

# Putting your own personal twist on a flipped organic classroom and selling the idea to students

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## Abstract

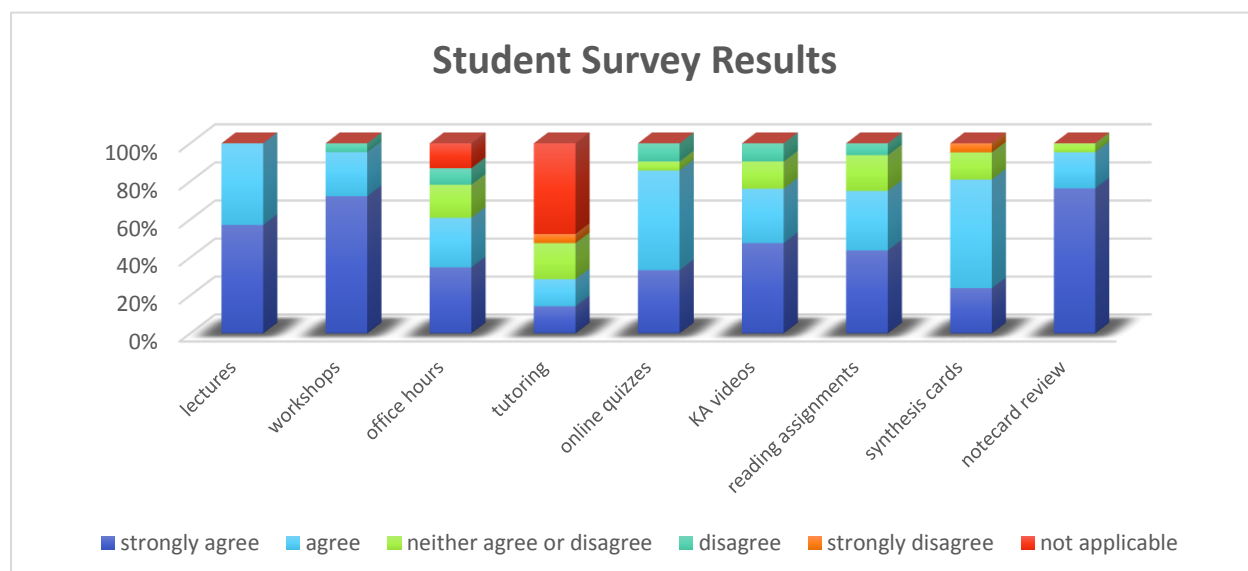
Do you want to incorporate active learning into your organic lectures, but don't have the time or resources to start recording your own videos just yet? If so, there are other alternatives! While "flipping" any course involves a substantial increase in the workload of the faculty, it also requires that you absolutely sell the idea to your students. While taking into account student feedback and interest, a traditional two-semester organic course was gradually modified throughout the academic year to incorporate additional active learning techniques, such as videos, reading assignments, online quizzes, and classroom activities. This presentation will focus on my experiences gradually implementing an active learning approach based on student feedback and ideas for getting students on board with this new approach. In addition, a description of the techniques used will be discussed including several unique hands-on activities for the classroom. Although results are preliminary, there has been a significant increase in student retention and peer-to-peer engagement, both inside and outside of the classroom.

## Introduction

While attending the 2014 Biennial Conference on Chemical Education, I listened to numerous presentations on "flipping" your classroom.<sup>1</sup> Speaker after speaker enthusiastically praised this student-centered approach to teaching that increased both student engagement and retention. The more I understood, the more I realized that this teaching style is similar to methods I currently use in the classroom...except more refined. Before leaving Grand Rapids, I was sold on the idea of flipping my classroom. However, I knew I would also have to overcome two major obstacles: the immense initial investment of time by the instructor and getting students on board with the idea. I then set the following goal for myself:

***To gradually "flip" my classroom in a way that best complements my teaching philosophy and my students' learning styles.***

If I only learned one thing at that conference two years ago, it was that there is no one right way to flip your classroom. As a matter of fact, most would agree that the opposite case is true. There are so many options currently available, that it can easily become overwhelming. PowerPoints, reading assignments, in-class activities, clicker questions, video recording....where does one even start? The primary objective of this paper is give other faculty who are considering adopting active learning approaches the tools (and the courage) to do so successfully, one step at a time. A description of my teaching methods prior to incorporating elements of a flipped classroom are discussed, followed by an account of my experiences and rationale behind implementing select active learning strategies.



**Figure 1.** Results from students surveys regarding contribution of selected aspects to overall learning of course material during the Fall 2015 – Spring 2016 semesters. 21 Students completed the survey.

### Methods: The Traditional Lecture

So how do you convince students that this new “flipped” method of classroom management is more effective than a traditional lecture? The simple answer is...you don’t. It has been my experience that students are considerably more willing to listen to their peers than to take advice from the expert lecturing in the front of the room. Instead, you must persuade them to convince themselves. At the end of every semester (and even sometimes throughout the semester), I have students complete anonymous surveys regarding various aspects of the course, then share the results with the class. Student survey results regarding selected aspects of my organic chemistry course after incorporating various active learning strategies are shown in Figure 1.

In order to ensure that the majority of students thoughtfully completed the survey, a small amount of extra credit was offered. A couple of humorous questions are typically included on each survey to entice students to read the results. Students are also informed that the results will be used to modify future courses, so their honest opinions are appreciated.

To begin, the results show that 100% of students agree/strongly agree that lectures contributed to their overall learning of the course material. By golly going to class helps, who would have thought?!?! In addition to the use of Powerpoints and a whiteboard to introduce material during lecture, I also routinely distribute workshops containing practice problems. After lecturing for approximately 30 minutes, we usually work a few problems together as a class. Students then use the remainder of class time to continue working on the workshop. Prior to the next class period, students are expected to complete the workshop and compare their answers to the key posted online. Once again, students found this to be a very effective method of learning with 95% of students agreeing/strongly agreeing that workshops are an effective method of learning. Fewer students take advantage of my office hours and the free tutoring available on campus and thus unfortunately considered those aspects of the course to be less valuable.

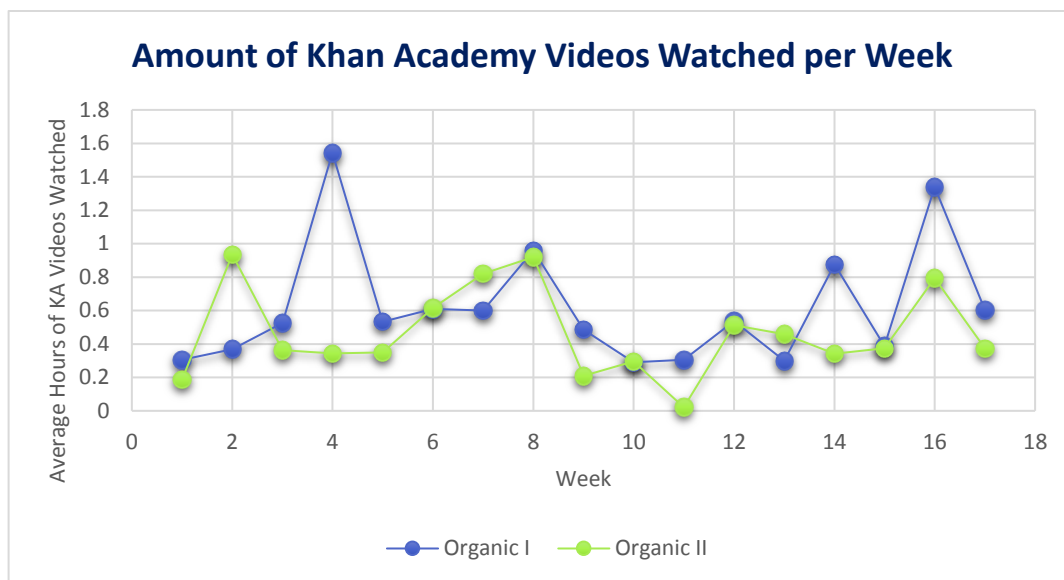
## Methods: The Flipped Lecture

In addition to the Likert survey results in Figure 1, students were asked free response questions. A selection of student comments regarding various course aspects are available in Table 1. I also asked students what changes they would like to see in the course. One of the most prevalent responses was to “work more problems together.” In order to allow more time for problem-solving during class, the traditional paper quizzes given at the end of class on a routine basis were replaced with weekly Blackboard quizzes. Students were allowed to use their textbook & notes to answer ten multiple choice questions within the hour time limit. All students received similar, but different questions to discourage cheating. There was a favorable response to the online quizzes with 85% of students in agreement that these quizzes had a positive impact on their learning of course material.

While the weekly quizzes provided a checkpoint for students, I also wanted to give students the opportunity to gain exposure to the course material prior to lecture. However, like most faculty at small liberal arts colleges, I routinely have a substantial teaching load so recording my own videos wasn't a project I had time to undertake. While looking for alternative options, I was introduced to Khan Academy Videos.<sup>2</sup> I required students to watch a minimum of thirty minutes of Khan Academy Videos per week,

**Table 1.** Sampling of student comments regarding various aspects of course material during the Fall 2015 – Spring 2016 semesters. 21 Students completed the survey.

<b>Lectures</b>
“The most beneficial part of lecture is when the mechanisms are worked out step by step the board” “Really enjoyed working problems together in class and then going over it step by step to explain what exactly was going on”
<b>Workshops</b>
“It shows me what I understand and what I need to work on the most” “It is helpful to make the workshops as difficult as the exam will be”
<b>Online Quizzes</b>
“Kept us fresh and up to date in order to discourage slacking” “The more relaxed environment helps me to concentrate better”
<b>Khan Academy Videos</b>
“Reinforce what is taught” “Great way to learn at your own pace”
<b>Reading Assignments</b>
“They really do help focus attention on the important material we go over. It makes me feel more prepared for each lecture” These were a little rough because you have to do the problems before we learn the material, but I think it helped a lot”
<b>Synthesis Activity</b>
“Although I found synthesis to be the most interesting, I believe that was also one of the most challenging topics of the semester” “The synthesis problems were the most interesting because it was like a puzzle”
<b>Review Activity</b>
“My favorite assignment was making the notecards for the final review. I think it was a good exercise to make up my own problems” “It gave us a good overview of the entire semester by having to come up with questions on our own to give to other students”

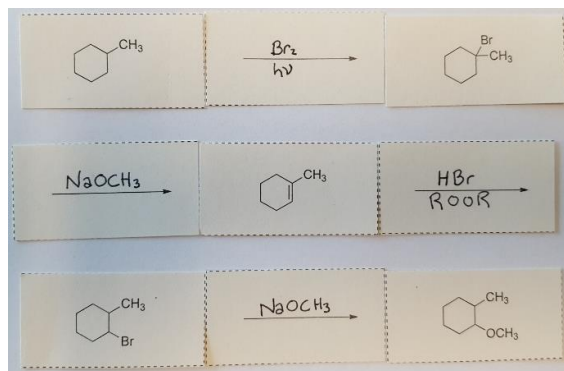


**Figure 2.** The average amount of hours of Khan Academy Videos watched per week during the Fall 2015 – Spring 2016 semesters.

which I could easily monitor online. As shown in Figure 2, the average amount of hours watched per week fluctuated throughout the semester with higher activity toward the beginning and end of the semester. The highest week of activity during the two-semester sequence was during week 4 of the Organic I class, which just so happened to correspond with the week that exam 1 was returned to students. I presume that was quite the wake up call to students.

It was suggested to students that they watch videos on topics prior to class, but they were given the freedom to select videos on any topics to watch at any point during the semester. Thus Khan Academy videos provided a resource for students that allowed them to tailor their learning to their own skill level and allow them to work at their own pace. Overall, students were pleased with the addition of Khan Academy videos to the course with results showing 77% of students agree/strongly agree that it contributed to their overall learning of course material. Many textbooks on the market have an option for an interactive web-based assignment and assessment platform, for a price of course. Having used those programs in the past, both students and I were left dissatisfied. I feel that a combination of online quizzes and Khan Academy videos are an inexpensive, viable alternative to those costly programs.

After the semester of Organic I was complete, students seemed accepting of the technology-focused course additions (Blackboard quizzes and Khan Academy videos), in addition to the workshops they were already accustomed to. *So what next?* As all organic professors know too well, students routinely struggle with organizing the large amount of material. Therefore I decided to introduce reading assignments at the beginning of Organic II, with the expectation that it would force students to read the material prior to class, help students get organized, and allow us to have more thought provoking discussions during lecture. These reading assignments, usually one per week, focused on concepts, reagents, and functional group transformations, while usually leaving the more complex topics of mechanisms and synthesis to focus on during lecture. Initially, there was a little resistance and students struggled reaching a basic understanding of the material on their own. Eventually though, by the end of the semester they realized the benefit of such pre-lecture assignments, which even promoted the formation of study groups.



**Figure 3.** Example of a solved synthetic problem used to introduce multi-step synthesis as a classroom activity.

One final twist I wanted to add to my “flipped” classroom is the addition of more hands-on activities to promote higher level cognitive thinking during lecture. I will briefly describe the design of two such activities that have recently been utilized. I chose to focus my first activity on multi-step synthesis because students have described it as being the most interesting aspect of organic chemistry, yet also the most difficult. This activity asks students to design synthetic routes using a restricted set of molecules printed on cards, thereby allowing them to focus on pattern recognition instead of falling into the trap of memorization.<sup>3</sup> One such example of a completed synthetic scheme is shown in Figure 3. This scaffolding approach allows students to begin multi-step synthesis with a set of training wheels. Over time, students gradually stopped using the cards on their own as their confidence level improved and believed that the activity greatly contributed to their overall learning.

**#1**

**Concepts**

- Ranking acidity
- Resonance
- Functional groups

**Mechanisms**

- $S_N1$  reaction without rearrangement
- Addition of  $X_2$  to alkene

**Predict Products**

- Formation of an alkyl bromide using free-radical halogenation
- Epoxidation of an alkene
- Reaction of an alkyne with 2 equivalents of HX
- Formation of a secondary alcohol using a Grignard reaction

**Synthesis**

- Transform an alkane  $\rightarrow$  primary alcohol
- Contains an alcohol as an intermediate
- Incorporate an elimination reaction

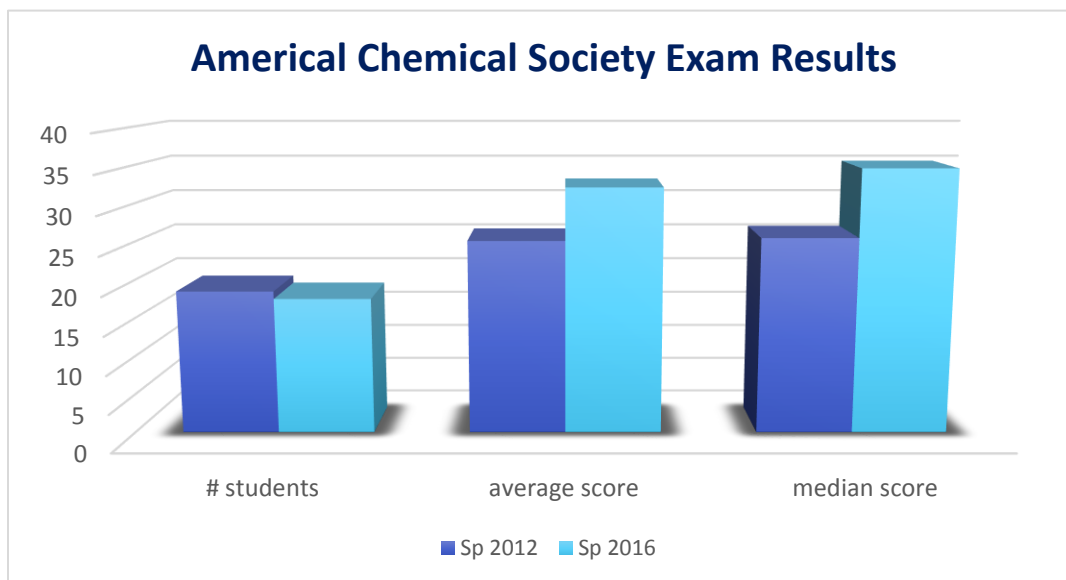
**Figure 4.** Example of question prompts used as a classroom activity for an end-of-semester review.

After numerous discussions with students, I realized that during study groups students would quiz their classmates with questions they created on their own. The next activity I designed takes this concept one step further. Students are given specific prompts and asked to write their own questions, with answers, on note cards.<sup>4</sup> The topics on the prompts, as the example in Figure 4 shows, range from simple concepts and predict the products, to more challenging mechanisms and synthesis problems. Because the prompts are designed to cover topics spanning the entire semester, once completed, the class would have a study guide they wrote themselves. The students shared their questions with the class and were even able to correct and find the few mistakes that were made on other student-generated questions. The response to this activity was overwhelmingly positive, with 95% of students agreeing/strongly agreeing that this activity contributed to their learning of organic chemistry.

### Conclusions

So the students liked this new (at least new to them) flipped classroom approach, but did it improve their grades? I compared my average score on the American Chemical Society standardized final exam covering two semesters of organic chemistry before (Spring 2012) and after (Spring 2016) the implementation of active learning strategies (Figure 5). The median score increased by nine points! Although the data set is small, the results are very encouraging. Using student survey responses and ACS exam scores as support, I believe the major advantages to partially flipping your classroom and incorporating active learning methods include:

- Increased student engagement
- Allowing students to work at their own pace
- Classroom time can be used for higher order learning activities
- Instructors have more insight into topics that students find most challenging



**Figure 5.** Results from American Chemical Society exam covering two semesters of organic chemistry before (Spring 2012) and after (Spring 2016) the implementation of active learning strategies.

This article has described methods to successfully incorporate select elements of a flipped classroom ranging from online technology to hands-on activities. This was accomplished using freely available Khan Academy videos instead of going through a time-intensive process of recording my own videos. Student surveys were used to gauge the preferences of the students and then shared with class thereby persuading students to convince themselves that an active learning model is preferable to the traditional lecture. However, if students are not willing to invest the time in preparing for lecture by watching videos, completing reading assignments, and taking notes, they will inevitably be lost during classroom activities and are likely to become frustrated with the course structure. Future plans include exploring additional modifications to the course structure with the intent of shifting study habits from larger chunks of time on an infrequent basis to a more preferred smaller chunks of time everyday approach. I also would like to see students watching videos prior to lecture on a more routine and are likely to become frustrated with the course structure.

Future plans include exploring additional modifications to the course structure with the intent of shifting study habits from larger chunks of time on an infrequent basis to a more preferred smaller chunks of time everyday approach. I also would like to see students watching videos prior to lecture on a more routine basis. In addition, I also plan on introducing a similar active learning approach to my freshman students by adopting it in my general chemistry courses. I have no plans on recording my own videos in the near future or completely eliminating lectures all together from my courses. I believe that certain topics, such as advanced mechanisms and synthesis, are better explained in a traditional lecture format. I encourage any instructor who is interested in active learning methods to personalize their methodology and listen to student feedback. Don't feel overwhelmed by the initial challenge, but instead take your time to merge some active learning approaches into your current teaching philosophy. Again, there is no one right way to flip your classroom.

Thank you for your time, and I look forward to answering any questions.

### Works Cited

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