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Flipped classroom approach to global outreach: cross-cultural teaching of horizontal strabismus to Chinese ophthalmology residents

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Abstract

• **AIM:** To evaluate the flipped classroom model for teaching horizontal strabismus didactics in an ophthalmology residency program in China as part of a visiting professorship from the United States.

• **METHODS:** Residents from an ophthalmology residency program in China were invited to participate in flipped classroom sessions taught by an experienced American ophthalmology faculty in 2018. Residents were instructed to watch a pre-class video lecture prior to the in-class-case-based activity. Content tests (5 Ophthalmic Knowledge Assessment Program style questions) and surveys were administered before and after the classroom sessions (100% response rate). These results were compared to that of an American cohort who were taught the same content.

• **RESULTS:** The Chinese cohort of 12 residents preferred the flipped classroom to the traditional classroom at higher rates than the American cohort of 40 residents (92% vs

55%, $P=0.04$) and felt that all ophthalmology topics would be appropriate for the flipped classroom teaching style (P -values between 0.008 and <0.001). In both Chinese and American cohorts, we found that the exotropia curriculum saw a small but significant improvement in performance following the flipped classroom session ($P=0.025$ for Chinese residents; $P=0.001$ for US residents), whereas scores in both groups for the esotropia course did not significantly improve.

• **CONCLUSION:** This is the first study to evaluate the flipped classroom model implemented by a visiting ophthalmology professor in a global outreach setting. The flipped classroom sessions are viewed favorably by the Chinese residents relative to the US cohort with a modest impact on knowledge. Decreased in-person interpreter requirement and increased student engagement make this model valuable in cross-cultural visiting professorship settings. Finally, the flipped classroom may lend itself well to a virtual format to prevent the transmission of COVID-19, although such a format requires further study.

• **KEYWORDS:** flipped classroom; international ophthalmology residency; graduate medical education; China; active learning; medical education; ophthalmology

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INTRODUCTION

In the flipped classroom teaching model, learners are first introduced to content outside the classroom, such as viewing a prepared didactic lecture recorded by the instructor. In-class time is dedicated to group activities and active learning. In referencing Bloom's taxonomy, the flipped classroom model allows for lower hierarchical learning and comprehension to be completed outside the classroom with

classroom time focused on higher levels of learning such as analysis, synthesis, and evaluation of content^[1]. Recent efforts to promote higher order learning through learner-to-learner interactions have shown benefit^[2], with the largest body of evidence in undergraduate settings and medical schools^[3-10]. However, residency education in ophthalmology both in the United States (US) and abroad are currently largely delivered in a traditional lecture format.

International cross-cultural education through global outreach may be an opportunity to apply the flipped classroom model to settings challenged by barriers in communication. Today's visiting professors tend to educate local ophthalmologists and ophthalmology trainees in target countries to provide sustainable medical care, rather than visiting professors carrying out the care themselves during medical mission trips^[11]. With increasing access to medical education and technology, middle income and developing countries worldwide have robust ophthalmology training programs that may nonetheless benefit from additional educational opportunities, such as international visiting professors. The flipped classroom model may be particularly suitable for these international settings for several reasons: early distribution of translated educational material allows local ophthalmologists and ophthalmology trainees the opportunity to review the material in their native language ahead of time; the flipped classroom could also reduce the need for in-person translator services and may encourage a higher level of active participation with fewer linguistic barriers among learners.

The literature on the flipped classroom model in cross-cultural global outreach settings is limited. While no studies were found to incorporate the flipped classroom model for international ophthalmology education, a study of international graduate medical education in psychiatry demonstrated preliminary success in establishing a functional flipped classroom model in the US and Brazil^[12], but focused on developing an online model and did not explore global outreach-type educational settings. The present study investigates the efficacy of the flipped classroom model applied to a visiting professorship to a Chinese ophthalmology residency, comparing results to a recently published US cohort learning the same curriculum^[13].

SUBJECTS AND METHODS

Ethical Approval Institutional Review Board (IRB) was approved at Liaocheng People's Hospital, Shandong Province, China, with IRB exemption obtained at the University of Washington (Seattle, Washington, US). This study adhered to the tenets of the Declaration of Helsinki. This study was exempt from requiring informed consent by the IRB.

Study Participants Twelve ophthalmology residents from Liaocheng People's Hospital (Shandong Province, China) were invited to participate in 2018. This hospital site was identified

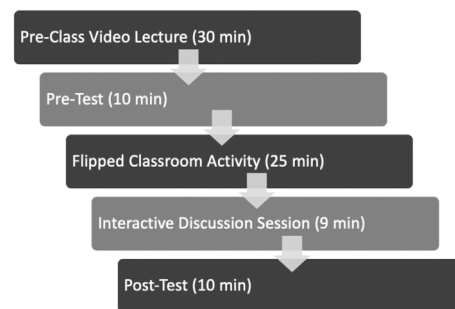


Figure 1 Flipped classroom protocol in both Chinese and US ophthalmology residencies All written materials, presentations, and verbal discussion took place in the residents' native language.

for global outreach by Lifeline Express, a Hong Kong-based non-profit organization that facilitates global outreach ophthalmology education by bringing ophthalmologists worldwide to multiple hospital teaching sites in China. In this study, the sessions were facilitated by a single US fellowship trained pediatric ophthalmology faculty (Cabrera MT). Two one-hour flipped classroom strabismus sessions (esotropia followed by exotropia) were scheduled in succession without a break. All curriculum materials including presentations, content testing, and surveys were provided in Chinese. These materials were previously developed and trialed in English^[11], translated into Chinese, then back-translated to English by two separate masked bilingual translators (including Ding L) to confirm translation accuracy. All classroom activities were facilitated by a bilingual interpreter.

United States Cohort Comparison Raw data from the previously published US cohort pilot study were used for comparison^[13]. There were 40 participants from four US ophthalmology residency programs that participated in the flipped classroom pilot study.

Home Preparation One week prior to the classroom session, residents were instructed to download two 30-minute PowerPoint (Microsoft, Redmond, Washington, US) presentations on exotropia and esotropia (Figure 1). Residents were instructed to watch the presentations individually prior to the in-class session, with content that differed from the in-class session PowerPoint presentations later used for the group activities. Residents were asked to arrive on time and to be prepared to participate in the classroom session.

Pre-Test and Post-Test At the start of the classroom session for each topic, a five-question content test (pre-test) on that session's topic was administered to assess baseline knowledge after completing any home preparation activities, but before experiencing the flipped classroom group activities. These Ophthalmic Knowledge Assessment Program (OKAP)-style questions were developed and validated in the prior US study^[11]. Following completion of the classroom session, all residents were given the same five-question content test (post-

Table 1 Characteristics of participating ophthalmology residents and their flipped classroom experience

Characteristics	China (n=12)	US (prior study) ^[11] (n=40)
Institution	Single institution: Liaocheng People's Hospital (Shandong)	4 sites: Duke University (Durham, NC); University of Washington (Seattle, WA); UC Davis (Davis, CA); University of Oklahoma (Oklahoma City, OK)
Years in ophthalmology residency training	6 (50%) first-year; 6 (50%) second-year; 0 third-year	17 (42.5%) first-year; 13 (32.5%) second-year; 10 (25%) third-year
Instructor	Cabrera MT	Based on institution: Enyedi L, Cabrera MT, Gandhi N, or Yanovitch T
Classroom topic	12 (100%) esotropia; 12 (100%) exotropia	16 (40%) esotropia; 24 (60%) exotropia
Traditional classroom experience	Outside experiences	Randomized to receive traditional lecture in the other strabismus topic (esotropia if flipped exotropia and vice versa) from the same instructor

test). Residents were required to complete both tests within a 10-minute period before and after the classroom session.

Flipped Classroom Following the pre-test, residents were asked to form into small groups. The residents were given access to the classroom group activity PowerPoint presentation, which contained clinical case-based exercises that had no overlap with the preparation presentation, although it covered the same subject matter. Residents were given instructions to work through each clinical case and relevant questions, committing as a group to answers before advancing to the next slide. The presentations provided suggested time limits for each case with the goal to complete all cases in the 25 allotted minutes. During the sessions, the instructor circulated to answer questions and engage residents in discussion. Following 25min of group work time, the instructor led a nine-minute large group discussion to review difficult concepts. The final post-test was then administered.

Resident Surveys The last minute of each one-hour session for all classes was devoted to a Likert-scale written survey for resident participants specific to the flipped classroom style, including questions about the preparation for that day's session. One week following completion of both sessions, residents were sent a link to an online survey (see appendix). 12/12 participants completed all surveys (100% response rate). Surveys were previously validated in the US study and were administered anonymously^[13].

Statistical Analysis Chinese residents' survey and content test results were compared to the previously published American survey results^[13]. All results were compared to the American baseline in order to better understand differences stemming from a cross-cultural setting. Sub-analyses were performed separately for the two different strabismus classes (exotropia/esotropia). An independent *t*-test with Bonferroni correction were used for all comparisons. A *P*-value of less than 0.05 was considered statistically significant. All analyses used SPSS V23 (IBM Corporation, New York, New York, USA).

RESULTS

Participants A total of twelve Chinese residents from a

single institution and forty US residents from four different institutions participated in the flipped classroom experience. Additional comparisons between the Chinese and US cohorts are shown in Table 1.

Resident Preference Overall, 11/12 (92%) Chinese participants preferred the flipped classroom over the traditional classroom. In comparison, the US cohort was split in their preference with only 55% favoring the flipped classroom model (*P*=0.04). Additionally, Chinese residents felt that the flipped classroom would be appropriate for more ophthalmology topics compared to their US counterparts (*P*=0.008 to <0.001; Figure 2). However, when asked how often participants would like to see the flipped classroom in residency, there was no significant difference between the Chinese and US cohorts (54% vs 43%, *P*=0.14).

Class Preparation and Activity In the survey administered at the end of the session, the residents were asked to estimate how much of the preparatory video they had reviewed prior to the classroom session (0, 25%, 50%, 75%, or 100%). The average percent of the preparatory video reviewed by Chinese residents was lower than that of the US residents (48% vs 81%, *P*=0.002). Of note, all 12 Chinese residents "agreed" or "strongly agreed" that the preparatory material helped reinforce their knowledge or helped them understand the course, compared to 88% among US residents (*P*=0.89), regardless of how much they prepared. The residents were also asked to evaluate the effectiveness of the classroom activity, and all 12 Chinese residents "agreed" or "strongly agreed" that the classroom activity was effective in helping them learn about the topic, compared to 90% among the US residents (*P*=0.40).

Content Testing The Chinese residents performed worse compared to the US cohort on all pre-tests (*P*=0.025 for esotropia, *P*<0.001 for exotropia) and post-tests (*P*=0.002 for esotropia, *P*=0.001 for exotropia; Figure 3). In the Chinese cohort, there was a modest improvement in performance following the classroom session for exotropia [1.83/5 (37%) vs 2.67/5 (53%), *P*=0.03] but not esotropia coursework [1.67/5 (33%) vs 1.75/5 (35%), *P*=0.39; Figure 3]. However,

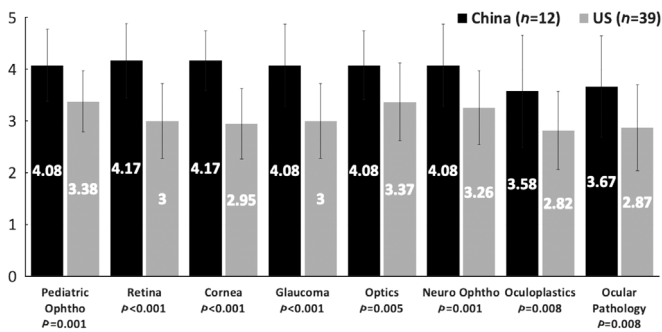


Figure 2 Residents were surveyed regarding how appropriate the flipped classroom format would be for learning different ophthalmology subjects Chinese residents preferred the flipped classroom format at a significantly higher rate for all ophthalmology subjects compared to US residents (P -values between 0.008 and <0.001). Overall, 92% of Chinese participants preferred the flipped classroom over the traditional classroom compared to 55% of US residents ($P=0.04$).

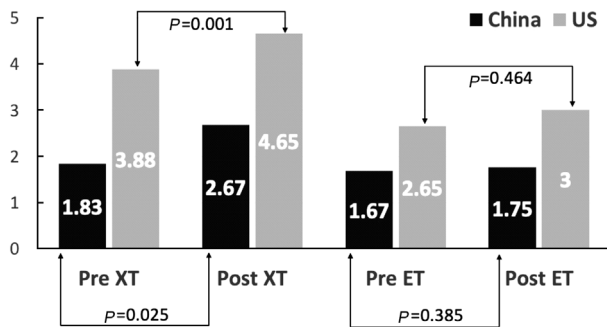


Figure 3 Forty US residents performed better on both pre-test (Pre) and post-test (Post) for both esotropia (ET) and exotropia (XT) lectures when compared to 12 Chinese residents ($P=0.03$ and $P=0.002$, respectively) In the Chinese cohort, there was a modest improvement in performance following the flipped classroom session in the exotropia topic (1.83 pre-test to 2.67 post-test, $P=0.025$) but not the esotropia topic (1.67 to 1.75, $P=0.385$). This is similar to the US cohort, where the exotropia topic showed a larger improvement (3.88 pre-test to 4.65 post-test, $P=0.001$) than the esotropia topic (2.65 pre-test to 3.00 post-test, $P=0.464$). There were no significant differences in the improvement between pre-test and post-test when comparing the Chinese and US cohorts.

the improvement between pre-test and post-test was similar between the Chinese and US cohorts ($P=0.59$ for esotropia, $P=0.87$ for exotropia).

Within the Chinese cohort, those who prepared more had higher post-test scores ($r=0.61$, $P=0.04$) as well as pre-test to post-test improvement ($r=0.61$, $P=0.03$). There was no association between satisfaction with either the preparatory material or in-class session with pre-test scores, post-test scores, or improvement from pre-test to post-test.

DISCUSSION

This pilot study demonstrates the application and feasibility

of a flipped classroom approach for teaching strabismus in a cross-cultural visiting professorship setting at a single site in China. There was a strong preference for the flipped classroom model among Chinese ophthalmology residents, with 92% of Chinese participants preferring the flipped classroom over traditional classroom compared to 55% of US residents ($P=0.02$). Additionally, the Chinese residents indicated that they would like to see the flipped classroom model utilized more frequently and felt that all ophthalmology topics would be appropriate for this teaching style (P -values between 0.008 and <0.001; Figure 2). The higher satisfaction for flipped classroom compared to traditional classroom aligns with other US studies in both medical school^[14-15] and graduate medical education^[16-17], including our previously conducted multi-center randomized-control study where 110 US ophthalmology residents preferred the flipped-classroom model over the traditional lecture model^[18]. Based on a prior meta-analysis, this preference may result from increasing levels of engagement with the flipped classroom approach as well as a greater focus on personalized teaching^[19]. Other general benefits of the flipped classroom include the ability to review the lecture video at the learners' own pace^[19-20], greater engagement during the classroom session^[2,14,21], and enhanced motivation to prepare for the session^[20].

Despite higher satisfaction scores, overall content test performance was lower among the Chinese residents compared to the US residents for both esotropia (pretest $P=0.025$, post-test $P=0.002$) and exotropia courses (pretest $P<0.001$, post-test $P=0.001$), which may reflect the lower reported pre-class preparation among Chinese residents compared to US residents (48% vs 81%, $P=0.002$). Alternatively, cultural pedagogical differences may explain these results. Prior studies indicate that Chinese classrooms generally utilize a collaborative repetition model where learners are less incentivized to share their thoughts and ideas, whereas US schools generally employ a more individualistic critical thinking model^[22-23]. Therefore, while neither group had any prior residency flipped classroom experience, the curriculum shift toward active learning and group collaboration may have been a steeper transition for Chinese residents when compared to their US counterparts. In both groups, we found that the exotropia curriculum saw a small but significant improvement in performance following the flipped classroom session ($P=0.025$ for Chinese residents; $P=0.001$ for US residents), whereas scores in both groups for the esotropia course did not significantly improve. This aligns with our previously published study where residents favored the flipped-classroom model relative to the traditional lecture model in knowledge retention for exotropia but not esotropia coursework^[18]. The performance difference between esotropia and exotropia courses could reflect differences in curriculum

efficacy, where some aspects of the case-based material may have been more effective than others^[18]. This also aligns with studies from other medical specialties which saw small improvements or no significant differences when comparing flipped classroom to traditional classroom settings with regard to content test scores^[15-16,24-25]. In one crossover study, members of three US emergency medicine residency programs demonstrated similar knowledge gained in the flipped classroom model and standard lecture model^[24]. In another study, anesthesiology residents from eight US programs were found to have significant improvement in knowledge retention and preference for the flipped classroom model compared to the traditional lecture-based model^[25].

The main limitations of this study include a small sample size and the lack of a traditional classroom control experience for the Chinese residents. The Chinese cohort may be comparing the flipped classroom to traditional classrooms taught by entirely different educators whereas the US residents experienced the same educators for both classroom styles. Nonetheless, the authors believe that comparisons between the two cohorts are still valid given that Chinese residents may still be able to quantify differences between the flipped classroom format and their previous traditional lecture experiences. The Chinese residents' previous lectures can be categorized as "traditional" due to the classroom dynamic consisting of one instructor teaching and the class absorbing information passively. Overall, this study demonstrates the successful implementation of a flipped classroom curriculum in a cross-cultural international setting with a high rate of participation and survey responses. Specific benefits to international residents in a cross-cultural global outreach setting include the ability to view preparatory and in-class material in the residents' native language, decreased need for in-person interpreter services, and exposure to a different type of learning style. As cross-cultural global outreach shifts toward sustainable education-centered rather than care-centered visits, employing effective and novel educational strategies, such as the flipped-classroom technique, will be critical to supporting a rapidly developing global health community. Future studies should also explore virtual modalities for the flipped classroom approach in global outreach efforts.

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