

Application of a SPOC-Based Blended Teaching System in the Full Lifecycle Training of Imaging Interns

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ABSTRACT

To explore the application effects of a SPOC-based blended teaching system in the full lifecycle training of imaging interns. A total of 60 imaging interns who conducted their internships in the Interventional Department of Deyang People's Hospital from May 2023 to May 2024 were selected as research subjects. Using the random number table method, they were randomly divided into an experimental group and a control group in a 1:1 ratio, with 30 students in each group. The control group adopted the traditional clinical internship teaching model, while the experimental group employed a SPOC-based blended teaching system combined with a full lifecycle teaching approach. The job competence, self-directed learning ability, teaching satisfaction, and departmental exam scores of the two groups were compared. After the teaching intervention, the experimental group demonstrated significantly higher job competence, self-directed learning ability, teaching satisfaction, and departmental exam scores compared to the control group, with statistically significant differences ($P < 0.05$). Implementing a SPOC-based blended teaching model combined with full lifecycle training in the clinical instruction of imaging interns effectively enhances their job competence, improves self-directed learning ability, and increases teaching satisfaction. This teaching approach not only promotes the development of students' comprehensive skills but also plays a positive role in the improvement of teaching faculty development.

KEYWORDS

Small Private Online Course(SPOC); Full lifecycle training; Imaging interns

1 Introduction

Medical imaging is a discipline that integrates theory, practice, and application. The internship period for imaging students is a critical phase for transitioning from theoretical teaching in school to clinical work. It is also a necessary step in the shift from medical student to physician^[1]. Through learning during the internship phase, students can accumulate professional knowledge, acquire basic machine operation skills, independently interpret images and diagnose common diseases, and develop imaging diagnostic thinking that complements clinical work. This process helps students integrate theory, practice, and application more holistically^[2]. However, there are several common issues faced by imaging interns, such as poor clinical diagnostic thinking, inadequate skill acquisition, weak practical foundations, difficulty in complex imaging diagnostics, and a general lack of motivation^[3]. Therefore, it is crucial to innovate clinical teaching models in imaging to effectively engage interns and boost their enthusiasm and initiative.

With the development of the internet and modern educational technologies, a new form of online education—blended teaching based on Small Private Online Courses (SPOC)—has emerged^[4]. This model combines online teaching activities, primarily through micro-videos, with offline activities centered on flipped classroom instruction. Due to its features such as small scale, restricted access, ease of implementation, and hybrid teaching, SPOC has gained widespread recognition in the education sector^[5].

Leading global universities, such as Harvard University and the University of California, Berkeley, were among the first to propose and experiment with the SPOC blended teaching method. They argue that, compared to MOOCs, SPOCs are more conducive to increasing student engagement, facilitating teacher-student interaction, and providing students with a more personalized and comprehensive learning experience^[6]. In China, institutions like Peking University and Tsinghua University have also started implementing SPOC practices on their campuses in recent years. The construction of this model includes course preparation, the design of online and offline teaching activities, and course evaluation design^[7]. Its core philosophy emphasizes greater flexibility in learning time and location, enabling learners to make full use of fragmented time for personalized study, and placing a strong emphasis on the practicality and real-world relevance of learning^[5].

At present, the SPOC blended teaching method is still in its early stages of application in China, primarily used in the reform of teaching models at major universities, with few reports on its use in clinical internships for radiology. However, the characteristics of small sample size and personalized teaching align well with the training philosophy of radiology internships, making it a suitable model for exploring teaching methods in medical imaging internship training. This study aims to apply the SPOC blended teaching model, using a variety of teaching formats such as live broadcasts, micro-videos, and offline training, to deliver multidisciplinary content, including medical imaging knowledge, basic skills, communication techniques, and scientific thinking.

2 Methods

2.1 Subjects

A total of 60 medical imaging interns who completed their internships in the Department of Interventional Radiology at Deyang People's Hospital between May 2023 and May 2024 were selected as the subjects for this study. Using a random number table, the interns were randomly assigned to either the experimental group or the control group in a 1:1 ratio, with 30 participants in each group. The experimental group consisted of 12 males and 18 females, while the control group included 14 males and 16 females.

2.2 Inclusion and Exclusion Criteria

Inclusion Criteria: Participants must be interns specializing in medical imaging; Interns must have a clinical internship period of more than three months; Interns must voluntarily agree to participate in this study.

Exclusion Criteria: Resident Physicians and Visiting Physicians; Mid-study Withdrawal; Incomplete Questionnaires (>5%).

2.3 Research Methods

The control group will follow the traditional clinical internship teaching model, where the supervising instructors will conduct teaching activities based on the clinical teaching plan and curriculum guidelines for the medical imaging program. The teaching content will cover two main areas: fundamental knowledge of imaging and interventional radiology, as well as interventional procedural skills. Teaching will be delivered using a work-and-teach approach, integrating clinical tasks with direct supervision and instruction from the teaching staff.

The experimental group will adopt a SPOC-based blended teaching model combined with a life-cycle teaching approach. Teaching activities will be carried out according to the educational objectives and curriculum guidelines. The specific teaching content includes the following: (1) Pre-teaching Phase: Each intern will be required to download the "Rain Classroom" and "Tencent Meeting" apps on their mobile devices. The supervising instructors will push the teaching materials to these apps. Interns will use their free time to log into the apps for self-directed learning, which includes reviewing textbooks, searching for relevant literature, and completing online self-assessments. Instructors will extract learning data from the apps to summarize and analyze the effectiveness of the interns' self-directed study. Based on the analysis, key and difficult areas of the training will be identified. Additionally, instructors will engage with interns through interactive discussions to address any questions or challenging points raised by the learners. (2) In the teaching process, the supervising instructor first evaluates and summarizes the students' independent learning outcomes based on learning data, providing guidance for their online learning. To facilitate the internalization of knowledge from mere storage, classroom learning is primarily centered around group-based collaborative learning through clinical case studies. The instructor pre-creates simulated clinical scenarios (e.g., a case of managing hemoptysis) and divides the students into groups of 4 to 5, appointing a group leader. The group leader guides the members in proposing individual perspectives on the case based on their existing knowledge, and through group discussions, they reach a consensus. The leader then assigns specific roles to each member, who engage in team-based learning through role-play or scenario simulation. The groups present their learning outcomes in various formats, such as research findings, case reports, role-plays, scenario simulations, or skill assessments. During inter-group discussions, each group selects one representative to present their viewpoints, while other group members may add supplementary information as needed. Finally, the supervising instructor summarizes the key points from the students' discussions, provides feedback and corrections for any deficiencies identified during group discussions, and offers timely praise for particularly innovative ideas. (3) After the teaching session, students log into the app to complete a survey assessing their mastery of the teaching content and submit a reflective learning report. The supervising instructor reviews the student data to reflect on the teaching content and methods, making timely adjustments as necessary. Once students begin clinical practice, they can access the app at any time to review the knowledge they have learned.

2.4 Evaluation Metrics

2.4.1 Job Competency

The "Clinical Internship Physician Job Competency Rating Scale" was used to evaluate the job competency of two groups of radiology interns. The questionnaire consists of 16 items across four dimensions: professional knowledge (4 items), professional skills (4 items), professional competence (4 items), and comprehensive qualities (4 items). Each item is rated using a 5-point Likert scale, with scores ranging from 1 to 5 points. The total score ranges from 16 to 80, with higher scores indicating a higher level of job competency among the radiology interns.

2.4.2 Self-Directed Learning Ability

The "Self-Directed Learning Ability Scale" was used to assess the self-directed learning ability of two groups of radiology interns. The questionnaire consists of 61 items distributed across four dimensions: learning awareness (12 items), learning strategies (24 items), learning evaluation (12 items), and interpersonal skills (13 items). Each item is rated using a 5-point Likert scale, with scores ranging from 1 to 5 points. The total score ranges from 61 to 305, with higher scores indicating a higher level of self-directed learning ability among the radiology interns.

2.4.3 Teaching Satisfaction

The "Teaching Satisfaction Rating Scale" was used to evaluate the job competency of two groups of radiology interns. The questionnaire consists of five dimensions: satisfaction with the teaching plan, teaching methods, teaching environment, teaching content, and teaching duration. Each dimension is rated using a 5-point Likert scale, with scores ranging from 1 to 5 points. The total score ranges from 5 to 25, with higher scores indicating greater teaching satisfaction among the radiology interns.

2.4.4 End-of-Rotation Exam Scores

After the completion of the training, theoretical knowledge and practical skills assessments were conducted for both groups of radiology interns, and their exam scores were compared.

2.5 Statistical analysis

Statistical analysis was performed using SPSS 29.0. Categorical data were expressed as $n(\%)$, and continuous data following a normal distribution were presented as mean $\pm$ standard deviation ($\bar{x} \pm s$). Non-normally distributed data were expressed as median (interquartile range). For intergroup comparisons, an independent samples t-test was used for normally distributed data, while non-normally distributed data were compared using non-parametric tests.

3 Results

3.1 Job competency scores of the two groups of radiology interns

The job competency scores of the radiology interns in the experimental group were significantly higher than those in the control group, with the difference being statistically significant ($P < 0.05$), as shown in Table 1.

Table 1 Job competency scores of the two groups of radiology interns

Group	Experimental group	Control group	Z	P
Professional knowledge	18(17~18)	12.5(11~13)	-6.789	<0.001
Professional skills	18(17~18)	13(11~13)	-6.718	<0.001
Professional competence	18(17~18)	12.5(11~13)	-6.755	<0.001
Comprehensive qualities	18(17.75~18)	13(12~14)	-6.778	<0.001
Total score	71(69.75~72.25)	49.5(47~51)	-6.675	<0.001

3.2 Self-directed learning ability scores of the two groups of radiology interns

The self-directed learning ability scores of the radiology interns in the experimental group were significantly higher than those in the control group, with the difference being statistically significant ($P < 0.05$), as shown in Table 2.

Table 2 Self-directed learning ability scores of the two groups of radiology interns

Group	Experimental group	Control group	Z	P
Learning awareness	56.5(55.75~57)	46.5(35.75~50)	-6.676	<0.001
Learning strategies	113(111~114)	68.5(61~74.25)	-6.666	<0.001
Learning evaluation	56(55~57.25)	42(28.75~48.5)	-6.567	<0.001
Interpersonal skills	62(60~63.25)	49(33.25~54)	-6.652	<0.001
Total score	285.5(283~290)	207(151~223.5)	-6.657	<0.001

3.3 Teaching satisfaction scores of the two groups of radiology interns

The teaching satisfaction scores and end-of-rotation exam scores of the radiology interns in the experimental group were significantly higher than those in the control group, with the differences being statistically significant ($P < 0.05$), as

shown in Table 3.

Table 3 Teaching satisfaction scores of the two groups of radiology interns

Group	Experimental group	Control group	Z/t	P
Teaching plan	5(5~5)	3(3~4)	-6.893	<0.001
Teaching methods	5(4~5)	3(3~4)	-6.387	<0.001
Teaching environment	5(4~5)	3(3~3)	-6.630	<0.001
Teaching content	5(5~5)	3(3~3)	-6.895	<0.001
Teaching duration	5(5~5)	3(3~3)	-7.019	<0.001
Total score	24(23~25)	16(15~16)	-6.742	<0.001
End-of-rotation exam scores	90.870±2.596	86.230±3.730	5.585	<0.001

4 Ethics approval and consent to participate

All methods were carried out in accordance with relevant guidelines and regulations. The experimental protocols have been approved by the Ethics Committee of the People's Hospital of Deyang City. Written informed consent was obtained from all participants in accordance with the Declaration of Helsinki.

5 Discussion

Medical imaging, as an interdisciplinary field integrating knowledge from multiple disciplines, plays an irreplaceable role in clinical medicine. It not only provides clinicians with detailed anatomical, pathological, and physiological information about diseases but also closely integrates with clinical practice through in-depth and precise imaging research^[8]. For medical students, mastering a wide range of knowledge and skills during the internship stage is essential for laying a solid foundation for future clinical work. The core concept of traditional teaching models is to "transfer" knowledge from teachers to students, with students passively receiving and storing this information. However, this approach often fails to stimulate students' interest and enthusiasm for learning, leaving them in a passive state and lacking a deep understanding of and ability to apply the knowledge^[9-10]. In this context, Small Private Online Courses (SPOCs) have emerged as a new teaching model. This model makes full use of current internet information technologies, combining different teaching objectives, content, and learner characteristics with high-quality courses, teaching resources, and a variety of in-person activities. It promotes blended and participatory learning, facilitates effective classroom "flipping," and reconstructs the teaching process and structure. In doing so, it enhances teaching quality and optimizes the comprehensive training of interns throughout their entire learning lifecycle, achieving more with less effort^[11].

The results of this study show that after implementing the SPOC-based blended teaching model, the experimental group exhibited significantly higher job competency, self-directed learning ability, teaching satisfaction, and post-rotation exam scores compared to the control group. This is consistent with the findings of Xiao-jun Gong et al.^[12] indicating that applying a SPOC-based blended teaching model combined with full lifecycle training in the imaging internship process can significantly enhance the job competency of imaging interns. Simultaneously, it also strengthens their self-directed learning abilities and improves teaching satisfaction. The underlying reason is that the SPOC-based blended teaching model organically integrates online short video instruction with offline classroom activities, embedding this approach throughout the entire lifecycle of imaging internship training. Short video instruction serves as the primary channel for students to acquire knowledge, while offline classrooms complement the online content. By incorporating diverse teaching activities, such as flipped classrooms, literature discussions, and topic-specific seminars, this teaching model maximizes the active role of students, enhancing their motivation and initiative in learning.

6 Conclusion

In conclusion, the implementation of a SPOC-based blended teaching model combined with full lifecycle training in the clinical teaching of imaging interns can effectively improve interns' job competency, enhance their self-directed learning ability, and increase teaching satisfaction. This teaching model not only fosters the development of students' comprehensive abilities but also contributes positively to the development of the teaching faculty.

Limitations: First, the sample size included in this study is small. By increasing the sample size, the conclusions can become more reliable. The subjects of this study are primarily interns majoring in imaging, and it is not yet clear whether the conclusions of the study are applicable to interns from other majors.

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