Use of Peer Instruction and TopHat in a Pharmacology Lecture: Observation of Students' Engagement and Perception

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Introduction

Research has shown that students' retention of course materials and critical thinking can be enhanced if active learning is engaged (e.g., Cherney, 2008; Kim et al., 2013). Active learning can be broadly understood as a class structure which allows the students to have a prominent role in what they learn inside the classroom (Prince, 2004). There can be different interpretations and levels to engagement and what the practice entails. In traditional lecture-based classes, engagement may be recognized through note-taking or giving one's attention to the speaker, whereas other forms of instructions may get the students involved in the learning process through discussion, questions, or collaboration.

As technology has become more available, there have been a variety of applications that can be adopted in the classroom to support active learning. Studies have shown that if properly integrated into the pedagogy, technology use in the classroom can be an important tool in achieving better learning results (Schmid et al, 2014).

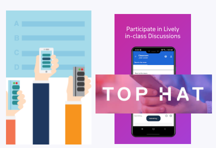
In recent year, TopHat, an interactive engagement tool that promotes participation and collaboration, has been introduced into the classroom. The purpose of this study is to provide a quantitative comparison between a section of an upper level Biomedical Sciences course using TopHat paired with peer instructions and a section of the same course with traditional lecture-based instructions in terms of how class time was spent and what kinds of student engagements were involved.

Methods

Course Observed: Two sections of an upper level BMS course on pharmacology.

Section	Instructional Methods	Number of students	Length of class	Starting Time	Times met per week
Technology assisted	TopHat Peer instruction Lecture Discussions	85	75	4pm	2
Traditional	Lecture Discussions	31	50	1pm	3

TopHat: It is a classroom response system. This system is used to present students with case studies and questions that can be answered by their personal electronic devices during the class period.



Peer instruction:

This technique involves students responding individually to questions through TopHat. The students then discuss their answer choices with a peer, after which they subsequently resubmit their TopHat answers. This method of instruction is used to enhance conceptual understanding as well as quantitative problem solving in a large lecture classroom setting.

Data collection:

Data were collected through direct observation in each of these two sections. Observations of instructional practices and student engagement were coded using the Classroom Observation Protocol for Undergraduate STEM (COPUS) coding schema (Smith et al., 2013).

A total of five class periods were observed, three TopHat classes, and two traditional classes. Initially, 10 observations, five classes from each section, were planned. However, data collection was terminated due to school closure in responding to the Corona pandemics.

Coding schema

COPUS records both the instructor and students' behavior in the classroom in 2-minute intervals. The protocol is divided into two categories: "What the students are doing" and "What the instructor is doing." In this study, only the instructor's behaviors were recorded. The student's engagement was inferred based on the relevant coding of the instructor's behaviors (see measure of "Student Engagement" for more details).

Methods (Cont.)

A sample of the Excel file used to record instructor's behaviors for each class period. The first column on the left shows the time intervals, and the subsequent columns are designated to individual behaviors.

Time intervals (minutes)			Lecturing	Interjection'	Real-time writing	Follow up on clicker ques	Posing non-clicker questi	Asking clicker question	Answering student questi	Moving through the class	One on one discussion wi	Conducting a demo, expe	Administration	Waiting	Other
Time	Start	Stop	Lec		RtW	FUp	PQ	CQ	AnQ	MG	1o1	D/V	Adm	W	O
4.00	0.00	2.00	X												
4.02	2.01	4.00													
4.04	4.01	6.00	x												
4.06	6.01	8.00					x		x					x	
4.08	8.01	10.00	x				x								
4.10	10.01	12.00	x												
⋮	⋮	⋮													
4.28	28.01	30.00	x	x			x								
4.30	30.01	32.00	x												
4.32	32.01	34.00	x	x											
4.34	34.01	36.00	x												
4.36	36.01	38.00													
4.38	38.01	40.00	x	xx											

Measures:

Class time allocation: The percentage of class time spent in specific instructional practice is calculated by having the total time spent on the coded behaviors (i.e., instructional practices) divided by the total class time and then averaged over the number of class periods.

The percentage of class time allocated to the following behaviors/instructional practices are calculated for both the TopHat and the traditional sections.

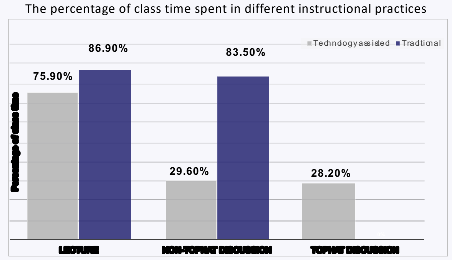
- Lec: lecturing (presenting content, deriving mathematical results, presenting a problem solution, etc.)
- PQ and AnQ: Posing a non-clicker question to students (non-rhetorical) and listening to and answering student questions with entire class listening
- CQ: Asking a clicker question and also referred as "use of TopHat" in this study (N/A for the traditional instruction section).

Student engagement: It was not measured separately. Instead, it was inferred based on what the instructor was doing in the classroom. The following three types of engagements were included:

- *Active collaborative* engagement: Percentage of class time spent on posing TopHat questions. After the TopHat questions were given to the students, the students conducted peer instructions. During this time, they discussed the questions in pairs, an activity considered as both active and collaborative.
- *Discussion* engagement: Percentage of class time spent on asking and answering non-TopHat questions. The students had to engage in active thinking because the instructor was expecting the questions to be answered once they were posed to the students.
- *Attentional* engagement: Percentage of class time spent lecturing as note-taking or attentional engagement. Students' note-taking is considered as a form of attentional engagement.

Results

The percentage of class time spent in different instructional practices



- The traditional lecture-based section spent 11% more of the total class time lecturing than the section using TopHat.
- The traditional lecture-based section also spent 55.7% more of the total class time asking/answering non-TopHat questions.
- The section that used TopHat spent 28.2% of total class time on the TopHat/Peer instruction.

Discussions

The greater amount of time spent lecturing in the traditional section suggests that there is more passive engagement through note-taking. However, in the traditional-lecture based classroom, the instructor also asked the students almost two times more questions. In contrast, the students in the TopHat section spent about a third of the class time using TopHat.

As the use of TopHat was associated with peer instructions, the task of engaging students by asking students questions seems to be shifted from the instructor in the traditional classroom to the technology device used in the classroom (i.e., TopHat).

Whether these differences in instructional practice and student engagement entailed have different impacts on students' learning still needs to be investigated.

There are a number of limitations in this study:

- The COPUS coding protocol measured behaviors in terms of two-minute intervals. There were many instances where multiple actions or activities occurring in the same 2-minute interval. As a result of this problem, the overall percentages do not always add up to 100.
- Fewer than planned sessions were observed due to the switch to remote learning in the middle of the semester. Data collection could not be completed.
- Student engagement was inferred based on the instructor's activities instead of being assessed directly.
- Had the project not been interrupted, the students in the section assisted by TopHat would have been given a survey to gage their perception of using the in-class response system. This tool would have provided a better understanding of how the students viewed this classroom resource, and whether they felt it enhanced their learning experience.
- The TopHat and traditional sections were not taught by the same instructor. Teaching style can be a confounding factor.
- Learning was not measured. Therefore, it is unclear whether different ways of engaging students result in different levels of learning.

Future Studies

Assessing student behavior and engagement:

This study was initially designed to measure the behavior of both the instructor and the students, as can be seen from the COPUS protocol. To observe both categories there would need to be two observers present so that each could observe one of the categories, and later combine and compare data. In addition to using the COPUS protocol, perhaps student engagement can also be evaluated using other measures.

Dealing with confounding factors:

In future studies, the following can help make the comparisons between tech-assisted section and traditional section more meaningful:

- Both sections taught by the same professor. Differences in instructional practices can lead to differences in learning outcome.
- Both sections have the same number of students. A smaller class may have the advantage of less intimidation from peers, therefore biasing the results.
- Both sections are the same class length. Attention and engagement can be altered by the length of the class regardless of instructional methods.
- Both sections are at similar time of day. This will avoid any differences in engagement due to one class being very early/late.

Assessing both short-term and long-term learning outcomes:

In order to determine the benefit of using a technology-based resource in the classroom, understanding of material taught in class should be assessed objectively in both sections with and without the use of technology. Assessments of learning should be done right after the materials were presented and after an extended period (e.g., assessed in their capstone class prior to graduation) to better understand the impacts of technology use on learning outcomes.

References:

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