

# Comparison of Academic Outcomes of Epidemiology and Biostatistics Course between Traditional Lecture and Flipped Classroom Blended approach in 2<sup>nd</sup> Year Medical Students: A Retrospective Cohort Study

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## ABSTRACT

**Objective:** To compare academic outcomes between integrated flipped classroom (FC) and solely traditional lecture (TL) teaching approach among 2<sup>nd</sup> year medical students in *Epidemiology and Biostatistics* course.

**Methods:** General information and academic achievements including grade point average, scores of the basic statistics course and scores of *Epidemiology and Biostatistics* course were extracted from the database of the Education Department. The records were excluded if they belonged to repeated or transferred students. The students in 2014 and 2015 academic year represented the TL group and the FC group respectively. The main outcome was the examination score from the two groups which was converted to a comparable scale out of a hundred.

**Results:** Six-hundred twenty-eight records were included in the analysis. Based on independent t-test, the TL group showed higher mean score as compared to the FC group (p-value < 0.01). Further comparison using ANCOVA adjusted for age, gender, hometown location, high school location, grade point average and score of a basic statistics course showed a higher score in the TL group (p-value < 0.01).

**Conclusion:** TL yielded higher examination score than FC from this retrospective study.

**Keywords:** Flipped classroom; traditional lecture; epidemiology and biostatistics (Siriraj Med J 2019;71: 123-126)

## INTRODUCTION

According to a competency-based framework, paradigm shift in medical education transforms traditional lecture (TL) toward other methods to create lifelong learners.<sup>1,2</sup> Depending on co-operation of both students and teachers, active learning curriculum demonstrated

long-lasting knowledge by developing intrapersonal skills to solve future problems.<sup>3,4</sup>

The flipped classroom (FC) is an educational method that reverses a student role from a passive learner to an active learner. Certain self-studied resources such as recommended textbooks, articles or even video records

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are arranged for the students prior to each class. During the class, activities were designed for application or integration of the given assignments. Teachers are not lecturers but they are coaches or supporters.<sup>5</sup> Thus, engagement of both students and teachers are highly required to achieve the excellent outcome.<sup>6,7</sup>

The Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand (“the faculty”) provides the *Epidemiology and Biostatistics* course for the second-year medical students. Before 2014 academic year, this course mainly consisted of one-way TL in which instructors were required to deliver the lecture to a large group of audiences (about 300 students). However, “Outcome-Based Curriculum” was implemented in 2014. The new curriculum emphasized the importance of active learning methods and encouraged to eliminate all previous passive teachings. Thus, reduction in TL and integration of FC were implemented to all courses.

Several studies demonstrated that FC could improve knowledge as compared before and after the class<sup>8</sup>, or compared with TL.<sup>9</sup> Other evidences<sup>10-12</sup> demonstrated efficacy and advantage of this educational method, although one systematic review focused on medical education suggested that there is no strong evidence for the effectiveness of FC.<sup>13</sup> Inconsistency in learning outcome of FC may come from difference in participants’ background, learning culture or heterogeneity of education tools.

As far as we know, there is no evidence in Thailand comparing learning outcome between TC and FC in *Epidemiology and Biostatistics*. The objective of this study was to evaluate changes in *Epidemiology and Biostatistics* learning outcomes after implementing FC in our institute.

## MATERIALS AND METHODS

This study was conducted as a retrospective cohort design. The study was approved by Siriraj Institutional Review Board (SIRB), Faculty of Medicine Siriraj Hospital, Mahidol University (Si 536/2558).

### Data retrieval and management

General information and academic outcome of the medical students in 2014 and 2015 academic year were acquired from the Education Department, Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand. The background information of each student included gender, age, hometown location, high school location, grade point average (GPA), scores of a basic biostatistics course in pre-medical year and score of *Epidemiology and Biostatistics* course. Any student with repeated grade or transferred credit was excluded from the analysis. We

used data of all eligible students (students enrolled in 2014-2015 academic year) for analysis.

### Traditional lecture course (TL) vs. Flipped Classroom (FC) course

The 2014 cohort (total students = 319) received TL method. The TL course consisted of thirteen hours of one-way lecture and six hours of workshops. The evaluation consisted solely of examination score. The FC method was implemented in the 2015 group (total students = 313). The course provided eleven hours of interactive lecture and four hours of workshop. The FC course also included one additional online module on revisiting basic statistics which was about three hours. Additionally, two formative evaluations were incorporated in the FC course which were not scored, but were required to be eligible to take the final examination. Both courses were designed based on the same set of learning outcome from the Medical Competency Assessment Criteria for National License 2012 of Thailand.<sup>14</sup> Also, the same set of instructors taught in both courses on each topic. Since the FC group score was categorized as a multiple-choice question (MCQ), attitude, essay, and coursework, we only compared MCQ and essay score with the total score of the TL group (100% of MCQ). Thus, the score of the FC group (50% of MCQ and 50% of short answer question) was converted to a scale of a hundred to be comparable with the TL score. Test analysis of both courses revealed that their MCQ test property fell into the same category with very good average difficulty index and good average discrimination index.

### Statistical analysis

All analyses were performed with PASW Statistics for Windows version 18 (SPSS Inc., Chicago, Ill, USA). Descriptive statistics were presented as mean  $\pm$  SD and n (%). Independent t-test was used to compare the difference between mean of scores. ANCOVA was used to further compare the mean difference with adjustment for age, gender, hometown, high school, grade point average and a score of basic statistics course as covariates.

### Power analysis

Because we recruited data of all medical students who met eligibility criteria for this study, no sample size was calculated. We performed power analysis using two-sided test for mean difference. Based on total students enrolled in the TL and FC group (319 vs. 313 students), we estimated that we could retrieve data without missing at 95% of total enrolled students. Using pooled average and standard deviation (SD) of examination score from

a previous study<sup>15</sup>, power of the study was estimated to be > 90% at a  $\alpha = 0.05$  (difference of pooled means = 4.5, pooled SD of the control group = 5.94, pooled SD of the experimental group = 6.13).

## RESULTS

Six-hundred and thirty-two records were eligible for the study which comprised of 319 records in the traditional lecture group and 313 records in the flipped classroom group. In the traditional lecture group, three records were excluded: two records belonged to repeated grade students and one record was a transferred student. For the flipped classroom group, one record belonged to a transfer student and was excluded. Therefore, a total of 628 records were included in the analyses. The demographic data of both groups is presented in Table 1.

The independent t-test revealed that the TL group had a higher score than the FC group ( $p$ -value < 0.01). Subsequently, ANCOVA with adjustment for covariates

showed the same outcome ( $p$ -value < 0.01). The details of the comparison are shown in Table 2.

## DISCUSSION

This study illustrates the difference in academic outcome between TL and FC method in *Epidemiology and Biostatistics* courses among Thai 2<sup>nd</sup> year undergraduate medical students. The main finding from this study suggests that TL yields better academic achievement compared to FC in this subject.

It is clear that the FC group had statistically lower examination score even though all the teaching topics were the same and the test analysis illustrated similar test property. Additionally, the ANCOVA with adjusted covariates presented a consistent result and the power analysis guaranteed a sufficient power. Other studies aiming at exploring the effect of implementing FC on the same or related subjects have illustrated the similar academic outcome between the two groups.<sup>16,17</sup> Hence,

**TABLE 1.** Characteristic of TL and FC groups.

| Characteristic                                  | Traditional Lecture group<br>(N = 315) | Flipped Classroom group<br>(N = 313) |
|---|--|--------------------------------------|
| Gender: female                                  | 153 (48.6)                             | 145 (46.3)                           |
| Age (year)                                      | 19.63 ± 0.91                           | 19.50 ± 0.58                         |
| Hometown located in Bangkok                     | 152 (48.3)                             | 146 (46.6)                           |
| High school located in Bangkok                  | 182 (57.8)                             | 188 (60.1)                           |
| Grade point average during 1 <sup>st</sup> year | 3.30 ± 0.39                            | 3.53 ± 0.31                          |
| Score of basic statistics course                | 60.24 ± 12.72                          | 75.46 ± 10.58                        |

\*Data is presented in n (%) for categorical data and mean ± SD for continuous data

**TABLE 2.** Comparison of academic outcome between TL and FC group.

| Score comparison  | TL group <sup>1</sup> | FC group <sup>1</sup> | P-value | 95% Confidence Interval (CI) |
|---|-----------------------|-----------------------|---------|------------------------------|
| Examination score <sup>2</sup>                                | 77.97 ± 9.44          | 69.82 ± 10.83         | < 0.001 | 6.56, 9.74                   |
| Examination score with adjustment for covariates <sup>3</sup> | 77.97 ± 9.44          | 69.82 ± 10.83         | < 0.001 | 11.16, 14.15                 |

<sup>1</sup>Data is presented in mean ± SD

<sup>2</sup>p-value and 95% CI from independent t-test

<sup>3</sup>p-value and 95% CI from ANCOVA with gender, age, hometown location, high school location, GPA and score of basic statistic course as covariates

our results support the evidence that the integration of FC into the curriculum did not show better academic outcome, but worse.

Nevertheless, a number of studies have showed a significant increase in students' satisfaction in the FC group.<sup>10,13,18</sup> Furthermore, implementation of FC results in the better development of several practical soft skills.<sup>19</sup> Thus, it is clear that integration of FC should not be aimed only at better academic outcome of the students, but also focusing on maturation process of the learning ability of the students to eventually acquire adult learning which is the ultimate outcome for learners in this era. Thus, it is highly suggested that evaluation of these skills should be included in the FC curriculum as well.

This study did have some limitations. Firstly, the active learning policy was implemented in every course for the 2015 cohort. Thus, the result of this study could be affected by the overt workload from other courses as well. Secondly, other factors that could affect the examination score such as examination preparation technique or additional peer tutoring within each cohort were not explored due to the nature of a retrospective study. Nevertheless, this study did retrieve all related objective data, controlled numerous potential confounders and presented consistent findings across statistical analyses which were comparable with other published studies.

## CONCLUSION

TL method shows better academic outcome as compared to FC method in the subject of *Epidemiology and Biostatistics* from the historical records of Thai 2<sup>nd</sup> year medical students.

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## REFERENCES

- Schumacher DJ, Englander R, Carraccio C. Developing the master learner: applying learning theory to the learner, the teacher, and the learning environment. *Acad Med* 2013;88:1635-45.
- Collins J. Education techniques for lifelong learning: principles of adult learning. *Radiographics: a review publication of the Radiological Society of North America, Inc* 2004;24:1483-9.
- Hurtubise L, Roman B. Competency-based curricular design to encourage significant learning. *Curr Probl Pediatr Adolesc Health Care* 2014;44:164-9.
- Inra JA, Pelletier S, Kumar NL, Barnes EL, Shields HM. An active learning curriculum improves fellows' knowledge and faculty teaching skills. *Adv Med Educ Pract* 2017;8:359-64.
- Moffett J. Twelve tips for "flipping" the classroom. *Med Teach* 2015;37:331-6.
- Sharma N, Lau CS, Doherty I, Harbutt D. How we flipped the medical classroom. *Med Teach* 2015;37:327-30.
- Ramnanan CJ, Pound LD. Advances in medical education and practice: student perceptions of the flipped classroom. *Adv Med Educ Pract* 2017;8:63-73.
- Tainter CR, Wong NL, Cudemus-Deseda GA, Bittner EA. The "Flipped Classroom" Model for Teaching in the Intensive Care Unit. *J Intensive Care Med* 2017;32:187-96.
- Rui Z, Lian-rui X, Rong-zheng Y, Jing Z, Xue-hong W, Chuan Z. Friend or Foe? Flipped Classroom for Undergraduate Electrocardiogram Learning: a Randomized Controlled Study. *BMC Med Educ* 2017;17.
- Betihavas V, Bridgman H, Kornhaber R, Cross M. The evidence for 'flipping out': A systematic review of the flipped classroom in nursing education. *Nurse Educ Today* 2016;38:15-21.
- Moraros J, Islam A, Yu S, Banow R, Schindelka B. Flipping for success: evaluating the effectiveness of a novel teaching approach in a graduate level setting. *BMC Med Educ* 2015;15:27.
- Mortensen CJ, Nicholson AM. The flipped classroom stimulates greater learning and is a modern 21<sup>st</sup> century approach to teaching today's undergraduates. *J Anim Sci* 2015;93:3722-31.
- Chen F, Lui AM, Martinelli SM. A systematic review of the effectiveness of flipped classrooms in medical education. *Med Educ* 2017;51:585-97.
- Shin YI, Yang CY, Joo MC, Lee SG, Kim JH, Lee MS. Patterns of using complementary and alternative medicine by stroke patients at two university hospitals in Korea. *Evid Based Complement Alternat Med* 2008;5:231-5.
- Hu R, Gao H, Ye Y, Ni Z, Jiang N, Jiang X. Effectiveness of flipped classrooms in Chinese baccalaureate nursing education: A meta-analysis of randomized controlled trials. *Int J Nurs Stud* 2017;79:94-103.
- Evans KH, Thompson AC, O'Brien C, Bryant M, Basaviah P, Prober C, et al. An innovative blended preclinical curriculum in clinical epidemiology and biostatistics: Impact on student satisfaction and performance. *Acad Med* 2016;91:696-700.
- Galway LP, Corbett KK, Takaro TK, Tairyan K, Frank E. A novel integration of online and flipped classroom instructional models in public health higher education. *BMC Med Educ* 2014;14.
- Graham M. Blended learning: A way to engage undergraduate students in learning epidemiology and biostatistics? *Australian Epidemiologist* 2016;23:16-9.
- Lin Y, Zhu Y, Chen C, Wang W, Chen T, Li T, et al. Facing the challenges in ophthalmology clerkship teaching: Is flipped classroom the answer? *PLoS One* 2017;12:e0174829.