

# The Effectiveness of a Simulation-Based Flipped Classroom in the Acquisition of Laparoscopic Suturing Skills in Medical Students—A Pilot Study

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**OBJECTIVE:** To evaluate the effectiveness of a simulation-based flipped classroom in gaining the laparoscopic skills in medical students.

**DESIGN:** An intervention trial.

**SETTING:** Taipei Medical University Hospital, an academic teaching hospital.

**PARTICIPANTS AND METHODS:** Fifty-nine medical students participating in a 1-hour laparoscopic skill training session were randomly assigned to a conventional classroom ( $n = 29$ ) or a flipped classroom approach ( $n = 30$ ) based on their registered order. At the end of the session, instructors assessed participants' performance in laparoscopic suturing and intracorporeal knot-tying using the assessment checklist based on a modified Objective Structured Assessment of Technical Skills tool.

**RESULTS:** Students in the flipped group completed more numbers of stitches (mean [ $M$ ] = 0.47; standard deviation [SD]

= 0.507) than those in the conventional group ( $M = 0.10$ ; SD = 0.310) (mean difference: 0.37; 95% CI: 0.114-582;  $p = 0.002$ ). Moreover, students in the flipped group also had higher stitch quality scores ( $M = 7.17$ ; SD = 2.730) than those in the conventional group ( $M = 5.14$ ; SD = 1.767) (mean difference = 2.03; 95% CI: 0.83-3.228;  $p = 0.001$ ). Meanwhile, students in the flipped group had higher pass rates for the second throw ( $p < 0.001$ ), third throw ( $p = 0.002$ ), appropriate tissue reapproximation without loosening or strangulation ( $p < 0.001$ ), needle cut from suture under direct visualization ( $p = 0.004$ ), and needle safely removed under direct visualization ( $p = 0.018$ ) than those in the conventional group.

**CONCLUSIONS:** Comparing with traditional approach, a simulation-based flipped classroom approach may improve laparoscopic intracorporeal knot-tying skill acquisition in medical students. (J Surg Ed ■■■■-■■■. © 2017 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

**KEY WORDS:** flipped classroom, clinical skills, laparoscopic suture, medical education, simulation

**COMPETENCIES:** Medical Knowledge, Practice-Based Learning and Improvement

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## INTRODUCTION

Medical schools have encountered a shift in their teaching paradigm recently. Simulation has been applied increasingly to the curricula of undergraduate medical education, especially on basic or surgical skills. Moreover, technology has made impressive strides in laparoscopic surgery, which is a pivotal element of surgical curricula for medical students. The simulation-based programs will facilitate medical students gaining the hands-on experiences that they will need in the surgery rotation. Moreover, failing without consequences by simulations fosters trainees to learn and shorten the learning curve so that they could accommodate the new skills in a nonclinical setting without influencing safety of patients.<sup>1</sup>

One of the new formats of the course delivery is flipped classroom. The flipped classroom is a pedagogical model in which the typical lecture and homework elements of a course are reversed. Short video lectures are viewed by students before class sessions, while in-class time is devoted to exercises or discussions.<sup>2,3</sup> This curricular model has been gaining popularity in many preclinical or clinical education programs, comprising departments of radiology,<sup>4</sup> surgery,<sup>5,6</sup> emergency medicine,<sup>7</sup> internal medicine,<sup>8</sup> and obstetrics and gynecology.<sup>9</sup> Nonetheless, the implementation of a flipped classroom in the surgical skill training program is scarce.

As laparoscopic surgery has been widely employed in a variety of surgical fields, acquiring the techniques of laparoscopic suturing has become essential for interns and surgical residents. In Taiwan, laparoscopic suturing skills have been considered a prerequisite for passing the endoscopic surgery board examinations at the Taiwan Association for Endoscopic Surgery (TAES). In North America, fundamentals of laparoscopic skills (FLS) program has also become a requisite curriculum for residents in their surgery rotation.<sup>10,11</sup> Furthermore, assessment tools for laparoscopic suturing are available, and the learning outcomes of trainees could also be evaluated objectively. Although FLS was hypothesized as an inherently complex task for medical students, Stoller et al. found that FLS program can be taught and given to novice learners without concern for detrimental effects.<sup>12</sup> However, it is less clear whether a simulation-based flipped classroom can improve students' laparoscopic surgical skills, which are considered as inherently complex and difficult.

Reports on flipped classroom in learning clinical skills for medical students are limited. We hypothesized that flipped classroom by a precourse video would enhance skill acquisition in numbers or quality of stitches. This pilot study was to evaluate the effectiveness of a simulation-based flipped classroom in learning the laparoscopic skills for medical students in this surgical education program. Furthermore, we assessed whether students' performances of laparoscopic suturing skills differed by sex.

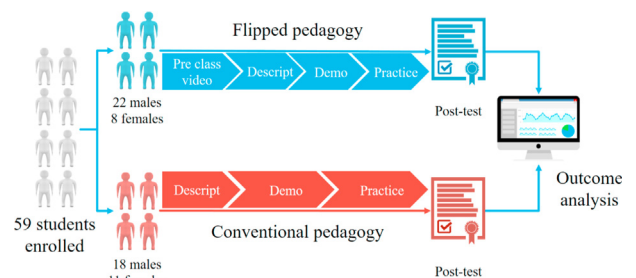
## MATERIAL AND METHODS

### Study Population and Study Design

Novices were recruited voluntarily on bulletin boards of medical students in Taipei Medical University Hospital (TMUH). We, prospectively, enrolled sixth-year medical students (equivalent to third-year medical students in US system) who had no previous laparoscopic suturing experiences into 2 groups: a "conventional group" and a "flipped classroom group." The assignment of participants was based on their registered order, for which the former half students ( $n = 29$ ) were allotted to "the conventional group" and the latter half ones ( $n = 30$ ) were to "the flipped group." Students in both groups had no significant differences in the performance of basic surgical skills, such as suturing, gowning, gloving, etc., according to their grades of basic surgical curriculum in the fifth year of medical school. The diagram of a simulation based with or without a flipped classroom curriculum model was illustrated in the Figure. Two groups of students took a 1-hour laparoscopic training class that accommodated up to 5 participants with 2 instructors at a time. Participants used 1 laparoscopic needle drive (Ethicon, E705R) and 1 laparoscopic grasper or 2 laparoscopic needle drives in each hand according to individual preference. This study was approved by the Institutional Review Boards of Taipei Medical University Hospital.

### Instructors

Four instructors are attending surgeons from Taipei Medical University Hospital, who have passed the surgery board and been qualified as laparoscopic surgeons by Taiwan Association for Endoscopic Surgery (TAES). Instructors assessed participants' laparoscopic suturing and intracorporeal knot-tying performances using the assessment checklist based on a modified Objective Structured Assessment of Technical Skills (OSATS) tool. Instructors were blinded to the grouping of the students.



**FIGURE.** Framework of the curriculum model. The diagram illustrated a simulation-based with or without a flipped classroom curriculum model.

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