

Association for Surgical Education

# Effectiveness of the Surgery Core Clerkship Flipped Classroom: a prospective cohort trial



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## KEYWORDS:

Flipped classroom;  
Medical student;  
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## Abstract

**BACKGROUND:** The flipped classroom has been proposed as an alternative curricular approach to traditional didactic lectures but has not been previously applied to a surgery clerkship.

**METHODS:** A 1-year prospective cohort of students ( $n = 89$ ) enrolled in the surgery clerkship was taught using a flipped classroom approach. A historical cohort of students ( $n = 92$ ) taught with a traditional lecture curriculum was used for comparison. Pretest and post-test performance, end-of-clerkship surveys, and National Board of Medical Examiners (NBME) scores were analyzed to assess effectiveness.

**RESULTS:** Mean pretest and post-test scores increased across all modules ( $P < .001$ ). There was no difference between mean NBME examination score in the prospective and historical cohorts (74.75 vs 75.74,  $P = .28$ ). Mean ratings of career interest in surgery increased after curriculum completion (4.75 to 6.50,  $P < .001$ ), with 90% reporting that the flipped classroom contributed to this increase.

**CONCLUSIONS:** Implementation of a flipped classroom in the surgery clerkship is feasible and results in high learner satisfaction, effective knowledge acquisition, and increased career interest in surgery with noninferior NBME performance.

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The flipped classroom, a blended learning paradigm using pre-session online videos reinforced with interactive small group sessions, has been proposed as an alternative to traditional medical lectures.<sup>1–3</sup> In this approach, students asynchronously watch online video lectures and review material before class, reserving in-class time for active learning through interactive group-based teaching methods.<sup>4</sup> This curricular model has been applied to educational programs across a variety of health disciplines, including nursing,<sup>5–10</sup> public health,<sup>11,12</sup> nutrition,<sup>13</sup> dentistry,<sup>14</sup> veterinary medicine,<sup>15</sup> pharmacy,<sup>16–20</sup> and medical school.<sup>2,21–24</sup> Belfi et al<sup>22</sup> describe “flipping” an

introductory radiology clerkship, with positive student perceptions and greater pretest to post-test improvement compared with lectures alone. The flipped classroom has also been implemented as part of a 4-week elective in obstetrics and gynecology for graduating 4th-year medical students<sup>23</sup> and has been piloted with limited scope in emergency medicine and internal medicine residency programs.<sup>25,26</sup>

Although no prior studies report application of a flipped classroom approach in the surgery clerkship setting, Lindeman et al<sup>27</sup> describe implementation of a blended online curriculum in which 7 of the 20 didactic lectures in the surgery clerkship were replaced with online Web Initiative for Surgical Education of Medical Doctors modules (WISE-MD; Med-U, New York, NY). They found no significant differences in academic performance based on National Board of Medical Examiners (NBME) examination scores or clinical evaluations, but noted a significant increase in clerkship ratings.<sup>27</sup> Although this study used blended learning modules to replace a portion of the lectures, a flipped classroom approach with pre-session online material and interactive group-based teaching methods was not used.

We aimed to create and implement a comprehensive flipped classroom curriculum for the surgery core clerkship to replace our traditional lecture-based clerkship curriculum. This decision to implement a flipped classroom was made to introduce curricular innovation, create a standardized curriculum that could be repeated each clerkship block, minimize the time students spend away from their clinical teams, increase the time spent in active learning, and allow increased time for surgical skill training. The purpose of this study was to investigate the effectiveness of this flipped classroom model in the surgery core clerkship with regard to learner satisfaction, knowledge acquisition, knowledge application, career interest, and faculty time commitment.

## Methods

### Study design and setting

This study describes a 1-year prospective cohort design to investigate the effectiveness of the flipped classroom approach. All 3rd-year medical students ( $n = 89$ ) enrolled in the 8-week surgery core clerkship at a single academic medical center for 1 calendar year, from March 2014 to February 2015, were included in the cohort. Outcome measures included faculty time, surgical education fellow staff time, student time, video utilization, session attendance, student satisfaction, pretest and post-test performance, and career interest. A 1-year matched historical cohort of students enrolled in the clerkship from March 2013 to February 2014 ( $n = 92$ ) was used for comparison of NBME Shelf Examination performance. The traditional curriculum was primarily lecture based and consisted of an orientation session, 18 hours of lecture, and five

2-hour skills sessions. The study protocol was submitted to the Institutional Review Board (IRB) at Stanford University. It was determined by the IRB that the study did not meet the federal definition of human subject research and was deemed exempt from further IRB review.

### Flipped classroom curriculum description

A comprehensive flipped classroom curriculum was created and implemented in the surgery core clerkship at our institution beginning in March 2014. This curriculum is organized into eight 1-week modules, including an orientation module, 6 clinical modules (breast; foregut/small intestine/hernias; hepatobiliary and pancreatic; colorectal; trauma; and perioperative care), and a debriefing module. The orientation module is held during the 1st week of the clerkship and consists of introduction to policies and procedures, discussion of the surgical learning environment and mistreatment, a suturing and knot-tying skills session, and a simulation-based procedural skills session (chest tube placement, central line placement, and laparoscopic camera setup and navigation).

Each clinical content module was comprised of a pre-test, pre-session online videos, review of pre-test questions, a case-based clinical reasoning session, a simulation-based skills session, and a post-test, as outlined in Fig. 1. Pre-tests and post-tests were module specific, consisting of 10 multiple-choice questions, and were completed electronically before access to online video content. Videos were created using 1 of 3 formats: Khan-academy style<sup>28</sup>; PowerPoint slides combined with voice-over and live digital inking; or PowerPoint slides with voice-over only. All formats used a black background to create a consistent appearance across the videos. Each module contained 1 to 4 videos, averaging 5 to 15 minutes in length. Videos were hosted on an online OpenEdX platform ([code.edx.org](http://code.edx.org); [Supplementary Fig. 1](#)), and students were required to view videos before attending the in-class session. Video utilization was tracked at the individual student level via the OpenEdX platform.

The in-class portion of the curriculum was held 1 afternoon per week during a 4-hour block of protected educational time and was organized as follows: review of pre-test questions (30 minutes); case-based clinical reasoning (60 to 90 minutes); break (15 minutes); and a simulation-based skills session (60 to 90 minutes). Before leaving the in-class session, students were asked to complete the online post-test for that module and the pre-test for the upcoming week's module. Simulation modalities incorporated in the curriculum included knot tying (knot-tying boards), suturing (synthetic skin pads), ultrasound-guided central line placement (Movat model),<sup>29</sup> chest tube placement (TraumaMan; SimuLab Corporation, Seattle, WA), ultrasound-guided breast biopsy (chicken breast model), stapled bowel anastomosis (porcine intestine model), Fundamentals of Laparoscopic Surgery tasks,

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