

## Flipped Classroom in Traditional Chinese Medicine Education in China: A Systematic Review and Meta-analysis

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### Abstract

**Objective:** Flipped classroom has received much attention in traditional Chinese medicine (TCM) education during the last several years in China. However, it is uncertain whether there is robust evidence on the effects of flipped classroom versus traditional classroom on TCM learning. This study investigated the findings of comparative articles to summarize the effects of the flipped classroom approach. We focused specifically on undergraduate level of TCM learning students. **Methods:** The study was designed as a systematic review and meta-analysis of randomized trials. The Medline database, the Wanfang database, the China National Knowledge Infrastructure and the Chinese Biomedical Literature database were searched up to May 2021 with no language restrictions. Methodological quality was graded using the Cochrane Collaboration tool. **Results:** Twenty-five studies satisfied the inclusion criteria for the meta-analysis. Since 2018, number of studies on the flipped classroom increased in TCM education. The results of meta-analysis showed that compared with traditional classroom, flipped classroom showed significant improvement for theoretical knowledge acquisition (MD= 6.61, 95%CI: 5.35~7.87, P<0.00001), practical skills (MD= 8.8, 95%CI: 6.91~10.7, P<0.00001), self-learning ability (RR=1.52, 95%CI: 1.23~1.88, P<0.0001), problem-solving ability (RR=1.67, 95%CI: 1.2~2.35, P=0.003), teamwork ability (RR=1.83, 95%CI: 1.26~2.66, P=0.002) and learning interest (RR=1.76, 95%CI: 1.35~2.31, P<0.0001). More students preferred flipped classroom to traditional classroom (RR=1.39, 95%CI: 1.27~1.53, P<0.00001). **Conclusions:** The current evidence indicates that the flipped classroom approach was more effective than traditional classroom in improving student learning outcomes and students' perceptions in TCM education. However, these results need to be confirmed in larger controlled and long-term follow-up trials.

### Keywords

Flipped classroom; Traditional Chinese medicine education; Systematic review; Meta-analysis.

### 1. Introduction

Flipped classroom, initially popularized in the United States, is widely spread all over the world and has become one of the ideal classroom teaching forms [1]. Flipped classroom subverts the traditional teaching mode, putting knowledge teaching outside the classroom and internalizing knowledge in the classroom, and replace teacher-led in-class instructions with student-centered model. In this model, students consume lecture materials at home while the class time is focused on application, discussion and problem solving [2].

Recently, the flipped classroom approach has been introduced into medical education and established for learning subjects, such as anatomy, biochemistry, nursing, etc [3]. The results of reviews and studies about flipped classrooms in medical education suggested that this teaching concept may have a high potential for improving knowledge and practical experiences [4-6]. Meanwhile, the flipped classroom also had a great impact on the teaching mode of traditional Chinese medicine (TCM). Traditional Chinese medicine is a clinical discipline, which is formed and developed in practice. TCM courses include basic theory of TCM, acupuncture and moxibustion, diagnostics of TCM, internal medicine of TCM, Formulas of Chinese medicine, surgery of TCM, traditional Chinese pharmacology and so on. All subjects require students to learn a lot of theoretical knowledge first. Therefore, the current teaching mode mainly focuses on the teaching of theoretical knowledge, appropriately supplemented by practical teaching and clinical practice. Therefore, the model of applying theoretical knowledge in the process of practice is very consistent with the flipped classroom teaching model. Though flipped classroom has been widely embraced and shows theoretical promise in TCM education [7-8], up to now the effectiveness of flipped classroom approach compared with traditional teaching model in TCM learning has not been established. The objective of this study was to explore the effect of flipped classroom versus traditional classroom on TCM learning in China.

## 2. Materials and Methods

### 2.1. Data Sources and Search Strategies

This review was performed based on the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analysis) guidelines [9]. This review was approved by medical ethics committee of Jinan University. A comprehensive electronic search was carried out using the Medline database (1989 to September 2021), the China National Knowledge Infrastructure database (1979 to September 2021), the Chinese Biomedical Literature database (1990 to September 2021) and the Wanfang database (1982 to September 2021). The search terms with Boolean operators were (“flipped classroom” or “flipped learning” or “flipped class” or “flipping the classroom”) and (“traditional Chinese medicine” or TCM or acupuncture or moxibustion or meridians or “traditional Chinese pharmacology” or formulas of Chinese medicine) to capture all potentially eligible articles.

### 2.2. Eligibility Criteria

Studies were included in this review if they met all the following criteria. (i) Studies which only focused on the undergraduate level of TCM education were included. (ii) The study was designed as a randomized controlled trial that compared the efficacy of flipped classroom versus traditional classroom. (iii) The contents of flipped classroom must include both pre-class and in-class activities.

### 2.3. Data Extraction and Quality Assessment

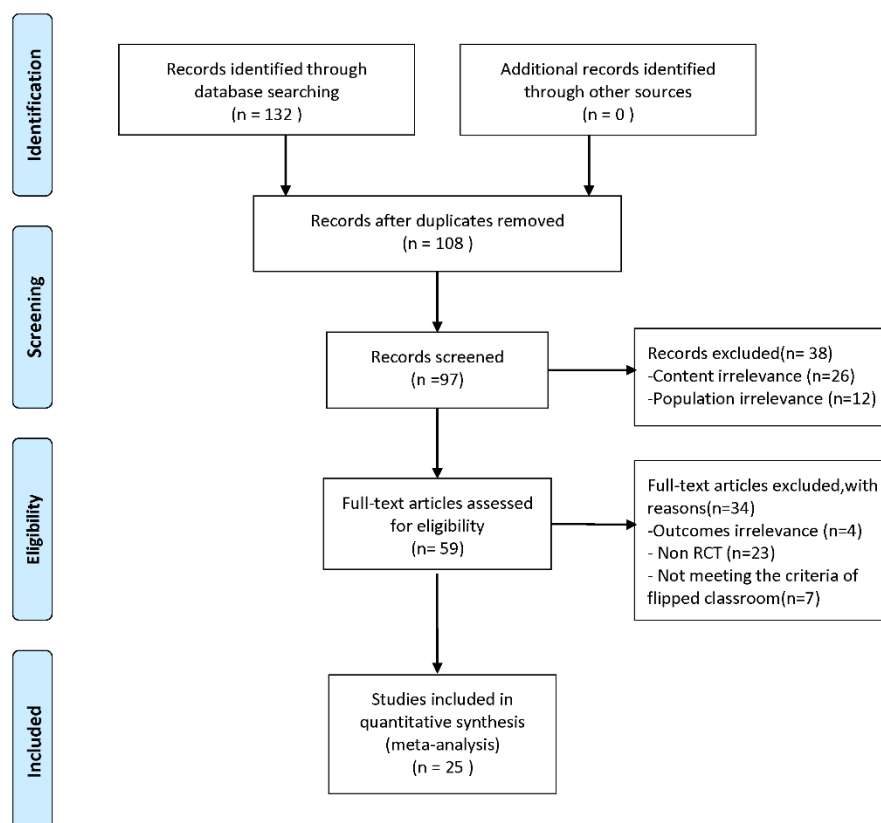
Two investigators independently extracted data, including authors of the study, publication year, study design, randomization, types of students, subject topic, participant sample and outcomes. To reach consensus, the disagreements between the two researchers were resolved after discussion with other researchers prior to data entry and analysis. The methodological quality of each trial was graded using the Cochrane Collaboration tool, which is composed of six domains: adequate sequence generation, allocation concealment, blinding of participants, personnel, and outcome assessors, complete outcome data addressed, selective outcome reporting and other sources of bias.

## 2.4. Data Synthesis and Analysis

Mean difference (MD) was reported for theoretical score and skill score, satisfaction with teaching mode. Summary relative risk (RR) was reported for perception of increase interest in learning, perception of improving self-study ability, perception of improving teamwork ability and perception of improving problem-solving ability. For all the included studies, in cases where articles reported multiple assessments of a single course subject, we selected the assessment that was most summative [10]. For example, we chose final exam over mid-term exam. Review Manager software (RevMan 5.3) was used for the meta-analysis. I<sup>2</sup> statistics is used to estimate heterogeneities. If there is no heterogeneity ( $I^2 < 50\%$  and  $P > 0.1$ ), a fixed-effect model is used to synthesize the data; Otherwise, if there is heterogeneity ( $50\% < I^2 < 75\%$ ), a random-effect model was applied. When  $I^2 > 75\%$ , subgroup analysis was performed to identify the causes of the heterogeneity. A funnel plot was selected to assess the publication bias.

## 3. Results

A total of 132 articles were identified by initial search. Of these, 24 articles were duplicates and removed. After reviewing their titles and abstracts, 11 articles were found to be irrelevant which were reviews or empirical researches. The remaining 97 reports were retrieved in full text, of which 38 studies were excluded because they were not related to TCM education and the participants were not college students. After further reading, four outcomes irrelevance, twenty-three non RCT and seven not meeting the criteria of flipped classroom were excluded. Finally, a total of twenty-five studies were included in this meta-analysis [11–35]. Figure 1 is a flow chart of the study selection process. Amongst all trials, the characteristics of participants in different groups were similar at baseline (age, sex and initial academic performance). A description of included trial characteristics can be found in Table 1.



**Figure 1.** PRISMA flow diagram of study selection

The effect of flipped classroom was evaluated in 25 studies including college students without major restrictions. There were 11 studies involving students majored in traditional Chinese Medicine, 5 in clinical medicine, 5 in nursing, 2 in acupuncture moxibustion and massage, 1 in clinical psychology, and 1 in traditional Chinese pharmacology and in Clinical integration of traditional Chinese and Western medicine.

**Table 1.** Characteristics of the included studies

Author, year	Study design	Major	Curricula	Sample	Outcomes
Hao L,2019[11]	RCT	Traditional Chinese Medicine	Surgery of Traditional Chinese Medicine	FC(n=60) TC(n=60)	Theoretical knowledge acquisition; Practical skills
Jiang RR,2018 [12]	RCT	Nursing	Meridians and Acupuncture Points	FC(n=59) TC(n=66)	Practical skills; Satisfaction with teaching mode; Perception of learning interest; Perception of self-learning ability; Perception of teamwork ability; Perception of problem-solving ability
Jing Q,2020[13]	RCT	Acupuncture Moxibustion and Massage	Acupuncture Moxibustion and Massage	FC(n=57) TC(n=57)	Theoretical knowledge acquisition
Jin MY,2020 [14]	RCT	Traditional Chinese Medicine	Internal Medicine of Traditional Chinese Medicine	FC(n=50) TC(n=50)	Theoretical knowledge acquisition; Practical skills
Kang LZ, 2020[15]	RCT	Traditional Chinese Medicine	Chinese Materia Medica	FC(n=67) TC(n=67)	Theoretical knowledge acquisition; Satisfaction with teaching mode
Liang XL[16]	RCT	Nursing	Nursing of traditional Chinese medicine	FC(n=84) TC(n=82)	Satisfaction with teaching mode
Li BB, 2020[17]	RCT	Traditional Chinese Medicine	Ophthalmology and Otolaryngology of Chinese Medicine	FC(n=78) TC(n=78)	Theoretical knowledge acquisition
	RCT	Traditional Chinese Pharmacology	Formulas of Chinese medicine	FC(n=39) TC(n=46)	Theoretical knowledge acquisition
Liu BW,2020 [18]	RCT	Traditional Chinese and Western medicine integration of traditional Chinese and Western medicine	Formulas of Chinese medicine	FC(n=50) TC(n=50)	Theoretical knowledge acquisition
Li YH,2020 [19]	RCT	Clinical medicine	Traditional Chinese Medicine	FC(n=30) TC(n=30)	Theoretical knowledge acquisition; Perception of self-learning ability; Perception of problem-solving ability
Meng SX,2019 [20]	RCT	Traditional Chinese Medicine	Internal Medicine of Traditional Chinese Medicine	FC(n=124) TC(n=124)	Theoretical knowledge acquisition; Practical skills
Ren D, 2020[21]	RCT	Nursing	Traditional Chinese Pharmacology	FC(n=40) TC(n=40)	Theoretical knowledge acquisition; Perception of learning interest; Perception of teamwork ability
Rong Z, 2019[22]	RCT	Traditional Chinese Medicine	Internal Medicine of Traditional Chinese Medicine	FC(n=152) TC(n=151)	Theoretical knowledge acquisition
Tan H,2020[23]	RCT	Traditional Chinese Medicine	Traditional Chinese Pharmacology	FC(n=60) TC(n=60)	Theoretical knowledge acquisition
Wang CY,2018 [24]	RCT	Traditional Chinese Medicine	Acupuncture	FC(n=25) TC(n=20)	Theoretical knowledge acquisition

Wang S,2018[25]	RCT	Clinical medicine	Emergency Medicine of Traditional Chinese Medicine	FC(n=30) TC(n=30)	Theoretical knowledge acquisition
Wang XM,2020 [26]	RCT	Traditional Chinese Medicine	Acupuncture Moxibustion and Massage	FC(n=58) TC(n=56)	Theoretical knowledge acquisition; Practical skills
Wang Y,2021[27]	RCT	Traditional Chinese Medicine	Diagnostics of Traditional Chinese Medicine	FC(n=60) TC(n=61)	Theoretical knowledge acquisition; Perception of learning interest; Perception of self-learning ability; Perception of teamwork ability
Xie HY, 2016[28]	RCT	Acupuncture Moxibustion and Massage	Acupuncture Moxibustion and Massage	FC(n=40) TC(n=40)	Theoretical knowledge acquisition
Xiong JY,2021[29]	RCT	Nursing	Fundamentals of Traditional Chinese Medicine Nursing	FC(n=78) TC(n=88)	Theoretical knowledge acquisition
Yang B,2018[30]	RCT	Clinical psychology	Psychology of Traditional Chinese Medicine	FC(n=40) TC(n=40)	Satisfaction with teaching mode; Perception of learning interest; Perception of self-learning ability; Perception of teamwork ability; Perception of problem-solving ability
Yang XP,2020 [31]	RCT	Clinical medicine	Internal Medicine of Traditional Chinese Medicine	FC(n=30) TC(n=30)	Theoretical knowledge acquisition; Practical skills; Satisfaction with teaching mode; Perception of learning interest; Perception of self-learning ability
Yuan K,2019[32]	RCT	Traditional Chinese Medicine	Traumatology and Orthopedics of Traditional Chinese Medicine	FC(n=34) TC(n=31)	Theoretical knowledge acquisition; Satisfaction with teaching mode
Zhang T,2020[33]	RCT	Clinical medicine	Syndrome Differentiation Internship of Traditional Chinese Medicine	FC(n=30) TC(n=30)	Theoretical knowledge acquisition
Zhao MJ,2019 [34]	RCT	Nursing	Medicinal Diet of Traditional Chinese Medicine	FC(n=50) TC(n=50)	Theoretical knowledge acquisition; Perception of learning interest
Zhu H,2018[35]	RCT	Clinical medicine	Traditional Chinese Pharmacology	FC(n=25) TC(n=25)	Theoretical knowledge acquisition

### 3.1. The Quality Assessment of Included Studies

Methodological quality was graded using the Cochrane Collaboration tool. The study quality was summarized in Figure 2 and Figure 3. In the aspect of random sequence generation, 11 studies [13,16,18-21,27-29,32,34] used random number table or random lottery, while 14 studies mentioned "random" but without details of randomization method. None of the studies mentioned the allocation concealment. It was not possible to blind the students to the flipped classroom designs. Therefore, we assessed the domain of performance bias as unclear. Four studies reported that the test was assessed by the teacher who did not attend the class. Thus, the domain of detection bias was evaluated as low risk of bias in the four studies [12,32,33,35]. All the studies had a low risk of bias in the domains of incomplete outcome data and selective outcome reporting.

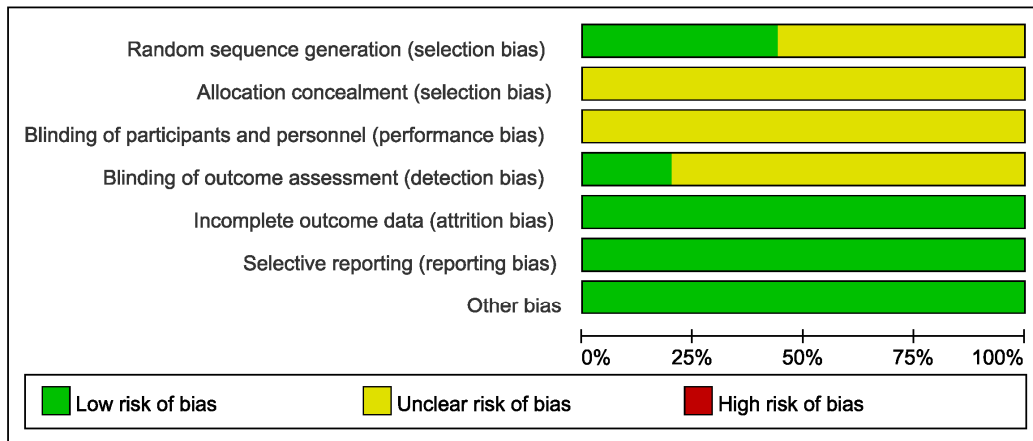


Figure 2. Risk of bias assessment

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Hao L.,2019	?	?	?	?	+	+	+
Jiang RR,2018	?	?	?	+	+	+	+
Jing Q.,2020	+	?	?	?	+	+	+
Jin MY,2020	?	?	?	?	+	+	+
Kang LZ,2020	?	?	?	?	+	+	+
Liang XL,2018	+	?	?	?	+	+	+
Li BB,2020	?	?	?	?	+	+	+
Liu BW,2020	+	?	?	?	+	+	+
Li YH,2020	+	?	?	?	+	+	+
Meng SX,2019	+	?	?	?	+	+	+
Ren D.,2020	+	?	?	?	+	+	+
Rong Z.,2019	?	?	?	?	+	+	+
Tan H.,2020	?	?	?	?	+	+	+
Wang CY,2018	?	?	?	?	+	+	+
Wang S.,2018	?	?	?	?	+	+	+
Wang XM,2020	?	?	?	?	+	+	+
Wang Y.,2021	+	?	?	?	+	+	+
Xie HY,2016	+	?	?	?	+	+	+
Xiong JY,2021	+	?	?	?	+	+	+
Yang B.,2018	?	?	?	?	+	+	+
Yang XP,2020	?	?	?	?	+	+	+
Yuan K,2019	+	?	?	+	+	+	+
Zhang T,2020	?	?	?	+	+	+	+
Zhao MJ,2019	+	?	?	?	+	+	+
Zhu H.,2018	?	?	?	+	+	+	+

Figure 3. Risk of bias summary: judgements about each risk of bias item for each included study

### 3.2. Effects of Flipped Classroom on Theoretical Knowledge Acquisition

Twenty-three trials with 2541 students reported the score of theoretical knowledge [11,13-15,17-29,31-35]. Flipped classroom showed significant increase in theoretical knowledge score compared with traditional classroom (MD= 6.61, 95%CI: 5.35~7.87, P<0.00001) (Figure 4). There was significant heterogeneity between the studies (P<0.00001, I2=97%). Due to the high statistical heterogeneity, we performed a subgroup analysis based on major. The results showed that the heterogeneity was significantly reduced in the studies of which participants majored in nursing (P=0.91, I2=0%), indicating that major may be an important source of the heterogeneity. The publication bias was evaluated by funnel plot which showed that the distribution was nearly symmetric in general (Figure 5).

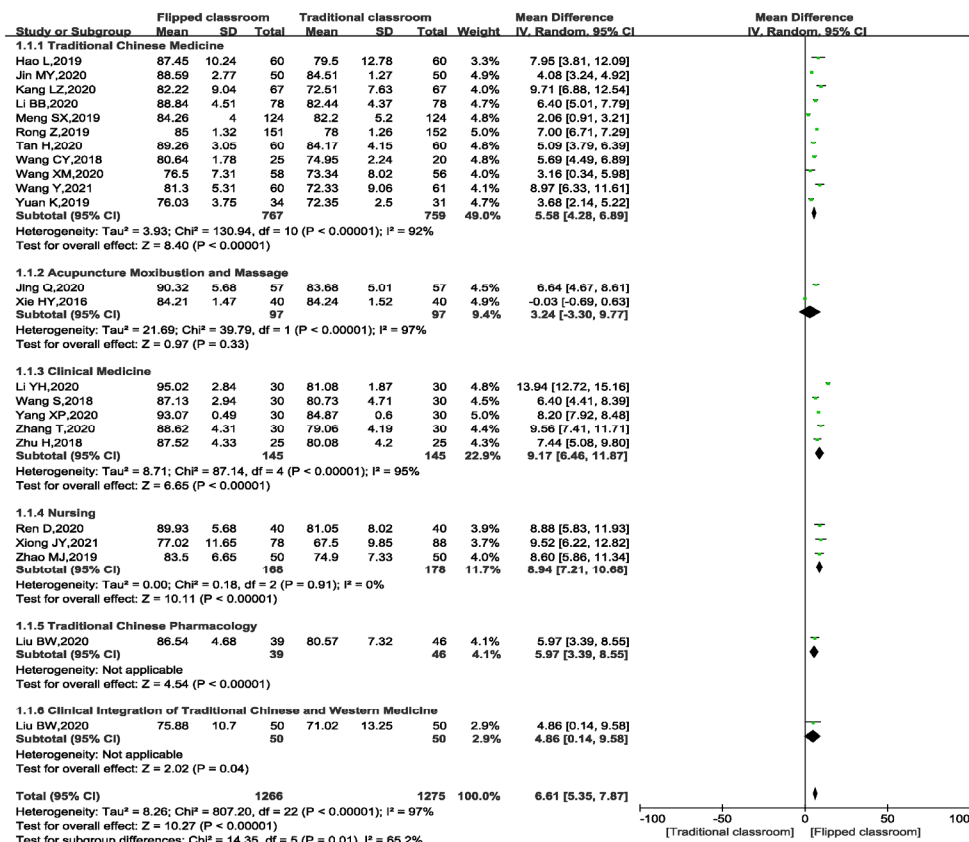


Figure 4. Forest plot of the effect of flipped classroom on theoretical knowledge acquisition

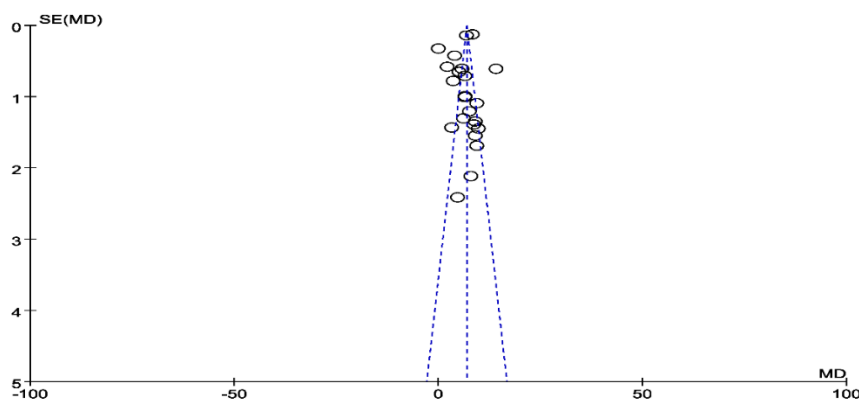


Figure 5. Funnel plot assessing publication bias

### 3.3. Effects of Flipped Classroom on Practical Skills

Six trials with 767 students reported the score of practical skills [1,2,4,10,16,31]. Flipped classroom showed significant improvement for practical skills compared with traditional classroom (MD= 8.8, 95%CI: 6.91~10.7,  $P < 0.00001$ ) (Figure 6). The heterogeneity was significant ( $P < 0.00001$ ,  $I^2 = 96\%$ ). We performed a subgroup analysis to explore sources of heterogeneity. The results showed that the heterogeneity was significantly reduced in the studies of which participants majored in traditional Chinese medicine ( $P = 0.18$ ,  $I^2 = 39\%$ ).

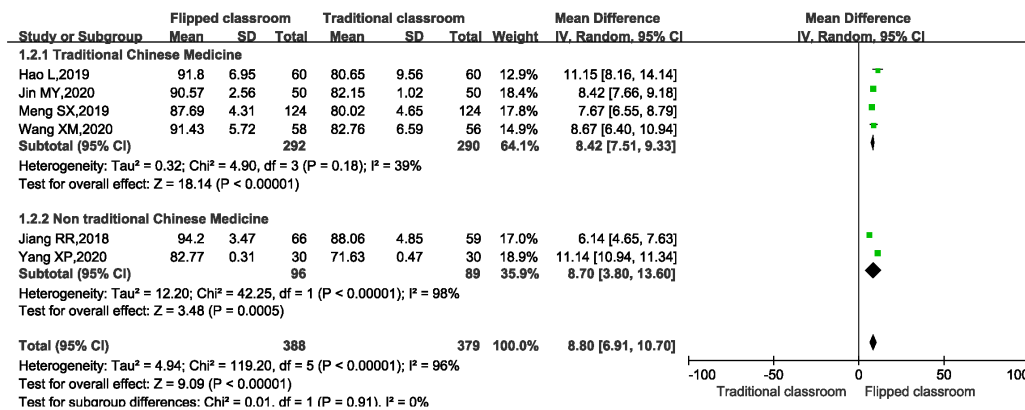


Figure 6. Forest plot of the effect of flipped classroom on practical skills

### 3.4. Effects of Flipped Classroom on Students' Perceptions

A total of ten studies assessed students' perceptions of the flipped classroom. All of them used self-assessment surveys. Among them, six studies assessed the satisfaction of the flipped classroom group and control group [12,15,16,30-32]. The results showed that students preferred flipped classrooms over traditional classrooms ( $RR = 1.39$ , 95%CI: 1.27~1.53,  $P < 0.00001$ ) with no substantial heterogeneity ( $P = 0.68$ ,  $I^2 = 0\%$ ) (Figure 7). Five studies assessed the effects of flipped classrooms on students' self-learning ability [12,19,27,30,31]. Flipped classroom showed significant improvement for self-learning ability compared with traditional classroom ( $RR = 1.52$ , 95%CI: 1.23~1.88,  $P < 0.0001$ ) with significant heterogeneity ( $P = 0.03$ ,  $I^2 = 61\%$ ) (Figure 8). Three studies assessed the effects of flipped classrooms on students' problem-solving ability [12,19,30]. Flipped classroom showed significant improvement for problem-solving ability compared with traditional classroom ( $RR = 1.67$ , 95%CI: 1.2~2.35,  $P = 0.003$ ) with significant heterogeneity ( $P = 0.06$ ,  $I^2 = 64\%$ ) (Figure 9). Four studies assessed the effects of flipped classrooms on students' teamwork ability [12,19,30]. Flipped classroom showed significant improvement for teamwork ability compared with traditional classroom ( $RR = 1.83$ , 95%CI: 1.26~2.66,  $P = 0.002$ ) with significant heterogeneity ( $P = 0.008$ ,  $I^2 = 75\%$ ) (Figure 10). Six studies assessed the effects of flipped classrooms on students' learning interest [12,21,27,30,31,34]. Flipped classroom showed significant improvement for learning interest compared with traditional classroom ( $RR = 1.76$ , 95%CI: 1.35~2.31,  $P < 0.0001$ ) with significant heterogeneity ( $P = 0.002$ ,  $I^2 = 74\%$ ) (Figure 11).



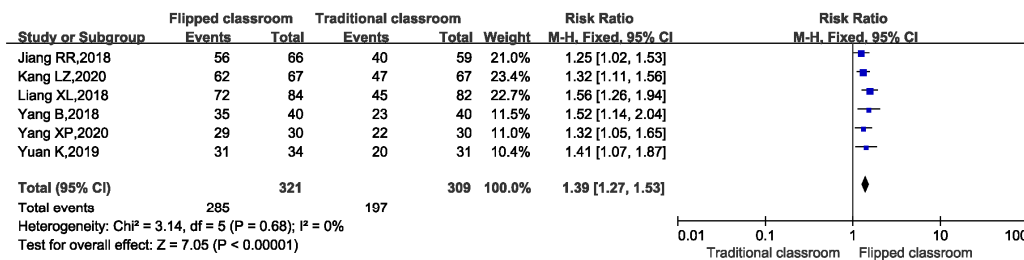


Figure 7. Forest plot of the effect of flipped classroom on satisfaction with teaching mode

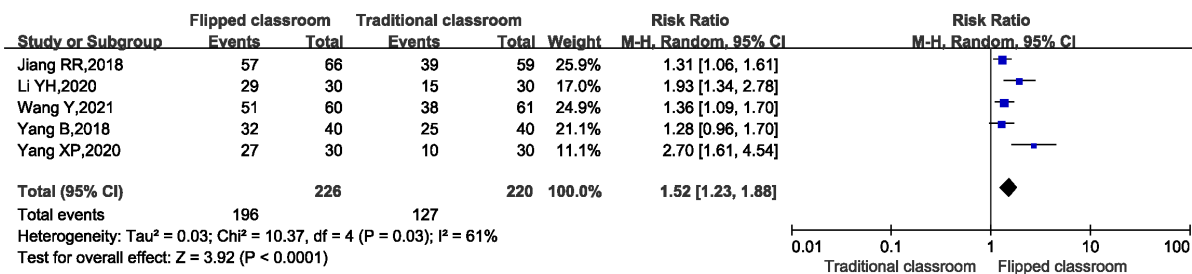


Figure 8. Forest plot of perception of self learning ability

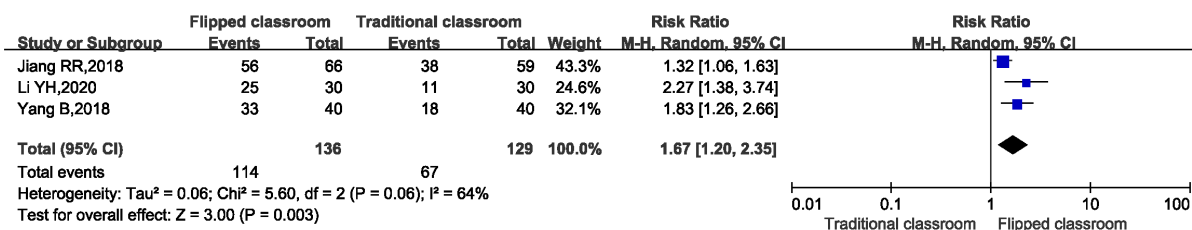


Figure 9. Forest plot of perception of problem solving ability

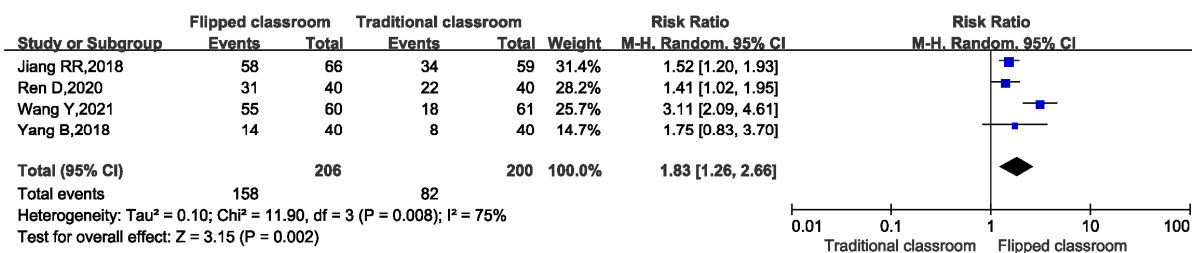
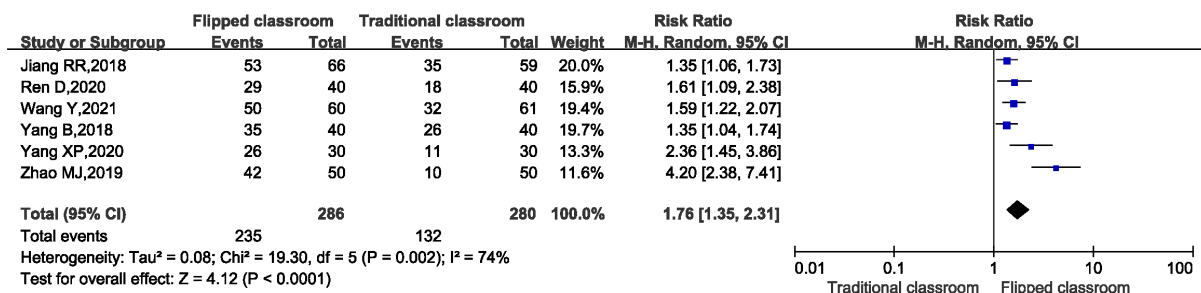


Figure 10. Forest plot of perception of teamwork ability



**Figure 11.** Forest plot of perception of learning interest

## 4. Discussion

From the time of publication, among the included studies, the first randomized controlled study on the flipped classroom in TCM education was published in 2016[28]. Since 2018, there have been a growing number of studies on the flipped classroom in TCM education in China, especially in 2020, there were 11 articles were published. This suggests that there has been an improvement in the research not only in quality but also in quantity. This trend continues in flipped classroom on TCM education in China.

To our knowledge, this is the first comprehensive systematic review and meta-analysis to confirm the efficacy of flipped classroom on TCM learning. Our results showed that the flipped classroom approach was more effective than traditional classroom in improving student learning outcomes including theoretical knowledge acquisition and practical skills. These findings are consistent with other systematic reviews that showed significant increase in students learning performance in health professions education [36-37]. One explanation for this finding is that the flipped classroom model has the potential to motivate and engage students in pre-class learning activities. In flipped classroom of the included studies, teachers assign learning tasks of each unit including micro-course video and learning materials before class. Students have free access to pre-recorded video lectures before class to better understand a particular topic. However, instructors need to consider that the length of all combined video should not exceed 20 minutes. Previous flipped classroom studies reported that most students spent up to 20-25 minutes on viewing pre-class video lectures [38-39]. Studies showed that quality of pre-class videos has an important effect on student learning performance, student satisfaction, and completion of assignments [40-41]. Further, in-class activities of flipped classroom such as small-group discussion promoted interactions of students with their peers and require students to apply their knowledge to solve problems and may led to higher order thinking. In addition, in the five studies of this meta-analysis, students in the flipped classroom group were given free access to the interactive app such as WeChat or Chaoxing, which improve students' participation and satisfaction and allow instructors to get more feedback during in-class sessions. Our results also showed that more students preferred flipped classroom over traditional classroom and the flipped classroom approach showed more significant improvement for self-learning ability, problem-solving ability, teamwork ability and learning interest compared with traditional classroom. Thus, these results can lead us to conclude that the flipped classroom model is promising in terms of enhancing students' learning outcomes in TCM education.

However, this review has some limitations. First, the heterogeneity was significant for the outcomes of theoretical knowledge acquisition and practical skills. Initially, we performed a subgroup analysis based on the pre-clinical learning curricula and clinical learning curricula. However, the heterogeneity remained significant (data not shown). Considering that TCM curricula are not only for TCM major, but also for clinical medicine, nursing and other majors, we did a subgroup analysis based on major and found that the major of the participants included in the studies may be one of the sources of the heterogeneity. Second, all the included studies used self-report questionnaires to assess students' perceptions of the flipped classroom, which maybe non-validated outcome measurement methods. Third, none of the included studies had a long-term (two-semester) follow-up to assess learning retention.

In conclusion, this systematic review and meta-analyses revealed that the flipped classroom approach was more effective than traditional classroom in improving student learning outcomes and students' perceptions in TCM education. However, these results need to be confirmed in larger controlled and long-term follow-up trials.

## Acknowledgments

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