Vol.5 No.1 (2022)

**Journal of Applied Learning & Teaching**

**ISSN** : **2591-801X**

Content Available at : **http://journals.sfu.ca/jalt/index.php/jalt/index**

# A quasi-experimental evaluation of a flipped class in a public health course

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**DOI:** https://doi.org/10.37074/jalt.2022.5.1.11

## Abstract

**Objective**: Evaluate the role of flipped class in an undergraduate epidemiology course.

**Methods**: A pre-post quasi-experiment with historical controls was conducted to evaluate students' attitude, perception, and self-efficacy of epidemiology through a flipped class approach.

**Results**: The sample included 254 undergraduate students. Students' attitude, perception, and the usefulness of epidemiology, along with self-efficacy in problem solving, significantly changed after end of class. The average grade rose from B to A-. Qualitative feedback captured two themes: increased pace of the course and collaborative learning.

**Conclusion**: To encourage collaborative learning, this study encourages the integration of active learning together with the traditional lecture style.

**Keywords**: Efficacy; epidemiology; flipped classroom; pedagogy; USA.

## Introduction

Higher education is undergoing a paradigm shift where the 'sage on the stage' approach is giving way to high-impact practices that actively involve students in the learning process (King, 1993). Moreover, as millennials respond faster to the evolving technologies, research shows a decreasing tolerance for the lecture-style dissemination of course materials (Roehl et al., 2013). Lecture-based teaching also constructs a barrier due to limited time for in-class activities that allow students to effectively practice the applicability of learned theories. As a result, such traditional modes of teaching promote passive learning, where students hear the theoretical foundations, but do little to enhance skill-building (Lowe, 2011).

## Literature review

To alleviate the barriers of such a pedagogical approach, Garrison (Garrison & Kanuka, 2004) argued the use of blended learning in higher education, which integrates both face-to-face and online components, to complement and effectively improve critical thinking among students, while Meyer (Meyer 2003) noted the feasibility of higher order thinking through online discussion forums. Similarly, one of the latest trending classrooms learning techniques of the 21st century is the utilization of a flipped classroom method, whereby technology is employed to foster a student-centered learning environment (Rahman & Mohamed, 2014). Such pedagogy is intended to produce a combination of traditional and online education by effectively utilizing students' time not only inside the classroom but also outside their scheduled class sessions (Tune et al., 2013). For example, in a computer interaction course, Day and Foley demonstrated that students in the flipped class score higher on course evaluation outcomes, as compared to their counterparts in the control group (Day & Foley, 2006). Similarly, in an introductory biology course, Moravec and colleagues implemented out-of-class lectures, followed by in-class mini-lectures and activities. Results showed that performance on exam questions that were related to flipped materials increased by 21% (Moravec et al., 2010).

Given the putative role of flipped classrooms in education, such pedagogical approaches may be beneficial to health professions courses. Often, such courses require students to develop practical skills; an opportunity that is limited when class time is spent on lectures and content delivery versus skill building. As such, evaluating the efficacy of flipped classrooms in health profession courses can provide the potential for improving student in-class skill building opportunities, while still covering the content essential for learning. While to-date, the flipped class has shown to be effective in K-12, little evidence exists for its place in health professions programs of higher education. To address this need, this study aimed to evaluate the role of flipped classrooms in an undergraduate epidemiology course at a public institute of higher learning.

## Methods

### Study population

The study population consisted of 254 undergraduate students enrolled in an epidemiology course for a span of two quarters (22 weeks); thus, two sessions. The course is a requirement for all public health, healthcare management, and environmental health students, thus providing a diverse background of student body. In addition, students from nursing, biology, and nutrition, etc. often enroll in the course as an elective option. Students in the course are third year or more in their academic year (not graduate students). The primary reason for limiting the flipped pedagogy to undergraduate students was the background of students. Often in Master or Doctorate level courses, students have significant background in course content (either through undergraduate preparation or job experiences) and/or have developed refined learning techniques. Moreover, undergraduate students taking epidemiology often encounter the depth of the content for the first time in their academic preparation and thus the flipped classroom can provide an opportunity to assess learning of new topics. The institution at which this study was conducted is largely populated by primarily first-generation Hispanic students .

This study was a pre-post quasi-experiment in an undergraduate epidemiology course, with the use of historical controls. Data from two quarters (Fall and Winter) were collected. In the program, the majority of students engage in an internship in the Spring quarter. As a result, the quarter was not included as part of the study due to the potential bias introduced by experience students may gain in epidemiology at their site of internship. The study was approved by the Institutional Review Board of the institution.

The epidemiology course was designed with lectures recorded using PowerPoint and light board technology. Each lecture topic was divided into several 5-10-minute videos and posted online for students. In addition, lectures in text format were also provided online utilizing SoftChalk technology, thus enabling integration of quizzes that allowed students to assess their learning. The videos and lectures also complemented each other, instead of repeating materials; thus, ensuring students would need to review both prior to class. Before attending class, students were also required to take an online quiz that assessed basic knowledge from lectures.

In class, students were provided a learning activity prior to any review of content. This enabled the instructor to evaluate the degree of retention of content from online modules. Immediately after the first learning activity, class discussion ensued to review content that was identified as unclear from online materials. Following this, case studies were provided where students would be required to work in groups to answer questions based on their interpretation of epidemiologic data. This allowed students to practice and develop practical skills in identifying disease outbreak, determinants, and at-risk populations. For example, lecture videos on incidence and prevalence were provided as part of online module. In class, students were given case studies of two hypothetical geographical areas and provided with data on new and existing cases of an unknown disease. Students had to use recently acquired learnings in order to work in groups and to calculate the incidence and prevalence for each geographic location and, to determine which area is having an epidemic and make recommendations of public health efforts. During historical controls, the same lectures and assignments were given and assessments and grading were the same. However, lectures were presented in class while assignments were take-home (non-flipped) activities.

Pre- and post-tests were developed to evaluate students' perception of epidemiologic skills, in addition to the quizzes and exams. These tests were part of the regular course assignment and thus it ensured a 100% response rate. The "Statistics Attitude Survey" was adapted and modified for the epidemiology course to evaluate student's attitude, perception, and self-efficacy related to epidemiology; thus, in turn providing a foundational validation for such an assessment. To ensure privacy of students, no demographic characteristics of the students were collected for this study. The student population of the institute is primarily first-generation minority college students.

The pre-post survey was provided on Blackboard through the survey option and students were given course credit for their response. The survey option on Blackboard ensured that students received credit, but all data remained anonymous. In addition, only aggregated mean values were evaluated for this study, to further protect student privacy. Moreover, all analyses were conducted one full quarter after the end of data collection.

All quantitative analyses were conducted in SPSS version 24 (IBM, Corp.) and alpha less than .05 was used to determine significance. All survey questions were Likert scale, ranging from 1 through 5, 1 being strongly agree and 5 being strongly disagree. Mean rank values of pre- and post-tests were compared by utilizing Mann-Whitney U test to assess distribution and differences in responses from students; with a higher mean ranking denoting strongly disagree while lower mean rank represents strongly agree. Historical data on course grade distribution were obtained from Institutional Research to compare whether change in course delivery method (flipped class versus traditional) resulted in differences in grades. Only previous courses which had the same instructor as the flipped class were used as historical controls to ensure limited bias due to the instructor. Students' qualitative feedback data were aggregated and imported in NVivo software for analysis. Common words were identified by reading and re-reading qualitative feedback until saturation was reached. Next, the words were grouped to identify emergent themes. The instructor's perspective is provided as anecdotal support.

## Analysis and discussion

As demonstrated in Table 1, students' attitudes and perceptions towards epidemiology as a subject and its usefulness significantly changed after the end of the class. For example, on average, more students reported agree or strongly agree on the usefulness of epidemiology in testing validity of studies heard in the media as well as

the epidemiology course being a requirement for their chosen profession. When asked whether taking additional epidemiology courses would be worrying, more students disagreed, which was further supported when significantly more students agreed or strongly agreed to take additional epidemiology courses, even if not required by their academic program.

As shown in Table 2, students' self-efficacy in epidemiology problem-solving also significantly increased after the end of the class. For example, more students agreed or strongly agreed that they were confident when solving epidemiologic problems, finding health determinants, and identifying limitations and biases in research studies.

Student perception of their study practices also showed differences in the post-test data, when compared to pre-test results (Table 3). For instance, at the beginning of the class, more students reported they did not find group work, in-class individual work, or online lectures useful. On the other hand, after the end of the class, significant increases in reporting agree or strongly agree was noted for all factors (group work, in-class individual work, and online lectures).

Finally, historical data demonstrates change in grade distribution. The instructor since Fall 2013 has been the same for the undergraduate epidemiology course. The traditional lecture method was utilized in Fall 2013, Winter 2014, Fall 2014, and Winter 2015. During each of these quarters, the average grade in the course was consistently B+. On the other hand, upon implementation of the flipped class, the average grade in the course rose to A- in Fall 2015 and Winter 2016.

Additionally, qualitative evaluation of student feedback showed two major emergent themes: pace of the course and collaborative learning. For example, students consistently reported that online lectures allowed them to learn content on their own time and review materials as needed throughout the course. Students also noted that the online quizzes allowed for further continuous review of materials without the fear and stress of in-person exam settings. Additionally, students stated that the in-class group activities were informative as the diverse student population (different majors) allowed them to problem solve a topic with different perspectives. Students further reported that the group activities provided scope for collegiality in a primarily commuter school.

## Conclusion and recommendation

This study examined the role of flipped classrooms in an undergraduate epidemiology course at a public institute of higher education. To date, there are no current studies conducted to address its efficacy among this specific population. Using pre- and post-tests, students' perception and attitudes towards epidemiologic skills were examined. Overall, findings from this study present a promising future of the utilization of flipped classroom methodology among epidemiology students.

There were several key findings from this study. Students' attitude and perception changed in a positive direction when it came to the use of technology, pre-and post class work as well as group assignments and hence this is a promising step towards the efficacy of flipped classroom pedagogy among health science students. Students' problem-solving skills improved. Although there are no current studies conducted with a focus on epidemiology students, other studies based on other majors have found similar findings whereby students' self-efficacy in problem-solving skills increased at the end of a flipped classroom course. Therefore, other educators should consider implementing flipped classroom methodologies over a long period of time among this study population (Tune et al., 2013; Roach, 2014). Students' perceptions of group work, in-class individual work, and online lectures improved. This finding is supported by the literature which suggests that today's students gravitate towards in-class group activities as well as collaborative learning experiences (Roach, 2014; Roehl et al., 2013; Enfield, 2013). The class grade average in the course rose from a B+ to an A- over a 4-quarter period. These promising student outcomes are supported by the literature which suggested that the incorporation of a flipped classroom model contributed to the improvement in students' exam performance conducted in other studies (Davies et al., 2013; Tune et al., 2013; Rahman & Mohamed, 2014; Roach, 2014).

Overall, in the context of this study, active learning continues to evolve. As students received more opportunities to engage and become active thinkers, their perceptions changed. Consequently, as students stay engaged and actively participate in class activities, their self-efficacy improves and so do their grades. It is promising to learn that students were very optimistic about taking additional epidemiology courses demonstrating that they are eager to learn more. Therefore, as students' perception and overall grade improves, so too does their preference for a flipped classroom methodology.

From an instructor's perspective, the online lectures allowed for more in-depth study of epidemiologic topics, which is often inadequate due to limited class hours. In addition, the in-class activities which allowed for application of learned theories, grew students' interest in epidemiologic research, resulting in several students demonstrating interest in or even initiating faculty-supervised research projects in consecutive quarters. Despite the considerably large class size, the in-class activities allowed for one-on-one interaction with students, thus leading to a better faculty/student relationship and allowing greater scope for mentorship. Finally, given the high proportion of students who work, flipped classroom allowed the flexibility in schedule for students to continue to learn while not being limited by their work schedule; an asset for an institution serving a primarily low-income service area.

Nevertheless, the flipped class is not without its limitations. Creation of online materials and accompanying case studies require significant time commitment, adding to faculty workload. For example, one flipped classroom study found out that, although the class was interactive, instructors spent around two hours per lesson to produce videotaped

lectures and digital slide presentations (Roehl et al., 2013). Furthermore, not all students prefer online lectures and as such, this pedagogical approach may not be effective for students who prefer to learn best through direct lectures from instructors. Similarly, the results of this study should be interpreted in the context of its limitations. The quasi-experimental design limits causal reference due to lack of randomization. This study had historical control measures in place and thus the research team is unable to address any causal relationship. Furthermore, attrition of students, resulting from graduation or change of major, makes it difficult to assess long-term retention of learned knowledge and perception of the usefulness of epidemiology. Further studies using a true randomized controlled trial would be effective in demonstrating the causal relationship between such innovative pedagogy in health professions-related courses.

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## Appendices

Table 1: Attitudes and perceptions towards epidemiology.

| | Mean rank | | p-value |
|---|---|---|---|
| Question | Pre | Post | |
| I don't know what Epidemiology means. | 120.2 | 133.3 | 0.0052 |
| I don't see the reason why I have to take an Epidemiology class for my career choice. | 125.7 | 127.4 | 0.5460 |
| Epidemiology will be useful to me to test the validity of studies I hear in the news. | 136.0 | 115.1 | 0.0118 |
| I might use Epidemiology at my job but wouldn't like doing it. | 124.4 | 128.8 | 0.6057 |
| Epidemiology will be useful to me when I describe my professional activities to other people. | 125.2 | 125.9 | 0.9312 |
| Epidemiology will be a useful tool that I can use to improve the quality of measures that I have or may develop in my profession. | 131.4 | 120.2 | 0.1726 |
| Epidemiology is so useful that it should be a required part of my professions skills. | 142.8 | 111.2 | 0.0002 |
| I find Epidemiology to be very useful in my profession. | 134.9 | 115.5 | 0.0228 |
| Epidemiology may be useful to someone who plans to pursue a career in research, but not very useful to the average healthcare professional. | 135.4 | 114.8 | 0.0173 |
| The average healthcare professional would find Epidemiology a boring subject. | 124.6 | 128.6 | 0.6422 |
| The thought of taking another Epidemiology course makes me feel worried. | 112.6 | 141.5 | 0.0005 |
| I think Epidemiology is very logical and clear. | 144.4 | 105.9 | 0.0000 |
| Given the opportunity, I would take another Epidemiology course even though it wasn't required. | 138.5 | 113.5 | 0.0041 |
| I am interested in an Epidemiology career, such as working at CDC as an Epidemic Intelligence Service agent. | 125.1 | 128.0 | 0.7408 |

Table 2: Self-efficacy for epidemiology.

| | Mean rank | | p-value |
|---|---|---|---|
| Question | Pre | Post | |
| I am not confident in solving an Epidemiologic problem. | 106.1 | 148.6 | 0.0000 |
| I am confident that I can easy solve a population health problem when presented to me using Epidemiologic reasoning. | 146.3 | 105.1 | 0.0000 |
| I am confident that given a health problem I can easily find the determinants. | 148.6 | 99.2 | 0.0000 |
| I am confident that given a research study, I can find the limitations and biases in the study. | 158.8 | 90.8 | 0.0000 |
| I am confident that the items I learn in this course will be useful to my career. | 131.1 | 118.5 | 0.1290 |

Table 3: Epidemiology study practice.

| | Mean rank | | p-value |
|---|---|---|---|
| Question | Pre | Post | |
| An average student can expect a good grade in Epidemiology if he/she studies. | 147.8 | 105.9 | 0.0000 |
| I find group work to be useful in learning concepts. | 136.3 | 115.9 | 0.0000 |
| I find homework to be useful in learning concepts. | 131.0 | 120.5 | 0.0000 |
| I find in-class individual work to be useful in learning concepts. | 137.1 | 114.1 | 0.0000 |
| I find online lectures to be useful in learning concepts. | 145.7 | 104.9 | 0.1290 |