

# Development of a Digital Textbook and the Use of Innovative Active Learning Strategies to Improve Student Learning Outcomes

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## Abstract

Development of a course-specific digital textbook and the incorporation of innovative student-centered learning strategies such as flipped teaching (FT) and team-based learning (TBL) were tested in a course titled *Biology of Cardiovascular and Metabolic Diseases* (KIN 412). Flipped teaching allows students to complete pre-class assignments such as selected readings, pre-recorded lecture videos, PowerPoint slides, and an individual assessment over the assigned content. The in-class TBL session was focused on engaging students in knowledge application and analysis. The traditional lecture format, on the other hand, was an interactive didactic live lecture presentation. FT-TBL teaching method was tested initially over half of the semester (partial flip) and their major exam grades were compared with that of traditional (unflipped) teaching. Students in the current semester (spring 2017) are taught in the flipped style the entire semester. Preliminary results suggest that students benefited from the flipped teaching the exams 1 and 2 when the course was flipped. Student surveys were positive about TBL and flipped teaching and the digital textbook. Attendance was significantly increased.

## Introduction

Recent research suggests that active learning methodologies yield superior educational outcomes compared to traditional lecture method of teaching. The use of in-class active learning strategies, however, limits the amount of available lecture time that can be devoted to instructor-provided content coverage (1-2). Flipped teaching (FT) has been shown to improve student preparedness as well as the level of engagement during class (3-4). It offers new challenges as well. For those students not accustomed to preparing ahead for class, FT may require modifications in their study habits and schedules. Team-based learning (TBL) offers additional benefits such as problem solving through peer teaching.

Despite controversy related to the cost and/or the quality, textbooks play a key role in medical science learning. Although the traditional textbook, if left unchanged, will probably not result in meaningful learning, the instructor-provided course specific textbook eliminates concerns related to content coverage. If educators mediate the interaction of students and texts with strategies for meaningful learning, the interaction can be even more productive (5-7).

The purpose of the current project was to prepare a digital textbook for students in the KIN-412 course as well as to teach in the student-centered FT-TBL format and compare the results from major exams with that of traditional teaching method. Student performance was expected to be higher in the FT-TBL portion of the teaching.

## Methods

**Comparison of Lecture-based Teaching with Flipped Teaching combined with Team-based Learning:** This study consisted of 118 students from KIN412 course in their third- or fourth year at SIUE, from fall 2015 to spring 2017. The class met 50 minutes, three times a week for 16 weeks. The study design between traditional lecture-based and flipped teaching is summarized in Table 1 and Figure 1.

Table 1. Study Approach Used in Different Semesters

Semester	Teaching approach	Number of sections	Number of students
Fall 2015	Lecture-based	1	20
Spring 2016	First half: Lecture-based; second half: FC-TBL	2	53
Fall 2016	First half: Lecture-based; second half: FC-TBL, with one class period to complete pre-class assignments	1	27
Spring 2016	Fully flipped with one class period to complete pre-class assignments	1	18

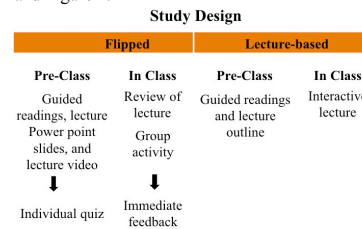


Figure 1. Study Design of Lecture-based and Flipped Teaching

### Development of a Digital textbook:

The digital textbook was written initially as individual chapters and shared with students through *Blackboard*. Selected illustrations and content was obtained from the Open-Stax publication of *Anatomy and Physiology* book, a free downloadable textbook (8). Additional details were added as needed to make the textbook a robust resource for our students in the KIN412 course. The textbook is revised as needed over the last two years.

## Results

The digital textbook production is now completed (Figure 2). FT combined with TBL study results are summarized in figures 3-5.

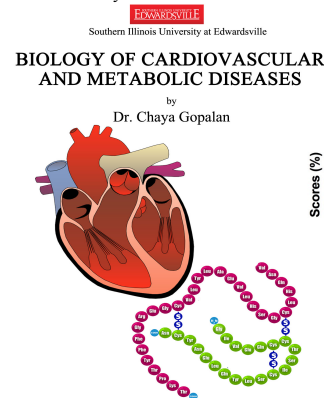


Figure 2. Front Cover of the Digital Textbook for KIN412 Course

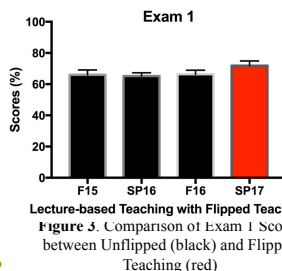


Figure 3. Comparison of Exam 1 Scores between Unflipped (black) and Flipped Teaching (red)

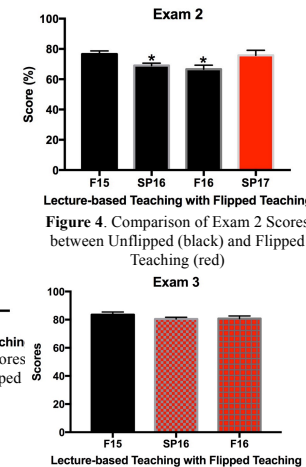


Figure 4. Comparison of Exam 2 Scores between Unflipped (black) and Flipped Teaching (red)

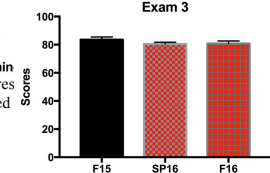


Figure 5. Comparison of Exam 3 Scores between Unflipped (black), Partially Flipped (SP16), Partially Flipped and Additional Time to Complete Pre-class Assignments

## Discussion

The production of a course specific digital textbook although is daunting, it is undoubtedly rewarding. This textbook will be revised periodically to update the content.

FT combined with TBL was initially considered as very time consuming by the students (Spring 2016). Based on their comments, the FT design was modified to offer extra class time for the students to complete their pre-class assignment and was overwhelmingly well received by the students (Fall 2016).

FT combined with TBL improved student performance in the first two exams as shown in figures 3 and 4. However, there was no significant difference in the exam 3 performance. Although this study is yet to be completed to fully comprehend the reasoning for the same, it appears that the students perform better in exam 3 in all of the semesters this course was taught.

In conclusion, students benefit from student-centered teaching methods. A course specific digital text is an additional benefit to the students to focus on selected content.

## Acknowledgements

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## References

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