Scientific Research Publishing

Open Journal of Applied Sciences, 2024, 14, 1204-1213
https://www.scirp.org/journal/ojapps
ISSN Online: 2165-3925
ISSN Print: 2165-3917

Effect Evaluation of CBL Combined with Rain Classroom Teaching Method in Medical Statistics

Man Luo*, Xiaofang Zhang, Wei Liu

Department of Preventive Medicine, Yangtze University, Jingzhou, China
Email: *luoman1215@126.com

How to cite this paper: Luo, M., Zhang, X.F. and Liu, W. (2024) Effect Evaluation of CBL Combined with Rain Classroom Teaching Method in Medical Statistics. *Open Journal of Applied Sciences*, **14**, 1204-1213.
https://doi.org/10.4236/ojapps.2024.145078

Received: April 10, 2024
Accepted: May 8, 2024
Published: May 11, 2024

Abstract

Objective: To explore the application effect of CBL combined with rain classroom teaching method in medical statistics courses. Methods: The undergraduate students of medical imaging technology in 2019 and 2020 in a university were selected as the research objects. A cluster sampling method was used to select 79 undergraduate students from 2019 in the control group and 75 undergraduate students from 2020 in the experimental group. Traditional teaching method and CBL combined with rain classroom teaching method was used in the control group and experimental group respectively. The final examination scores of the two groups were compared. In experimental group, the correlation between the average score in the rain classroom and the final examination score was tested, and the teaching effect was evaluated. Results: The average score of final examination in experimental group and control group was 79.13 ± 10.32 points and 71.54 ± 14.752 points, respectively, which had a statistically significant difference ($Z = 2.586$, $P = 0.012$); the final examination scores of the students in the experimental group were positively correlated with the average scores of the rain classroom ($r = 0.372$, $P = 0.001$), and the proportion of satisfaction in the experimental group was 94.7%. Conclusion: The CBL combined with rain classroom teaching method can improve the teaching effectiveness of medical statistics courses.

Keywords

Rain Classroom, CBL, Medical Statistics

1. Introduction

Medical statistics is a fundamental discipline in modern medical research, which applies the basic principles and methods of probability theory and mathematical

statistics to the medical field, and draws conclusions through research design and data analysis. This course is a compulsory course for students majoring in medical imaging technology to cultivate students' scientific research thinking ability and data analysis ability, which can lay a solid foundation for future scientific research work and practical application [1].

Although medical statistics is very important, medical students generally consider this curriculum difficult to learn and understand due to its strong logic, multiple formulas, and obscure content [2] [3] [4]. The traditional teaching method is generally teacher-centred, class-oriented didactic approach. Although this method can systematically complete the learning process, it is somewhat failing to promote students' learning initiatives and to develop their active thinking abilities, which is difficult for them to apply the knowledge they have learned into practice [5].

Case based learning (CBL), which is widely used in medical education, integrates clinical and healthcare cases into teaching models to promote active and reflective learning, cultivate students' critical thinking ability and problem-solving ability [6]. Rain Classroom is a smart teaching tool jointly developed by Xuetang Online and Tsinghua University. It combines WeChat and PPT. Teachers can distribute teaching materials with case to students' mobile phones via Rain Classrooms; students, in turn, can preview learning material with case before class and review it after class. In the whole online and offline learning process, Rain Classroom can record all students' learning data dynamically. Thus, it closely connects students' pre-class, in-class, and post-class learning through information push, dynamic learning, real-time data collection and analysis, forming an interactive classroom that never goes offline [7]. The combination of rain classroom and case based learning teaching method utilizes real cases to transform knowledge transmission from unidirectional to multi-directional, and meanwhile offer students new experiences in the whole teaching process. Previous research found that the teaching effects of case-based learning combined with Rain Classroom teaching method is better than traditional lecture method in the clinical course [7]. It is helpful to built students' critical thinking ability and independent learning ability [8] [9]. However, few studies have applied this method to the evaluation of medical statistics teaching effect. In this study, CBL combined with rain classroom teaching method was applied in medical statistics theory course on students majoring medical imaging technology. By comparing the final examination score of the traditional and experimental group, analyzing the correlation between the average score of rain classroom and the final examination score, and evaluating the teaching effect, this study aimed to provide scientific data for teaching reform.

2. Methods

2.1. Medical Statistics Course and Participants

The research subjects were selected from undergraduate students majoring in

medical imaging technology in the 2019 and 2020 levels of the Medical College. A cluster sampling method was used to select 79 undergraduate students from 2019 in the control group and 75 undergraduate students from 2020 in the experimental group. Traditional teaching method and CBL combined with rain classroom teaching method was used in the control group and experimental group respectively. The textbook used is medical statistics (seven edition, edited by Li Kang, He Jia, People's Medical Publishing House). The teaching teachers, teaching materials, and class hours of both groups are the same. This course has a total of 32 hours, including 24 hours for theoretical courses and 8 hours for experimental courses. This study only focuses on teaching reform for theoretical courses.

2.2. Teaching Methods

Control group: This group adopts the traditional teaching method, where the teacher creates PPTs for each chapter according to the teaching outline. In the classroom, the teacher uses a combination of PPTs and blackboard writing to teach, and students listen and answer the teacher's questions. After class, students complete exercises and assignments, and finally take a comprehensive exam.

Experimental group: This group adopts CBL combined with rain classroom teaching method, with the PPT content of each chapter unchanged. The specific methods are as follows: 1) Establish a class: The school's academic affairs office sets up course and class information under the teacher's Rain Classroom account based on the teacher's schedule. Both teachers and students have received training on Rain Classroom teaching methods in the early stage, and there are no technical obstacles during the use process. 2) Preview before class: Teachers create preview courseware for each chapter and send it to students in advance through Rain Classroom Software. The preview courseware includes statistics cases learning materials, several test questions with a total score of 10 and MOOC materials. Taking "Chapter 6 Parameter Estimation and Hypothesis Testing" as an example, "A researcher wanted to know the average level of systolic blood pressure of normal adult men over 35 years old in a certain city. 225 normal adult men were selected randomly in 2015. The mean and standard deviation systolic blood pressure of them was 113.2 mmHg and 10.2 mmHg, respectively. Thus, the researcher thinks the average level of systolic blood pressure of normal adult men in this city was 113.2 mmHg. Question 1: What types of data is this? Question 2: What design scheme does the data belong to? Question 3: Is the researcher's statistical method correct and why? Question 4: What statistical method should be used for this data?" Students are required to complete the preview before the specified date, and any questions that students do not understand during the preview process can be marked. Rain Classroom will automatically record students' online learning situation, including data such as preview courseware viewing time, test scores, and doubts during preview Classroom

teaching. 3) Teaching in class: Students scan QR codes through WeChat to enter the Rain Classroom. One student was selected to give a 5 minutes report of the question assigned. In the classroom, cases in the preview courseware are discussed, with a focus on issues with high error rates; At the same time, during the teaching process, fully utilize various interactive teaching functions such as bullet screen, submission, and online testing in Rain Classroom, activate the classroom atmosphere, concentrate students' attention, and timely detect the effectiveness of classroom learning, increasing the cultivation of case analysis ability. 4) Consolidation after class: In order to consolidate students' knowledge and test their learning effectiveness, a mind map of each chapter is required to submit to the rain classroom.

2.3. Statistical Indicators

Final Examination Scores: Two groups of students will take a comprehensive exam at the end of the semester. The control group and the experimental group have different test questions, but the test papers are set by the same teacher using a homogenization method to ensure that the difficulty of the two sets of test papers is similar and the knowledge points of the exam are the same. The exam questions include noun explanations, single choice questions, short questions, analysis questions, and calculation questions, with a maximum score of 100 points.

Questionnaire Survey Results: A survey questionnaire is designed to understand students' attitudes towards the CBL combined with rain classroom teaching method. The questionnaire includes three aspects: students' demographic data, satisfaction with teaching effectiveness, and cognitive evaluation of CBL combined with rain classroom teaching method on medical statistics courses.

2.4. Statistical Analysis

Statistical analysis was conducted using SPSS 26.0. The statistical description of quantitative data that follows a normal distribution adopted $\bar{x} \pm s$, and the statistical inference was made using the Z-test; The statistical description of quantitative data that does not follow a normal distribution adopted $P_{50}, P_{75} - P_{25}$, and the statistical inference of those data was conducted using the rank sum test. Simple correlation analysis was adopted for two variables. The statistical description of qualitative data adopted rate or ratio, and statistical inference of those data adopted χ^2 test. P-value less than 0.05 was considered significant.

3. Results

3.1. Comparison of Final Examination Scores

The average score of the experimental group students is 79.13 points, while the average score of the traditional group students is 71.54 points, $Z = 2.586$, $P = 0.012$. There is a statistically significant difference in the scores between the experimental group students and the control group students, as shown in Table 1.

Table 1. Comparison of average scores of final examinations between the two groups ($\bar{x} \pm s$) points.

Types of questions	Control group (79 students)	Experimental group (75 students)	z	95% CI	P
Noun explanations	15.95 ± 2.39	16.28 ± 2.56	0.591	−1.470, 0.797	0.556
Single choice questions	14.81 ± 3.05	15.28 ± 1.97	0.794	−1.657, 0.715	0.430
Short questions	16.32 ± 2.04	16.56 ± 2.79	0.426	−1.362, 0.882	0.672
Analysis questions	12.11 ± 6.24	16.23 ± 3.65	3.493	−6.485, −1.760	0.001
Calculation questions	12.35 ± 6.09	14.26 ± 4.95	1.499	−4.437, 0.626	0.138
Total	71.54 ± 14.75	79.13 ± 10.32	2.586	−13.450, −1.725	0.012

3.2. Correlation between Average Scores of Rain Classroom and Final Exam Scores

The average scores of students in Rain Classroom were the arithmetic mean of the test questions in all the preview courseware. The correlation between this score and students' final exam scores is shown in Figure 1 and Table 2. The results show that there was a positive correlation between the final exam scores of the experimental group students and the average scores of Rain Classroom (r = 0.372, P = 0.001).

3.3. Questionnaire Survey Results

3.3.1. General Demographic Data

A questionnaire survey was conducted on students participating in the experimental group. Electronic questionnaires were distributed and 75 valid questionnaires were collected. Among them, 38 were male and 37 were female, with an average age of 20.37 ± 1.09. Students with math scores < 90, 90 - 120, and 120 - 150 at enrollment accounted for 9.3%, 76%, and 14.7%, respectively. Only 8% of students had scientific research experience, as shown in Table 3.

3.3.2. Satisfaction of Teaching Effectiveness in the Experimental Group

40% of the students in the experimental group were satisfied with CBL combined with rain classroom teaching method, and 54.7% of the students were very satisfied with CBL combined with rain classroom teaching method. The total satisfaction rate was 94.7%.

3.3.3. Evaluation of CBL Combined with Rain Classroom Method in Experimental Group

77.4% of students in the experimental group believe that they have mobilized their learning enthusiasm, 80.0% believe that they have improved their ability to learn independently, 85.3% believe that they have improved learning efficiency, 88% believe that they have deepened their understanding and memory of knowledge, 94.7% believe that they have activated the classroom atmosphere, 93.3% believe that they have strengthened timely communication between teachers and students, and 89.4% of students believe that they have developed their scientific research thinking abilities, 70.6% of students believe that they have improved

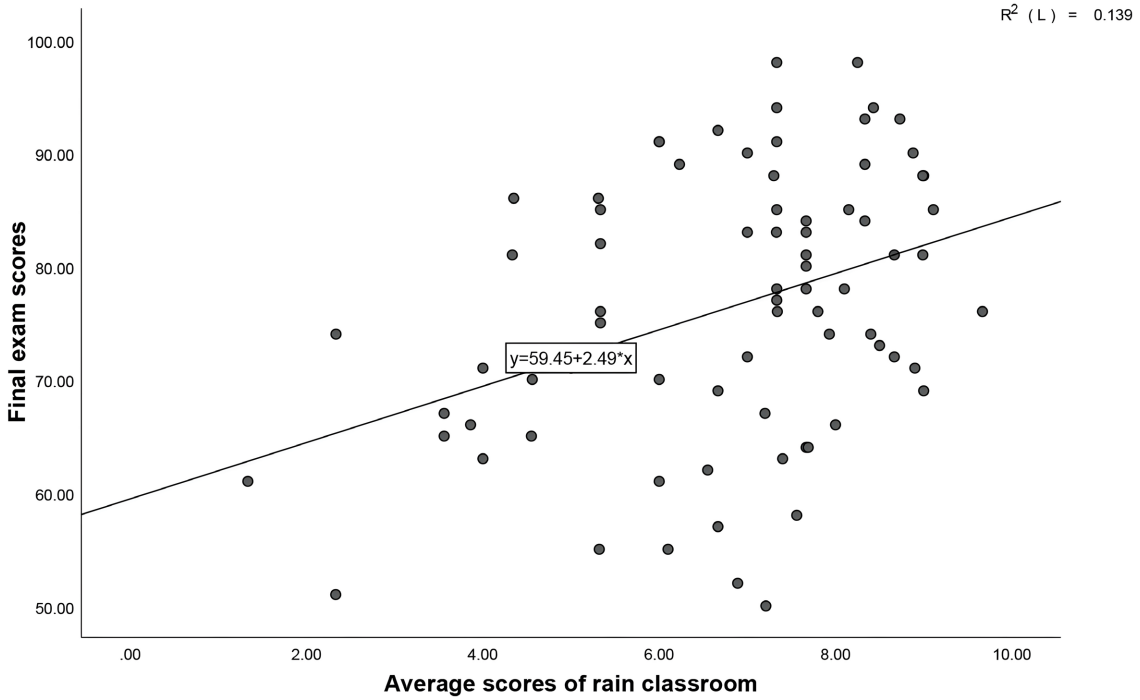

Figure 1. Scatterplot of the relationship between the final exam scores and the average scores in the rain classroom of students in the experimental group.

Table 2. Correlation analysis between final exam scores and rain classroom scores of students in experimental group.

Score	Mean ± standard deviation ($\overline{x} \pm s$)	r	P
Rain classroom	6.80 ± 1.80	0.372	0.001**
Final exam	79.13 ± 10.32		

Note: **There was a significant statistically correlation between final exam scores and rain classroom scores ($P < 0.01$).

Table 3. Demographic data of students in the experimental group.

Variable	Cases (%)/Mean ± standard deviation
Age	20.37 ± 1.09
Gender	
Male	38 (50.67)
Female	37 (49.33)
Mathematics scores at enrollment	
<90	7 (9.3)
90 - 120	57 (76.0)
120 - 150	11 (14.7)
Scientific research experience	
With	8 (10.7)
Without	67 (89.3)

their ability to solve practical professional problems, 96% support the combination of rain classroom and case teaching method, but 38.7% of students believe that rain classroom preview has increased the burden of learning, as shown in Table 4.

4. Discussion

Medical students find it difficult to adapt to the transformation of logical thinking abilities in medical statistics due to their lack of systematic learning of probability theory and mathematical statistics. This study introduces classic cases into classroom teaching, concretizing abstract concepts and connecting fragmented knowledge points. At the same time, intelligent teaching terminals are used to record the entire learning process of students, integrating teaching and learning, and cultivating students' ability to solve practical problems [10]. The results of this study indicate that students are highly satisfied with the teaching effectiveness of the CBL combined with rain classroom teaching method, and the advantages of this method are mainly reflected in the following points:

4.1. Mobilizing Learning Enthusiasm, Enhancing the Ability to Learn Independently, and Improving Academic Performance

In the experimental group, the teaching teacher pushes the case version preview courseware in advance through Rain Classroom, and students can view their preview situation and the accuracy of test questions in real time. This mode can stimulate students' learning enthusiasm and improve their self-learning ability [11]. Through the feedback information from Rain Classroom, the teacher can timely discover some common problems of students, thereby improving classroom efficiency. After class, teachers can consolidate and expand classroom knowledge by pushing homework and related scientific research articles through

Table 4. Evaluation of the students in the experimental group on the application of CBL combined with rain classroom teaching method.

Subject	Disagree	Uncertain	Agree
Motivated learning enthusiasm	4 (5.3%)	13 (17.3%)	58 (77.4%)
Enhanced the ability of self-directed learning	3 (4.0%)	12 (16.0%)	60 (80.0%)
Improved learning efficiency	2 (2.7%)	9 (12.0%)	64 (85.3%)
Deepened understanding and memory of knowledge	1 (1.3%)	8 (10.7%)	66 (88.0%)
Activated the classroom atmosphere	0 (0.00)	4 (5.3%)	71 (94.7%)
Enhanced communication between teachers and students timely	0 (0.00)	5 (6.7%)	70 (93.3%)
Rain classroom preview increased learning burden	25 (33.3%)	21 (28.0%)	29 (38.7%)
Cultivated my scientific thinking ability	1 (1.3%)	7 (9.3%)	67 (89.4%)
Improved my ability to solve practical problems	2 (2.7%)	20 (26.7%)	53 (70.6%)
I supported the CBL combined with Rain Classroom teaching method	0 (0.00)	3 (4.0%)	72 (96%)

the Rain Classroom. At the same time, this method is not limited by time and space. Students can not only communicate with teachers at any time, but also integrate fragmented time for autonomous learning. This convenient and systematic learning mode before, during, and after class significantly improves students' final exam scores.

4.2. Improving Students' Awareness of Scientific Research Innovation and Practical Ability

In the experimental group, teachers utilize real cases in the field of healthcare to help students complete the entire process of experimental design, data collection, organization, analysis, and result interpretation. While constructing a statistical knowledge framework, it matches similar cases from actual work with the knowledge points learned. This method has certain advantages in medical education [9] [12]. The results of this study indicate that in the final exam scores, the analysis questions in the experimental group scored higher than those in the control group, with a statistically significant difference. However, there was no statistically significant difference in scores for other question types between the experimental group and the control group. This is because question types such as noun explanations and short questions belong to the memory type and can be scored by rote memorization. Analysis questions examine students' comprehensive understanding of statistical knowledge from the perspective of application. This result is consistent with the training goal of the case-based learning combined with rain classroom teaching method. In addition, 89.4% of students believe that the CBL combined with rain classroom teaching method has improved their scientific research thinking ability and clinical practical problems solving ability, which may be related to pre-class case study and post class expansion of professional knowledge.

4.3. Thoughts and Prospects

Although the CBL combined with rain classroom teaching method has achieved good results in the evaluation of medical statistics courses, this study is only limited to students majoring in medical imaging technology. In the future, this method needs to be applied to students majoring in other medical majors to further verify its effectiveness. In addition, the results of this study indicate that 38.7% of students believe that rain classrooms preview increase their learning burden, but the final exam results and questionnaire survey results indicate that this method effectively improves students' mastery and application of medical statistics knowledge points. Therefore, it is recommended to appropriately shorten classroom time in the future. Finally, this model requires teachers to keep up with the forefront of academia, invest more time and energy in collecting data, creating case studies, fully tapping into two-way potential, comprehensively stimulating the innovative abilities of teachers and students, and promoting mutual learning and teaching.

Acknowledgements

This work was financially supported by Campus Level Teaching and Research Project of Yangtze University under grant No. JY2021049.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Hunponu-Wusu, O.O. (1977) The Need for Medical Statistics in the Training of Health Personnel. *Medical Education*, **11**, 351-354. https://doi.org/10.1111/j.1365-2923.1977.tb00627.x

[2] Li, F., Chen, J., Song, Q.Y., Zhang, Y.Q., Liu, L., Yi, D. and Wu, Y.Z. (2022) Literature Evaluation on the Reform and Development of Medical Statistics Teaching Methods. *Chinese Journal of Health Statistics*, **39**, 621-624.

[3] León-Mantero, C., Casas-Rosal, J.C., Maz-Machado, A., *et al.* (2022) Analysis of Attitudinal Components towards Statistics among Students from Different Academic Degrees. *PLOS ONE*, **15**, e0227213. https://doi.org/10.1371/journal.pone.0227213

[4] Zhang, Y., Shang, L., Wang, R., *et al.* (2012) Attitudes toward Statistics in Medical Postgraduates: Measuring, Evaluating and Monitoring. *BMC Medical Education*, **12**, 1-8. https://doi.org/10.1186/1472-6920-12-117

[5] Li, C., Wang, L., Zhang, Y., *et al.* (2018) Assessment of a Block Curriculum Design on Medical Postgraduates' Perception towards Biostatistics: A Cohort Study. *BMC Medical Education*, **18**, 1-10. https://doi.org/10.1186/s12909-018-1232-0

[6] Li, S.S., Ye, X.C. and Chen, W.T. (2019) Practice and Effectiveness of "Nursing Case-Based Learning" Course on Nursing Student's Critical Thinking Ability: A Comparative Study. *Nurse Education in Practice*, **3**, 91-96. https://doi.org/10.1016/j.nepr.2019.03.007

[7] Li, X., Li, Y., Li, X., *et al.* (2022) Comparison of Case-Based Learning Combined with Rain Classroom Teaching and Traditional Method in Complete Denture Course for Undergraduate Interns. *BMC Medical Education*, **22**, Article Number: 610. https://doi.org/10.1186/s12909-022-03678-z

[8] Hong, S. and Yu, P. (2017) Comparison of the Effectiveness of Two Styles of Case-Based Learning Implemented in Lectures for Developing Nursing Students' Critical Thinking Ability: A Randomized Controlled Trial. *International Journal of Nursing Studies*, **68**, 16-24. https://doi.org/10.1016/j.ijnurstu.2016.12.008

[9] Li, Y., Cao, L., Zhang, H., Pang, W., Sun, Y. and Zhang, Z. (2023) Application of Flipped Classroom Combined with Case-Based Learning in Introduction to Environmental Health Science. *Frontiers in Public Health*, **11**, Article ID: 1264843. https://doi.org/10.3389/fpubh.2023.1264843

[10] Chang, W.W., Zhu, L.J., Wen, L.Y., Song, J.G., Zou, Y.F. and Jin, Y.L. (2022) Effectiveness of Seminar-Case Learning for Use in Practice Teaching of Statistics for Undergraduates Majoring in Preventive Medicine: A Prospective Cluster-Randomized Controlled Trial. *BMC Medical Education*, **22**, 237-244. https://doi.org/10.1186/s12909-022-03297-8

[11] Chen, J., Gao, B., Wang, K., *et al.* (2023) WeChat as a Platform for Blending Problem/Case-Based Learning and Paper Review Methods in Undergraduate Paediatric

Orthopaedics Internships: A Feasibility and Effectiveness Study. *BMC Medical Education*, **23**, 1-10. https://doi.org/10.1186/s12909-023-04269-2

[12] Burgess, A., Matar, E., Roberts, C., *et al.* (2021) Scaffolding Medical Student Knowledge and Skills: Team-Based Learning (TBL) and Case-Based Learning (CBL). *BMC Medical Education*, **21**, Article Number: 238. https://doi.org/10.1186/s12909-021-02638-3