



Case Report

Flipped Classroom, Problem-Based Basic Surgical Skills Training in Chinese Military Medical University

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Equally contributed to the study

Abstract

Background: “Duck-stuffing” teaching mode has been quite popular in Chinese medical education for years. It may be a practicable training method to cultivate a physician, but far from satisfactory among the will-be surgeons, especially in military medical graduates. We introduced flipped classroom and problem-based surgical skills training program, two of the world’s most popular training methods, into our university, trying to improve our medical students’ study initiative and capacities in solving surgical problems.

Methods: We randomly chose 128 5th grade students of our university, and divided them into two groups: FC group (n=64, receiving new training methods) and control group (n=64, receiving conventional training methods). Examinations were held to evaluate the abilities of the students’ surgical skills. A visual analog scale was used to conduct self-appraisal and Oxford NOTECHS was used to evaluate the team spirit.

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Results: The examination scores were significantly higher in FC group ($p < 0.001$), and students’ independent learning abilities ($p < 0.001$), confidence ($p < 0.001$), efficiency ($p < 0.001$) and teamwork ($p < 0.001$) in FC group showed similar trends. Scores of Oxford NOTECHS indicated a higher team spirit in the new training method ($p = 0.0001$).

Conclusions: Flipped classroom and PBL training method via WeChat Platform changes the relationship between teachers and students, and both technique and non-technique skills of the students were considerably improved. Further researches will be focused on the learning pace control and after-class supervision method to achieve optimal training effects.

Keywords: Flipped classroom; Problem-based learning; Surgical skills; Training

Introduction

Rapid changes are taking place in military rescue missions and related concepts and science and technologies around the world. These changes, such as the increase of catastrophic events, the growing number of regional wars, the changes of combat casualty patterns, the needs of medical and health care, etc., make huge challenges and developments in Chinese military medical education.

In the history of medical education in China, “Duck-stuffing” training mode played an important role that made medical students store theoretic knowledge in their minds and pass the written exams. It may be a practicable training method to cultivate a physician, but far from satisfactory among the will-be surgeons, for the lack of surgical skills, especially in military medical university. It is common that many medical graduates, even those with high scores, often do poorly in clinical practice. To revamp the medical educational systems, the Ministry of Health of China has launched new training programs for medical graduates such as standardized residency programs since 2003 and standardized specialists programs since 2010 [1,2]. However, these programs focus only on medical graduates, which is more like a remedy for the current medical education in China.

Therefore, in order to enhance training quality and effect as well as to improve medical undergraduates’ learning abilities, we were launching a new training program in our university [3], which flipped classroom and problem-based learning, two of the world’s most popular training methods, via WeChat Platform was introduced into, thus trying to develop an advanced training method in Chinese military medical university.

Methods

Training objects selection

128 5th grade students of our university were engaged and divided into two groups randomly in the study: FC group (n=64) and control group (n=64). Students in FC group were taught by flipped classroom method, while those in control group received conventional education.

Training methods

Flipped classroom, Problem-based training method

Videos are made by teachers before class based on the syllabus of different courses and the average learning ability of the class. Multimedia technologies are used in those videos, which consist of mini-lectures with PowerPoint presentations and surgical procedure demonstrations. In the purpose of highlighting the key points, several questions will be raised at the beginning of each video. Students will receive those videos via WeChat platform one week prior to the class, and learn independently by videos before class. In the process of preparation, students can refer to relevant papers online and discuss with their classmates in WeChat groups, thus trying to answer the questions in videos and to summarize the FAQs in learning. Teachers are always available in WeChat platform for communication and interaction.

In the didactic phase, workshops will be held in class by teachers to solve the questions that students have asked in We Chat platform, instead of a content-deliver. Meanwhile, key points and considerations of different surgical skills will be focused in classes, by introducing clinical cases and simulating clinical scenarios. Most of the class time will be provided to the students, who have already been divided into several 8-person groups so that they can do more practices under the guidance of teachers.

Traditional training method

Lectures based on the syllabus will be uploaded by teachers to the WeChat platform one week prior to the class, while students should preview relevant contents. Didactic lecture, demonstration, and practice are the main steps of the traditional training model. Likewise, students will study in 8-person groups, with the individualized instruction of the teachers.

Curriculum contents

The training includes two phases including didactic and practice. In the didactic phase, theories of head and neck trauma, thoracic trauma, abdominal trauma, limb fracture and shock resuscitation, etc will be delivered to the students. Students will be able to perform section, suture, knotting, hemostasis, bandaging, immobilization, thyrocricocentesis, closed drainage of pneumothorax, exploratory laparotomy, exploratory thoracotomy, splenectomy, intraosseous infusion, electrocardiogram monitoring on beagles in practice phase.

According to the teaching arrangement, students will conduct basic surgical skills training for 30 weeks (three 4-hour classes per week, totaling 360 hours). Among them, theoretical learning is divided into two parts: didactic phase and pre-practice review. The didactic phase will last two weeks (six 4-hour courses, totaling 24 hours). After didactic phase, we will carry out practical operations (using beagles as experimental animals). Before each practical operation, we will review the theory of this operation for about 30 minutes.

Evaluation

In-class real-time examinations and theoretical examination held at the end of the course were used to evaluate the students' abilities and the effects of flipped classroom training method. The scores of students were divided into 4 levels, which are Excellent (A), Good (B), Moderate (C) and Poor (D). After the course, teachers and students would be asked to fill the Visual Analogue Scale (VAS) questionnaires (Table 1) anonymously to evaluate the effects of flipped

classroom training method on improving self-learning ability, increasing interest in learning, developing problem-identifying and -solving ability, cultivating team spirit, improving theoretical level and surgical skills. 0~3-point represented "Helpless" and 8~10-point represented "Helpful", while 4~7-point meant "Just-so-so". We also used Oxford NOTECHS, an operating-theater team non-technical skills scoring system, to assess students' teamwork behavior (Table 2).

Introductions:												
1. Students should give scores to items 1~3.												
2. Teachers should give scores to items 4~5.												
3. Please circle the number corresponding to the each direct perception.												
4. 0~10 points represent weakest to strongest, respectively.												
5. Any signatures or symbols SHOULD NOT be added on the questionnaire.												
Items		Points										
1	Interest in learning	0	1	2	3	4	5	6	7	8	9	10
2	Capacity in active learning	0	1	2	3	4	5	6	7	8	9	10
3	Confidence in surgeries	0	1	2	3	4	5	6	7	8	9	10
4	Understandability	0	1	2	3	4	5	6	7	8	9	10
5	Teamwork	0	1	2	3	4	5	6	7	8	9	10

Table 1: Visual Analogue Scale (VAS) questionnaires.

Leadership and management	
Leadership	Involves/reflects on suggestions/visible/accessible/inspires/motivates/coaches
Maintenance of standards	Subscribes to standards/monitors compliance to standards/intervenes if deviation/deviates with team approval/demonstrates desire to achieve high standards
Planning and preparation	Team participation in planning/plan is shared/understanding confirmed/projects/changes in consultation
Workload management	Distributes tasks/monitors/reviews/tasks are prioritized/allots adequate time/responds to stress
Authority and assertiveness	Advocates position/values team input/takes control/persistent/appropriate assertiveness
Teamwork and cooperation	
Team building/maintaining	Relaxed/supportive/open/inclusive/polite/friendly/use of humour/does not compete
Support of others	Helps others/offers assistance/gives feedback
Understanding team needs	Listens to others/recognises ability of team/condition of others considered/gives personal feedback
Conflict solving	Keeps calm in conflicts/suggests conflict solutions/concentrates on what is right
Problem-solving and decision-making	
Definition and diagnosis	Uses all resources/analytical decision-making/reviews factors with team
Option generation	Suggests alternative options/asks for options/reviews outcomes/confirms options
Risk assessment	Estimates risks/considers risk in terms of team capabilities/estimates patient outcome
Outcome review	Reviews outcomes/reviews new options/objective, constructive and timely reviews/makes time for review/seeks feedback from others/conducts post-treatment review
Situation awareness	
Notice	Considers all team elements/asks for or shares information/aware of available of resources/encourages vigilance/checks and reports changes in team/requests reports/updates
Understand	Knows capabilities/cross-checks above/shares mental models/speaks up when unsure/updates other team members/discusses team constraints
Think ahead	Identifies future problems/discusses contingencies/anticipates requirements

Table 2: Operating-theatre team Non-Technical Skills assessment tool.

Statistical analysis

Statistical analysis was performed with IBM SPSS Statistics 21.0 statistical software. For univariate analyses, two-sample t-tests were used to compare continuous variables, while the χ^2 test or Fisher's exact test was used to compare categorical variables between the two groups. Continuous variables were described as mean \pm SD, while discrete variables were reported as frequencies and percentage. Statistical significance was defined as $P < 0.05$.

Results

Examination scores and the rate of good

Compared with control group, the rate of A in FC group was significantly higher (73.2% vs. 55.4%, $p = 0.008$) (Figure 1). Notable difference also appeared in examination scores between the two groups (79.85 \pm 9.09 vs. 85.86 \pm 6.35, $p < 0.001$) (Figure 2).

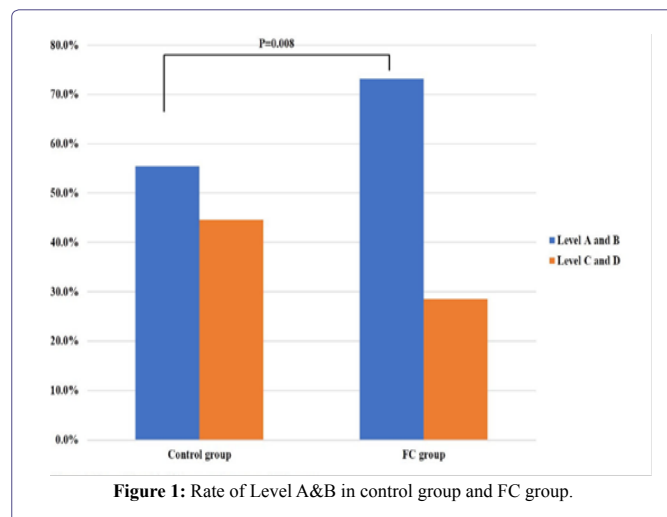


Figure 1: Rate of Level A&B in control group and FC group.

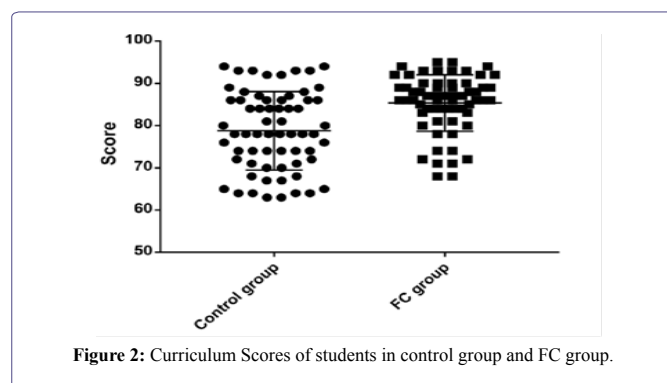


Figure 2: Curriculum Scores of students in control group and FC group.

VAS Scores of students

We received 141 pieces of questionnaires at all (128 students and 13 teachers), with a recovery rate of 100%. The VAS scores indicated that students in FC group significantly improved their self-learning capacity and the interest of study, and they showed more confidence in surgical practices (>4 points) (Table 3 and Figure 3).

Items	Groups	Points			χ^2	p-value
		0-3	4-7	8-10		
Interest in learning	Control	32 (50%)	20	12	30.487	0.000
	FC	8 (12.5%)	31	25		
Capacity in active learning	Control	35 (54.7%)	21	8	49.033	0.000
	FC	5 (7.8%)	26	33		
Confidence in surgeries	Control	22 (34.4%)	27	15	17.064	0.000
	FC	6 (9.4%)	48	10		

Data are presented as n (%)
FC = flipped classroom

Table 3: Results of VAS questionnaires from students.

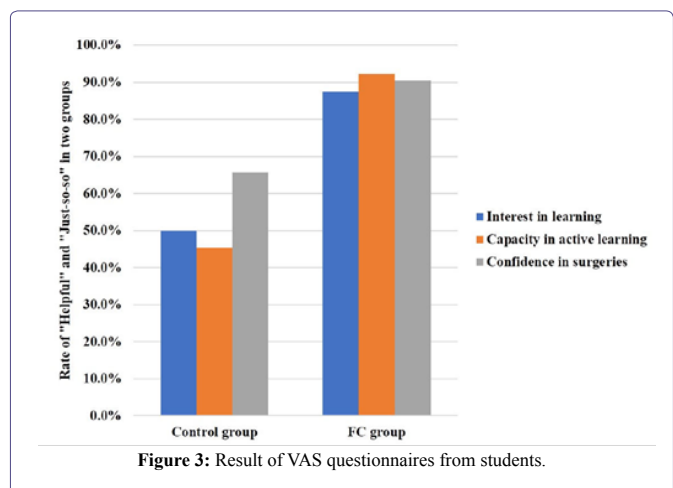


Figure 3: Result of VAS questionnaires from students.

VAS Scores of teachers

The VAS questionnaire for teachers showed that students in FC group were much easier to understand and acquire the knowledge as well as the surgical skills, than those in control group, and the team spirit enhanced simultaneously (>4 points) (Table 4 and Figure 4).

Items	Groups	Points			χ^2	p-value
		0-3	4-7	8-10		
Understandability	Control	6 (46.2%)	4	3	34.73	0.000
	FC	1 (7.69%)	3	9		
Teamwork	Control	8 (61.5%)	4	1	44.68	0.000
	FC	2 (15.4%)	5	6		

Data are presented as n (%)
FC = flipped classroom

Table 4: Results of VAS questionnaires from teachers.

Oxford NOTECHS scores of students

In our study, the results of Oxford NOTECHS scores in FC group were significantly higher than those of Control group (48.2 \pm 9.3 vs. 39.0 \pm 14.7, $p = 0.0001$) (Figure 5), which indicated a higher team spirit in flipped classroom training model.

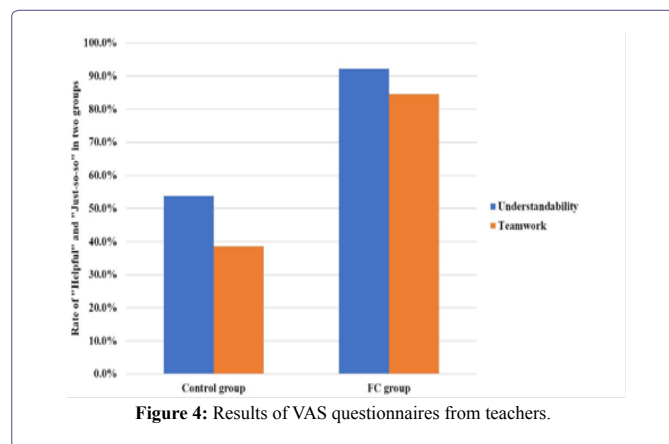


Figure 4: Results of VAS questionnaires from teachers.

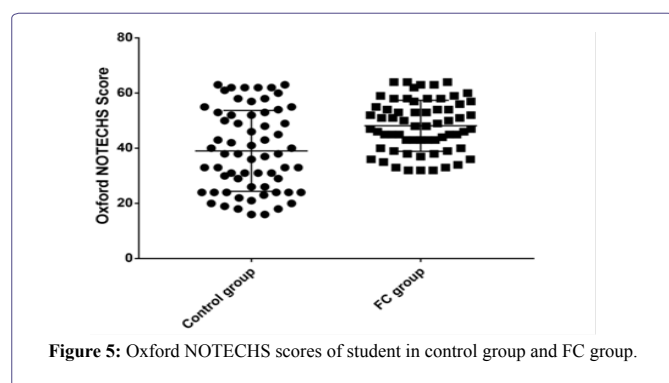


Figure 5: Oxford NOTECHS scores of student in control group and FC group.

Discussion

Basic surgical skills are extremely important for a surgeon, which should be well trained in medical universities, while advanced surgical skills should be trained in residency programs. Unfortunately, the actual main purpose of standardized residency programs in China is to teach medical graduates basic clinical skills, which will result in a waste of hospitals' resources and residents' time and cultivate doctors without solid clinical skills. It occurred to be a more and more serious problem under tremendous changes in models of current health care, especially in the military field. Different from surgeons working in hospitals, those who served in combat hospitals or Forward Surgical Teams (FSTs) need to have more solid theoretical foundations and surgical skills because it is more possible for them to face more complicated injuries under extreme conditions.

We first introduced basic surgical skills based on FST to 5th grade students in military medical university (equals to the last year of the undergraduate program in Chinese medical education model), trying to let our military medical students have good command on basic surgical skills and reach the entry-level of an FST member. To achieve this, we have established several labs, introduced advanced training equipment, designed innovative curriculums [3]. Unfortunately, the training qualities are below expectations under conventional training method, which is to divide the class into three phases including didactic, simulating demonstration and practice. In this training method, students usually don't have enough chances to practice by themselves for the lack of time which is taken up by a long period of didactic in class, which leads to high scores and low abilities.

Flipped classroom, a new training method designed and kept developing in America since 2007, may hopefully solve the problems of current poor training qualities [4]. It reverses the process of knowledge transference and internalization according to the people's apperception rule, changes the traditional teacher-student relationships and rearranges the use of class period, thus reforming the conventional training method. In flipped classroom, individualized and collaborative learning environment is made for the students with the support of information technology, which could contribute to the formation of a new learning culture and be beneficial to the growth of students [5-7].

In conventional training model, the teacher is typically the central focus of a lesson and the primary disseminator of information during the class period. After class, assignments for students are usually set by teachers for knowledge internalization. Students have to internalize the knowledge after class by themselves, which, however, is less effective. On the contrary, the flipped classroom shifts instruction to a learner-centered model that self-study following the introduction of online videos that teacher have prepared by students before class is the main method for disseminating knowledge, while workshop and group cooperation guided by teachers in class are used for students to apply new knowledge into solving clinical issues and surgical problems, which can achieve the goal of "learning for practice". Along with the development of mobile information technology and 4G Internet Services in China, WeChat platform becomes more and more popular in students, which provides opportunities not only for more communications but also training method revolution. Through new training method, students' self-study abilities will be cultivated gradually, which highlights the purpose of learner-centered training model.

It is common that surgical skills training always needs a combination of theories and practices, especially hard practices. We have made demonstrations of surgical procedures and uploaded to the WeChat platform so that the students can preview the videos before class. Several questions about the procedure keys will be raised in the demonstrations, to solve which, students should carry out extracurricular references searching, group discussion and communication with teachers via WeChat platform, all by themselves, thus making a deeper impression. For instance, students will be taught about the harm of severe tension pneumothorax in clinical context and anatomy of intercostal vascular and nerves while watching the demonstration of the surgical procedure of closed thoracic drainage before class, while online collaborative discussions, digital research, and text readings are used to deepen the understanding. In class, students can practice on simulators according to the demo, trying to solve the problems that teachers have raised. In this way, students will understand the key points of the surgical techniques and the reason why they should perform such surgery in that specific way (the cons and pros), thus they can grasp the skills much faster.

Traditional assessment focuses more on accumulation and memory of knowledge and usually evaluates students through unified questions, answers, and standards. Though some students muddle along in normal times, they can get good grades by cramming in last-minute, which leads to "high marks but poor competence". We reformed the conventional training method into flipped classroom and redesigned the scoring rules which combined surgical skills and theoretical knowledge. In the new scoring system, surgical skills evaluation contains three parts, including daily performance, exam results and

teamwork capacity. Problems and shortcomings of the students will be pointed out in time during the evaluation so that their study abilities can be improved while testing. Meanwhile, each group and its teachers will be responsible for their surgical skills training and evaluation independently, which will cultivate team spirit as well as improving students' humanistic quality.

Oxford NOTECHS System is to measure teamwork and cognitive skills in the operating theatre, which is widely used in western countries in FST training [8,9]. We first introduced this assessment tool into China to evaluate the individuals' performance in a surgical team, trying to find whether it was reliable, adaptable and universal in Chinese students. The result showed that students trained by flipped classroom and PBL training method got higher scores in Oxford NOTECHS System. However, limitations appeared that the score of sub-dimension titled "situation awareness" of our students was mostly below standard, which indicated that our students were always focused on what they were doing (e.g. performing surgeries, making decisions, etc.) instead of what they were to do (e.g. evaluating environment, preparing evacuation, etc.). With the development of our training center and scenario simulation lab, we are looking forward to train our students in "real battlefield".

In our study, the results indicated that the scores of the students in flipped classroom were much higher compared with those in the conventional classroom. Compared with conventional training methods, flipped classroom training method has been recognized not only because it can effectively improve students' self-learning capacity and arouse their interest in learning, but it can also cultivate their comprehensive qualities such as teamwork spirit.

Although flipped classroom has its distinct advantages, it requires capacities on higher technological and informational literacy for teachers. First of all, teachers need to grasp the necessary technology to shoot, record and clip videos and prepare presentations. Then, they need to know well enough about what they will teach as well as the characteristic and accepting way of each student in the class.

Last but not least, how to guarantee that students have studied the videos outside of class and how to control the learning pace remains unclear. In our study, nearly 30% of the students in FC group got C or D in exams, which were not satisfied. Further researches on the supervision mechanism after class need to be carried on in the future.

Conclusions

Flipped classroom and PBL training method via WeChat Platform changes the relationship between teachers and students. To ask questions, to discuss, to practice, to raise the solutions, to encourage learning by exams and to promote by assessment with the guidance of teachers along the whole class lead to the improvement of students' self-learning abilities and an increase of study scores. It can also cultivate the team spirit, which is so important in FST missions. Further researches will be focused on the learning pace control and after-class supervision method to achieve optimal training effects.

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Conflict of Interest

The authors declare no conflict of interest.

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