

Effects of blended versus offline case-centered learning on academic performance and critical thinking ability among undergraduate nursing students—a cluster randomized controlled trial

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Abstract

Background: Educational reform, especially methods of teaching, has been a focus among nursing educators. This study explored the impact of blended versus offline case-centered learning on academic performance of Medical Nursing and the development of critical thinking among undergraduate nursing students. Methods: A cluster randomized controlled study design was used, with assessments immediately before and one school year after the intervention. There were two classes for second-year undergraduate nursing students enrolled in the study. The two classes of Medical Nursing were randomly allocated to either the experimental class, which undertook blended case-centered learning, or the control class, which undertook offline case-centered learning. The primary outcomes were academic performance consisting of final exam and process assessment, as well as the critical thinking ability assessed with the Critical Thinking Disposition Inventory-Chinese Version (CTDI-CV). The Mann-Whitney U test and the unpaired t test was subsequently used. ANCOVA analyses were also performed to examine the two teaching methods' effect on critical thinking. Results: The median score in the Medical Nursing course was slightly higher in the experimental class than in the control class after 1 academic year, although was no significant difference in statistics. In addition, compared with the control class, the pre-post difference in competency in critical thinking self-confidence in the experimental class was significantly greater. In the experimental class, there was significant improvement compared with baseline in dimension of critical thinking self-confidence ($p < 0.05$). In the control class, there was significant improvement compared with baseline in the total score ($p < 0.05$) and two of the seven dimensions: truth-seeking ($p < 0.05$) and systematicity ($p < 0.05$). Conclusions: Our study confirms the effectiveness of blended and offline learning (both based on case-centered learning) for academic performance and components of critical thinking among undergraduate nursing students. Blended and offline case-centered learning could be applied to other nursing subjects in future studies. Moreover, further efforts to improve teaching are warranted. Keywords: education, nursing, teaching methods, critical thinking

Background

Nursing educational reform is needed to increase the quality of teaching

With the development of the social economy and the transition to the modern medical model and concept of health, developing comprehensive high-quality skills among nursing personnel is increasingly important. However, nowadays, much of nursing pedagogy relies on a traditional didactic approach that focuses on passive lecture-based delivery of content, leaving the students as passive participants who largely only take notes. Using this method, students do not have the opportunity to engage in contemplation, which is necessary during the learning process. In order to provide effective and efficient education for nursing students, calls to change traditional educational strategies are of increasing importance.

The goals of university nursing education are to teach theoretical knowledge, as well as develop the ability of students to critically analyze evidence [1]. Critical thinking is an important component of

nursing education and integral to the discipline of nursing [2, 3]. Critical thinking is an essential professional development core skill in nursing education and practice [4]. Worldwide, there is a need for nursing education to assist students in developing critical thinking, clinical reasoning, and clinical judgment skills [5]. Educational reform, especially regarding methods of teaching, has been a focus among nursing educators.

Case-based learning and the flipped classroom are feasible in nursing curricula

Active learning strategies applied to nursing education can enhance students' understanding, stimulate inquiry, and encourage critical thinking [6]. To best attract students and promote learning, there has been a shift toward student-centered learning and engagement of students as active learners. Case-based learning (CBL) is an instructional method within the context of student-centered learning for facilitating learning through the use of case studies [7]. It is a long-established pedagogical method that is defined in a number of ways depending on the discipline and type of "case" employed [8]. McLean's definition of CBL is "an inquiry structured learning utilizing live or simulated patient cases to solve, or examine a clinical problem, with the guidance of a teacher and stated learning objectives" [9]. In nursing education, CBL can be applied to preparing students for clinical practice through the use of authentic clinical cases [10, 11] and increase their capacity to ask questions, reflect, and deal with problems [12, 13]. Previous research has indicated that CBL is a more effective technique than traditional didactic lectures for improving communication skills, problem-solving ability, and motivation in undergraduate nursing students [14, 15]. In addition, the advantages of using CBL include increased focus on learning objectives, flexibility in the use of the cases, opportunity for the teacher to have more input toward the direction of learning, and enabling deeper learning. Owing to these benefits, CBL is likely to become part of numerous curricula for medical and health professional courses [9].

In addition to CBL, flipped classroom pedagogy has attracted the attention of educators and has been widely implemented and studied in many disciplines, including nursing [16-19]. Some studies have found that the strategy of flipped classroom in nursing education presents certain advantages over traditional lecture-based learning in terms of improving students' examination scores, grades and satisfaction [20, 21]. Conversely, some studies showed the flipped classroom not to be superior to traditional models with respect to student examination scores and satisfaction [22, 23]. A meta-analysis on the effects of the flipped classroom model among Chinese baccalaureate nursing students showed that flipped classrooms are more effective than traditional lectures at improving students' theoretical knowledge and skills [24].

Blended approaches have become more prevalent in the information age

Nowadays, technological advancements are rapidly changing nursing education in higher education settings. This has led to a push toward flexible delivery, online delivery, and blended learning. Blended learning refers to an educational approach that combines traditional classroom-based face-to-face teaching methods with online materials and activities [25]. Garrison and Kanuka, early promoters of the blended learning approach, have highlighted several advantages of blended learning [26]. They describe

blended learning as having the potential to transform the educational landscape by giving students more responsibility, control, and independence, while also increasing their capacities for critical and reflective thinking.

Blended learning is considered crucial for the education of today's health students [27]. In recent years, blended learning has been used in nursing and medicine, and many studies have been conducted in this area [28-32]. However, the implementation of blended learning in nursing education remains controversial. Some investigations have shown that blended learning is favored by undergraduate nursing students, facilitates communication and active learning, and enhances self-efficacy regarding communication skills [33-35]. On the other hand, one study did not find a direct impact on knowledge acquisition or self-learning readiness [31]. Another study did not show differences regarding overall satisfaction with the teaching received [28]. Hence, there is concern regarding the outcomes associated with this method.

Although blended learning has been extensively used, there is limited knowledge regarding the effective application of blended learning based on CBL in nursing curricula to support critical thinking [34, 36]. Therefore, the main objective of this study was to compare blended and offline learning (both based on case-centered learning) on academic performance and the development of critical thinking among undergraduate nursing students.

Methods

Design

This study used a cluster randomized controlled study design with pretest and posttest assessments undertaken immediately before the intervention and 1 school year after the intervention, respectively.

Samples and setting

The study population comprised two classes of second-year undergraduate nursing students with the average age of (19.95±0.81) starting the Medical Nursing course in the fourth semester at the Nursing School of Fujian Medical University (Fuzhou, China).

The students were randomly assigned by Zhengfang software (Zhengfang Corp., West Lake District, Hangzhou, China) to two classes when they entered the university. Class 1 had 164 students (141 females and 23 males) with eight groups, while Class 2 had 131 students (119 females and 12 males) with seven groups. Each group consisted of approximately 20 students. Thus, the randomization in this study occurred at the class level. An administrator employed by the university, who had no information regarding the recruitment or data collection, conducted the random allocation. Two labels (numbered 1 and 2) were placed in opaque envelopes, and the administrator then requested one of the Medical Nursing teacher to selected one envelope at random. As "number 1" was selected, class 1 was to be the experimental class while class 2 was to be the control class.

Prior to starting the Medical Nursing course, 295 students completed the CTDI-CV questionnaire. However, in the second semester, 22 students changed their major to Midwifery, three students changed their major to Public Health, and one student discontinued the course. Consequently, at the end of the Medical Nursing course, 269 students met the inclusion criteria (151 and 118 students, respectively) (Figure 1).

Intervention

The main features of undergraduate nursing curricula in Fujian Medical University are shown in an additional file [Additional file 1: Table S1].

Teaching arrangements

The Medical Nursing course was conducted for 1 academic year, in the fourth and fifth semesters, and it involved 144 teaching hours and 8 credits, which is the highest number of credits of all undergraduate nursing courses.

The learning objectives of the Medical Nursing course are: (i) to master the theoretical knowledge of this course; (ii) to improve students' capability regarding holistic nursing; (iii) to equip students with the ability to analyze and solve problems as well as the ability of clinical reasoning and critical thinking; (iv) to cultivate nursing students' professional ethics. Twelve teachers took part in teaching Medical Nursing. All of them underwent the same training regarding the specific processes of blended learning and offline case-centered learning. In addition, collective lesson preparation (involving all the teachers) was conducted before teaching each chapter in order to guarantee high-quality teaching.

The study was conducted between September 2018 and July 2019. The same teachers, textbook, and references were provided to both groups. The experimental class underwent blended case-centered learning including online and offline learning, whereas the control class totally underwent offline case-centered learning (Table 1). Notably, whether in lectures, flipped classrooms, or seminars, the teaching method involved case-based learning. Although blinding of the students and teachers was not possible, the data analyst was blinded.

Experimental class

Apart from traditional face-to-face lectures in class, there were three stages in the implementation of the blended case-centered learning, comprising before, in, and after each flipped classroom (Figure 2).

Before the flipped classroom, all students were required to log in the Chaoxing platform (<http://i.mooc.chaoxing.com/space/index.shtml>) to watch the pre-recorded lecture videos and access the online forums and study materials. Besides, group cases study was also required and necessary. Students subsequently divided into subgroups (approximately five students per subgroup) to discuss the cases and the questions that the teacher provided prior to the class, recording the whole process of their discussion and producing a report. Each flipped classroom involved one group, with approximately 20 students, and they were divided into four subgroups based on the pre-class group discussions. To assess

the students' mastery of the lesson prior to class, online quizzes, which lasted approximately 10 minutes, were performed at the beginning of the flipped classroom. Subsequently, the teacher provided detailed explanations of the quiz questions according to the students' results, then the students reported what they had discussed prior to class. Next, other classmates provided supplementary answers and questions. The teacher commented on each report, summarized and guided the students to think and discuss. After the flipped classroom, the students were requested to submit homework to the platform, raise questions in the online forums or review teaching videos. All study data were recorded via the platform and could be accessed by the teachers.

Control class

The control class underwent offline case-centered learning via traditional face-to-face lectures and seminars throughout the two semesters (Figure 3). Before the seminar, the students were required to preview the textbook. Each seminar involved one group, with approximately 20 students. During each seminar, students formed subgroups to discuss the cases under the guidance of the teacher. Subsequently, the teacher randomly selected subgroups to answer questions. Comments and explanations were provided by the teacher according to the answers. Additionally, the teacher guided the students to think, discuss, and summarize the knowledge points of the class. When class was almost over, a quiz was conducted to monitor the students' mastery of the lesson. After the seminar, the students were required to finish the homework and summarize the key knowledge points and then submit the learning notes.

Measurements

Academic performance

The Medical Nursing assessment contains two parts, the final exam and the process assessment. The maximum total score for the course was 100. The total score was determined using the weights (Table 1).

The final exam was conducted one week after the course was finished. The total score of the final exam is 100, it consists of 50 multiple choice (50%), 5 explanation of nouns (15%), 3 short answer questions (15%), and 1 case analysis questions (20%). The examination questions are taken from the question bank of Medical Nursing and then reviewed by two teachers. The content validity of the examination questions was 0.9, and the average difficulty and discrimination of this paper is about 0.6 and 0.5, respectively.

The process assessment included the quizzes, online learning progress (for experimental class) or offline learning notes (for control class), performance and homework. There were 29 quizzes in total and each quiz comprised ten multiple option questions for each flipped classroom or each seminar. Online learning progress or offline learning notes were recorded in the learning platform. Students' performance was

assessed according to their answers in class. The homework consisted of two experiment reports. The average difficulty of the quiz and homework is 0.7 and 0.5, respectively.

Assessment of the critical thinking ability of students

The California Critical Thinking Disposition Inventory (CTDI) has been specifically developed and used for nursing students [37]. It has been shown to be a valid instrument for assessing critical thinking ability among nursing students in different cultural contexts [38]. The population included in the present study consisted of Chinese students. Hence, the CTDI-Chinese Version (CTDI-CV), which was translated, modified, and validated by Chinese researchers, was more suitable than the original [39]. The CTDI-CV exhibits a good overall content validity index (0.89) and Cronbach's alpha (0.90), indicating satisfactory content validity and internal consistency, respectively [39].

The CCTDI measures overall critical thinking disposition. There are 70 items in total, and it consists of seven subscales that measure the following dispositions: truth-seeking, open-mindedness, analyticity, systematicity, critical thinking self-confidence, inquisitiveness, and cognitive maturity. Items are scored with a 6-point Likert scale: 1= strongly disagree to 6= strongly agree, with a maximum total score of 420. The internal reliability coefficients (Cronbach's alpha) in our study were 0.86 (pretest) and 0.87 (posttest), and the values for the subscales ranged from 0.73 to 0.82.

Ethical considerations

Approval was obtained from the Research Ethics Committee of Fujian Medical University. The participants were informed that they had the right not to participate and could withdraw from the study at any time. Written informed consent was obtained from all students who agreed to participate in the study. We informed the participants of the purpose, content, and extent of the study, and guaranteed that their responses were confidential.

Data collection procedure

The students in the two classes completed the questionnaire prior to and following the teaching experiment. The data collection procedure was explained to all participants, and information regarding the estimated time and number of contacts with participants was provided. Students who agreed to participate in the study were asked to provide demographic data and outcome data (critical thinking assessment) in a pretest assessment conducted during the meeting in which they were enrolled in the study. Outcome variables were measured again 1 school year after the intervention, as a posttest assessment. Additionally, we collected the final course grades of the participants. The data collection procedure primarily relied on a descriptive, noninvasive questionnaire on each student's demographic characteristics and critical thinking ability.

Data analysis

All statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS), version 22.0 (IBM Corp., Armonk, NY, USA). Mean and standard deviation were used to represent the normally distributed continuous data, while median (M) and quartiles (P_{25} - P_{75}) were used to represent the non-normally distributed continuous data. A Shapiro-Wilk test was first performed to verify the normal distribution of the academic performance data, and the Mann-Whitney U test was subsequently used. We used the two-tailed approach for the unpaired t test. In addition, ANCOVA analyses that were controlled for pretest scores as confounders were performed to examine the effect on critical thinking. The significance level was set at $p \leq 0.05$.

Results

Academic performance of participants

Prior to the initiation of the Medical Nursing course, the students in the control class were significantly superior to those in the experimental class in terms of academic performance regarding the seven Professional Basic courses ($p < 0.05$, Table 2). After the 1-year Medical Nursing course, there was no significant difference in the academic performance between the two classes (median (P_{25} - P_{75}) scores of 81 (77-85) and 80 (76-84) in the experimental and control classes, respectively; $p = 0.112$).

Critical thinking ability of participants

Compared with the control class, the pre-post difference in competency in critical thinking self-confidence in the experimental class was significantly greater ($p = 0.037$). There were no significant differences in other variables related to critical thinking ability between the two classes, either prior to or after the course. In the experimental class, the score of the critical thinking self-confidence dimension was significantly improved while in the control class, there were significant improvements in the total CTDI-CV score and two of the seven dimensions: truth-seeking and systematicity (Table 3).

Discussion

Effect on academic performance

In this study, both the experimental and control classes with the blended case-centered learning and offline case-centered learning had excellent academic performance, particularly the experimental class.

The majority of previous studies have compared blended learning with traditional didactic teaching, and the effect of blended learning on academic performance remains controversial. Some researchers found a significant increase in the academic performance of students taught using blended learning [40]. In contrast, other researchers reported no significant increase in academic performance [41]. This may be partly explained by the difference in the design of the course and the inconsistency in the use of instruments to assess student performance. In our study, the more carefully teaching design and the more comprehensive assessment were adopted on student learning outcomes.

Effect on critical thinking ability

As shown in Table 3, there was significant difference in critical thinking self-confidence in the experimental class, compared with the control class. And no significant differences were found in other variables related to critical thinking ability between the two classes, either prior to or after the course. However, both of the two classes slightly improved the critical thinking ability. These results are consistent with those of other studies conducted among nursing students, showing improvements in critical thinking skills based on effective teaching methods [36, 37, 42, 43]. Notably, blended case-centered learning focused on the subject status of the students, and provided the students with opportunities to express themselves in class. Students who expressed their ideas in the process of learning and discussion gained recognition from teachers and classmates, thereby enhancing their confidence and increasing their willingness to express themselves in subsequent classes. It is difficult to increase students' overall critical thinking ability in a relatively short period of time because Chinese basic education system from primary to high school was exam oriented in the past decades, which leads to students paying a lot of attention to exam skills but ignores the cultivation of creativity, critical thinking, etc.

In this study, offline case-centered learning led to improvements in two CTDI-CV dimensions of truth-seeking and systematicity. Offline case-centered learning focused on holistic learning with 74 teaching hours in teacher-lead lectures and 44 teaching hours for group seminars. In the group seminars, the discussion was under the teachers' guidance, thus, students can discuss more deeply and systematic. Thus, the systematicity of students was improved by the offline case-centered learning. A previous study supported the use of scientific discussions as beneficial educational tools to develop critical thinking [44]. Further studies should assess the discussion strategies used in blended learning.

In summary, the findings of our study imply that blended and offline case-centered learning both have potential for promoting students' academic performance and critical thinking. Optimization of the teaching design in future studies is vital to explore the effects of blended learning among undergraduate nursing students.

Limitation

There were certain limitations in this study. First, the study was conducted for only two semesters in one subject, which may limit the validity and reliability of the findings regarding the promotion of critical thinking. Thus, studies assessing the effectiveness of blended learning in other nursing subjects are necessary. Secondly, we did not interview students regarding their feelings and experiences. Therefore, qualitative research is also warranted. Moreover, it would be useful to follow up the students in this study by evaluating their performance in clinical practice.

Conclusions

The results confirmed the effectiveness of two teaching models for Medical Nursing on undergraduate nursing student. In the future, blended and offline case-centered learning could be implemented in other nursing subjects.

Abbreviations

CTDI-CV: Critical Thinking Disposition Inventory-Chinese Version; CBL: case-based learning; ANOVA: Analysis of variance

Declarations

Ethics approval and consent to participate

Ethical approval was granted by the Education Department of Fujian Medical University (reference number: +86-0591-22862100). Students were informed regarding the study and signed consent forms.

Consent for publication

Not applicable

Availability of data and materials

The dataset used during the study is available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

RH organized the data collection and wrote the application for ethical approval. All authors made substantial contributions to the design of teaching. All authors contributed to data analysis and the drafting and reviewing of the manuscript. All authors approved the final manuscript for submission and have agreed to be accountable for the accuracy and integrity of the work.

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Tables

Table 1 Teaching strategies and evaluation for Medical Nursing between two classes

	Experimental class	Control class
ing	Blended case-centered learning	Case-centered learning
s		
ing	1. Online learning and group case	
gies	study(43h)	1. Face to face lectures in class(74h)
ing	2. Face to face lectures in class(26h)	
)	3. Offline flipped classroom(49h)	2. Seminar in groups(44h)
	4. Laboratory teaching(11h)	3. Laboratory teaching(11h)
	5. Clinical practice(15h)	4. Clinical practice(15h)
ation	1. Academic performance	1. Academic performance
	(1) Final exam, 50%	(1) Final exam, 50%
	(2) Process assessment, 50%	(2) Process assessment, 50%
	a. Quiz in the flipped classrooms, 20%;	a. Quiz in seminars, 20%;
	b. Online learning progress requirements, 15%;	b. Offline learning notes, 15%;
	c. Performance in the flipped classrooms, 10%	c. Performance in seminars, 10%
	d. Homework, 5%	d. Homework, 5%
	2. Critical Thinking Disposition Inventory-Chinese Version	2. Critical Thinking Disposition Inventory-Chinese Version

*One teaching hour equal to 40 minutes

Table 2 Comparison of academic performance in the Professional Basic courses in the previous academic year

	Experimental group (n=151)		Control group (n=118)		z/t value	P value
	Median(P ₂₅ -P ₇₅)	Mean ± SD	Median(P ₂₅ -P ₇₅)	Mean ± SD		
	66 (60-72)	64.83±10.03	70.5 (63-78)	70.38±9.84	3.878	<0.001
	67 (61-72)	66.87±8.43	71 (65-77)	71.36±8.30	3.944	<0.001
into	64 (61-68)	64.58±5.82	65 (62-70)	66.20±5.86	2.342	0.019
	70 (65-75)	69.77±8.42	75.5 (68-82)	75.07±9.07	-5.008*	<0.001
ology	70 (65-76)	70.13±8.23	73 (68-78)	72.69±9.26	2.694	0.007
	71 (64-77)	69.59±9.96	75 (68-81)	73.79±10.14	3.248	0.001
	74 (70-78)	73.57±6.71	78 (74-83)	77.25±7.11	4.607	<0.001

*correspond to t value

Table 3 Values of the variables measured before and after the intervention: between both classes and intra-class variability

dependent variable	Experimental class Mean ± SD	Control class Mean ± SD	F	P value (inter-class)
Critical Thinking (Total)				
Pretest(covariate)	273.54±18.36	273.73±18.83	0.006	0.937
Posttest	276.17±23.00	279.30±19.24	1.625	0.203
F	1.352	4.821		
P value (intra-class)	0.245	0.029		
Math-seeking				
Pretest(covariate)	36.89±4.27	36.51±4.27	0.489	0.484
Posttest	37.23±5.68	37.82±3.81	1.495	0.222
F	0.433	5.836		
P value (intra-class)	0.511	0.016		
Open-mindedness				
Pretest(covariate)	40.25±0.33	40.81±0.36	1.307	0.253
Posttest	40.61±0.34	41.14±0.38	1.096	0.296
F	0.581	0.403		
P value (intra-class)	0.446	0.526		
Analyticity				
Pretest(covariate)	40.63±0.31	40.91±0.34	0.361	0.548
Posttest	41.05±0.32	41.77±0.36	2.265	0.133
F	0.876	3.007		
P value (intra-class)	0.350	0.083		
Systematicity				
Pretest(covariate)	37.03±0.29	36.94±0.32	0.038	0.845
Posttest	37.72±0.30	38.26±0.34*	1.444	0.230
F	2.791	8.014		
P value (intra-class)	0.095	0.005		
Critical thinking self-confidence				
Pretest(covariate)				
Posttest	37.42±0.32	36.89±0.36	1.238	0.266
F	38.48±0.33	37.43±0.38	4.358	0.037
F	5.507	1.119		
P value (intra-class)	0.022	0.291		
Inquisitiveness				
Pretest(covariate)	41.65±0.34	41.85±0.38	0.147	0.702
Posttest	41.60±0.36	42.23±0.40	1.381	0.240
F	0.012	0.471		
P value (intra-class)	0.913	0.493		
Cognitive maturity				
Pretest(covariate)	39.67±0.36	39.82±0.40	0.077	0.782
Posttest	39.48±0.37	40.53±0.42	3.517	0.061
F	0.129	1.536		
P value (intra-class)	0.719	0.216		

Additional File Legends

Additional file 1: Table S1. The main features of undergraduate nursing curricula in Fujian Medical University in China

Figures

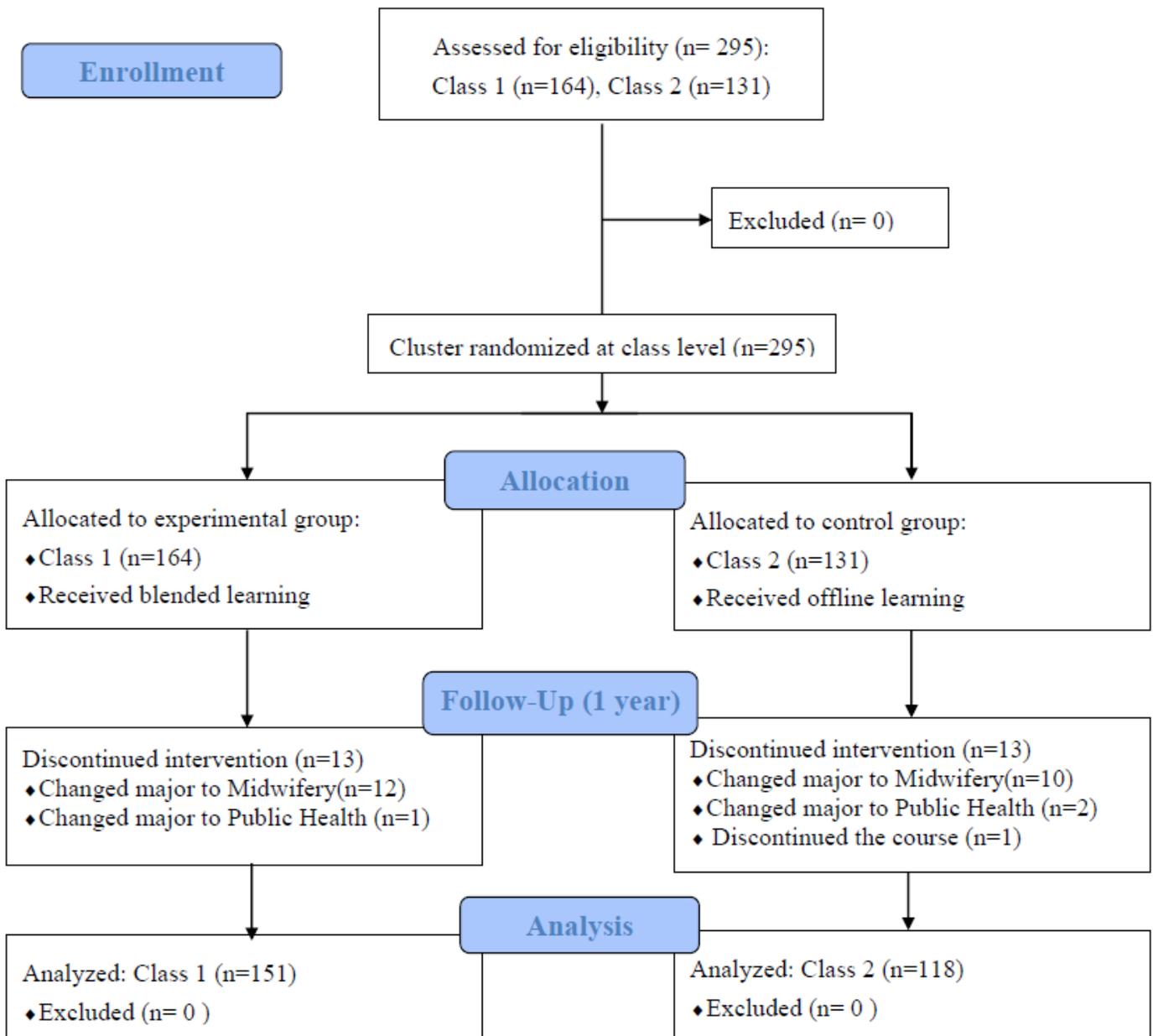


Figure 1

Participants flow diagram

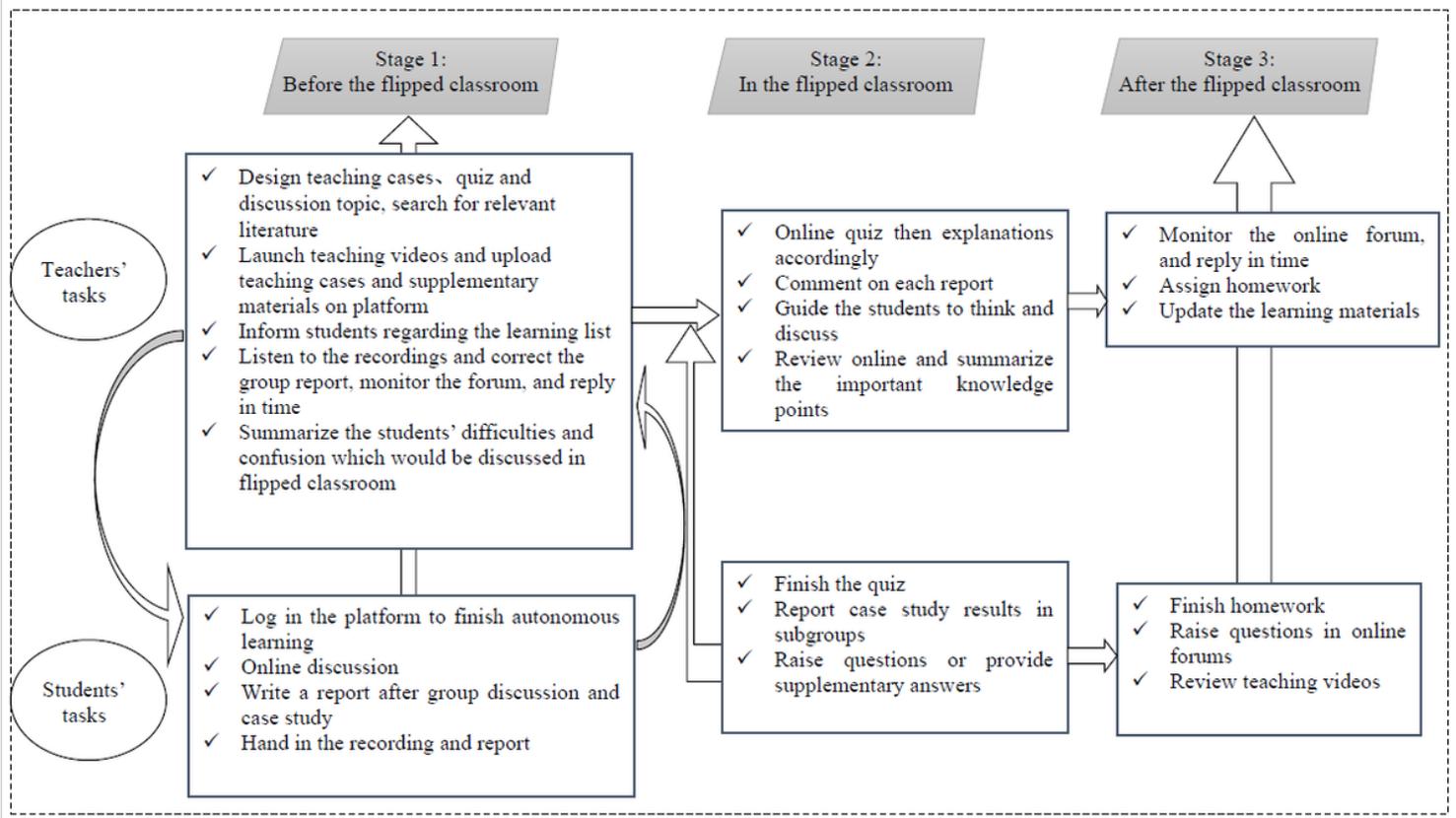


Figure 2

Blended case-centered learning in the experimental group

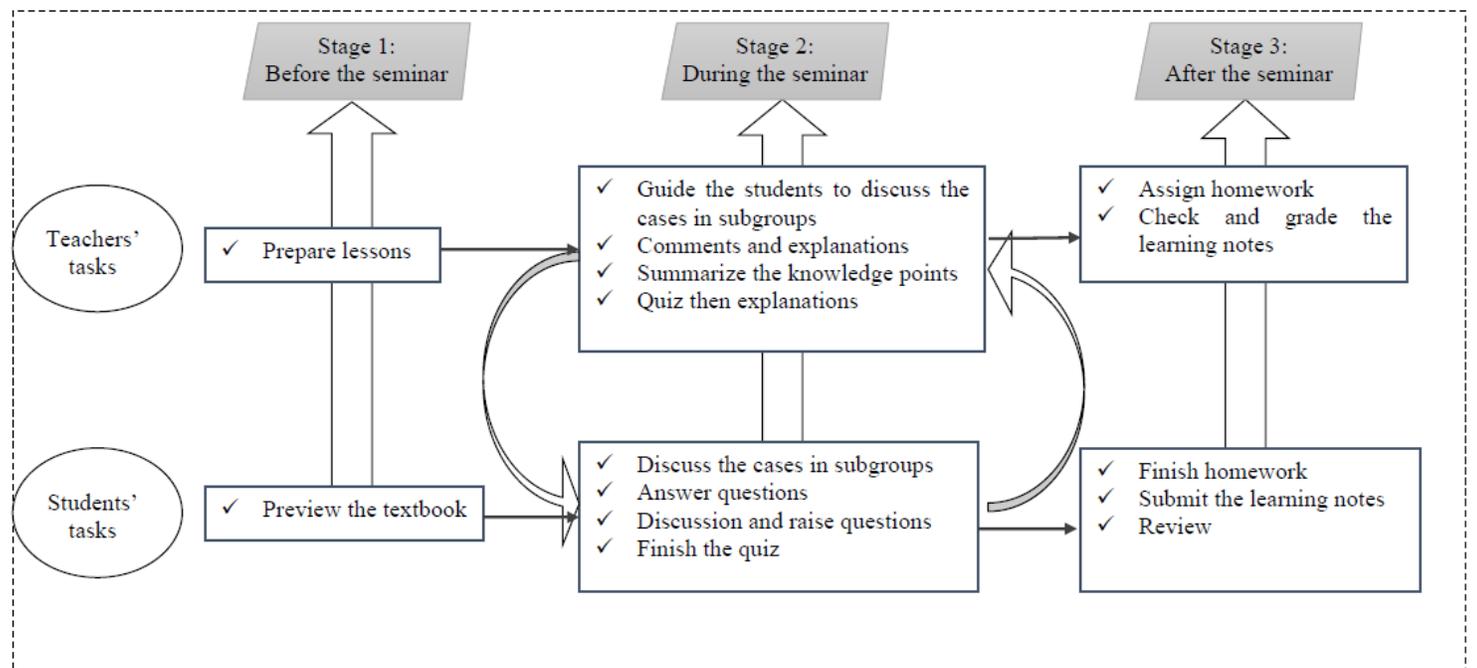


Figure 3

Offline case-centered learning in the control group

Supplementary Files

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- [2019.11.21AdditionalFile.docx](#)