3. Comparison of Mini-CEX score differences between the two groups.

5. Discussion

With the advent of the “Internet+” era, online teaching tools and platforms—such as Massive Open Online Courses (MOOC), Small Private Online Courses (SPOC), and Rain Classroom—along with innovative pedagogical models like the Flipped Classroom, have opened new avenues for reforming traditional teaching modes and enhancing instructional effectiveness.

Rain Classroom operates as a plugin integrated with PowerPoint, utilizing “cloud-based” services to consolidate the entire teaching process through cloud storage, computing, and services. It facilitates real-time communication with students and assists in resolving queries. Furthermore, HSEI-RC model dynamically records all student learning behaviors and data, enabling instructors to analyze this information promptly. This allows for quantitative measurement of teaching outcomes, evaluation of effectiveness, and dynamic adjustment of teaching strat-

egies [8].

In this study, the HSEI-RC dual-platform teaching model was implemented. The results indicated that clinical interns utilizing the combined teaching method achieved significantly higher discharge examination scores and superior DOPS and Mini-CEX ratings compared to those in the HSEI-LBL group. This suggests that the Rain Classroom blended teaching model holds substantial advantages in improving student performance [9]. Consistent with our findings, Li Lei *et al.* [10] reported that Rain Classroom combined with Case-Based Learning effectively enhances the competencies of emergency medicine residents. Similarly, Duan Yongchun *et al.* demonstrated that a participatory teaching model integrating “Rain Classroom + Workshop” significantly improved the academic performance and comprehensive abilities of emergency medicine interns, while also stimulating learning interest and efficiency [11].

In a study focusing on nephrology teaching for clinical medical students, the implementation of the Integrated, Targeted, Pre-assessment, Participatory Learning, Post-assessment, and Summary (IDIPPS) model combined with Rain Classroom resulted in significantly higher final examination scores compared to traditional teaching. Additionally, classroom engagement in the experimental group was markedly improved, indicating a more interactive learning environment. Student evaluations revealed enhanced satisfaction, autonomous learning enthusiasm, comprehension, and interest in nephrology within the experimental group. Research involving Rain Classroom combined with Case-Based Learning showed that interns in the experimental group exhibited significantly greater participation in Q&A sessions than the control group [12]. Furthermore, a flipped classroom model assisted by Rain Classroom was shown to elevate student learning levels; compared with the control group, the experimental group’s final examination scores increased significantly ($P < 0.01$). Final examination scores correlated significantly with both pre-class quiz scores ($P < 0.05$) and in-class quiz scores ($P < 0.001$). Student satisfaction, measured via a Likert scale questionnaire (1 - 5 points), yielded average scores above 4.5, suggesting that the majority of students held a positive attitude toward this teaching model [13]. Moreover, for clinical students, the integration of CBL with Rain Classroom helps enliven the classroom atmosphere and stimulate learning enthusiasm [14].

However, the effectiveness of Rain Classroom is influenced by class size; smaller class sizes and specialized courses tend to increase satisfaction with Rain Classroom-based blended learning. A relevant study indicated that in clinical teaching settings, class size was negatively correlated with all evaluation scores (Score 1: $\rho = -0.186$, $P = 0.002$; Score 2: $\rho = -0.210$, $P < 0.001$; Score 3: $\rho = -0.225$, $P < 0.001$), which may limit the broader application of the Rain Classroom model [15].

6. Conclusion

Compared with the HSEI-LBL model, the HSEI-RC model significantly improved the final theoretical examination scores, as well as the DOPS and Mini-CEX as-

assessment scores, among interns rotating in emergency medicine. The theoretical scores, DOPS rating levels, and Mini-CEX rating levels in the latter group were all superior to those in the former. Therefore, the HSEI-RC teaching model is worthy of promotion and application in the clinical teaching of interns across other medical specialties.

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Limitations

The accuracy of the findings is subject to certain limitations, including the small sample size, short duration, and single-center nature of the study. Additionally, potential evaluator bias, brief rotation periods, and period effects arising from teaching the two groups at different times may have influenced the results.

Author Contributions

Haibin Wang: manuscript writing; **Wentong Zhu:** study design, leading the research process; **Yuncheng Li:** research supervision; **Bingbin He:** DOPS design; **Jianfei Huang:** mini-CEX design; **Jiahua Yang** and **Wenshan Zeng:** intern teaching, attendance management, and theoretical exam design; **Zhiwei Liu:** statistical data analysis, manuscript revision; **Zhiwen Chu:** student grouping design, teaching and instruction, manuscript organization and revision.

Conflicts of Interest

The authors declare that they have no conflicts of interest with any internet platforms, enterprises, institutions, companies, or individuals related to this study.

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