International Journal for the Scholarship of Technology Enhanced Learning *Volume 1 Issue 1 2016*
Pages 135-144

Echo 360 Preparatory Videos as Aids to "Flipping the Classroom"

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Abstract
Chemistry faculty members at Georgia Gwinnett College have used preparatory videos created with Echo360 in order to facilitate use of their version of the "Flipped Classroom" method of teaching undergraduate organic chemistry. These preparatory videos are viewable by GGC students whether they have a mac, a pc, a smartphone or a tablet, and have proved to be extremely popular with students, being accessible anytime and from anywhere. Use of these videos as preparatory aids for pre-class assignments has enabled a much higher level of student engagement in organic chemistry classes that use the flipped classroom method.

Keywords: Echo360; flipped classroom; preparatory videos; organic chemistry; student engagement

Introduction

The challenge of organic chemistry

Organic Chemistry is well known to be one of the more challenging courses that STEM students undertake during their undergraduate career (Zurer, 2011). But, what is it that makes Organic Chemistry such a special challenge for students and faculty? It is typically a two-semester sophomore level course sequence, and is a gateway course for upper-level chemistry and biochemistry courses. In addition, it is required of virtually all students pursuing medical, dental, pharmaceutical or other health professional schools and training. As such, it is populated with students of broad academic and professional interests. Most students find the course exceptionally challenging because of the breadth and depth of content, the rapid pace of the course, and the notion that each successive lesson builds directly on previous lessons over the entire year-long sequence. In fact, students know Organic Chemistry as "the infamous, dreaded 'orgo', a marathon of memorization" (Zurer, 2011). Many students come into the class with preconceived notions of what their class experience is going to be, based on comments from their peers or from popular media (Udo et al, 2014).

In many cases, students view Organic Chemistry as an obstacle to overcome in order to get to their higher science classes. Many have the belief that overcoming this obstacle can be achieved by getting copies of old exams, relentless memorization of facts they think are important, and selection of whom they consider to be the "easiest" professor (Pienta, 2011).

In her 2007 James Flack Norris Award address, chemistry professor Diane Bunce of The Catholic University of America wrote that when students don't perform well, faculty usually believe that it is the students who are at fault, and rarely consider if they, as faculty members, have appropriately structured the course to align with students' levels of ability and understanding. Bunce concludes that creating a learning environment that is a community of learners with shared responsibility (rather than a learning environment that is teacher-driven) offers the best opportunity for student learning (Bunce,

2009). Thus, by changing the classroom culture in which student learning occurs, we may be able to directly impact student attitudes towards learning Organic Chemistry, which in turn may give rise to augmented student success in the course.

Research has shown that prior math and chemistry knowledge are not necessarily indicative of success in Organic Chemistry, but what is an indicator is a positive attitude towards the study of chemistry (Steiner & Sullivan, 1984).

The question: can student engagement be improved using a more active approach in the classroom?
This article aims to answer the above question by illustrating a Georgia Gwinnett College (GGC) chemistry faculty member's efforts to improve student engagement in a Spring 2015 Organic Chemistry class. Achieving the goal of improving student engagement was attempted via use of the flipped classroom method, supplemented with videos made using Echo 360 to aid in the students' pre-class preparation. As student engagement is not something that can be directly measured (unlike performance on exams and quizzes), the level of engagement students experienced was gauged by their responses to survey questions administered at the end of the semester. The overall goals were to gauge student Echo 360 video use during the semester (and the potentially augmented in-class student engagement) rather than student performance, so all of the surveys were conducted anonymously. The details of these survey questions, as well as student responses to them, are discussed in the "Student Surveys and Responses" section of this article.

Creating a more active learning environment
How can a positive attitude be fostered among Organic Chemistry students? One possible answer appears to lie in the use of teaching methods that keep students more engaged during class. Student-centered, guided-inquiry instruction methods such as PBL (problem-based learning), POGIL (process-oriented guided-inquiry learning) or PLTL (peer led team learning) have been reported to enhance student performance, engagement, and satisfaction in science courses (Smith, 2013; Ferreri & Connor, 2013).

In order for active learning to occur, more extensive pre-class preparation (on the part of the students) needs to occur. A variety of methods have been used to try and achieve this, such as with blogs (Benedict & Pence, 2012), pre-class worksheets and tutorials (Arnaud, 2013), and video capture of entire lectures (D'Angelo, 2014). Whichever preparation method is used, however, they all fall under the umbrella of "flipping the classroom." This term means simply that a large portion of work is shifted to happening outside of class (Christiansen, 2014), so that class time can be spent in a more targeted, efficient and student-centric way than with the traditional lecture method. Studies have indicated that there is enhanced learning and greater student satisfaction when the traditional lecture course is supplemented with other instructional techniques (Oliver-Hoyo & Allen, 2005; Hinde & Kovac, 2001; Katz, 1996; Landolt, 2006).

Method

The flipped classroom at GGC
GGC is an open-access four-year college located in Lawrenceville, Georgia. In Organic Chemistry at GGC, the "flipped classroom" terminology means that students are required to prepare before each class by working a set of assigned problems, and then during each class period demonstrate their knowledge by working more problems at whiteboards, ideally in groups of two or three students

(Pursell, Sloop et al, 2012). This particular approach is derived from pedagogy known as the Thayer Method (Ertwine & Palladino, 1987), originating at West Point Military Academy by Sylvanus Thayer.

The standard flipped classroom at GGC (assuming a 75-minute class period and a class size of 24 students) has the following format:

- Students come to class prepared, with questions ready to ask as needed.
- Initial Q&A session during which students ask targeted questions based on problems encountered when working assigned pre-class problems (~10 minutes).
- Instructor gives mini-lecture(s) as needed based on course material for that class (~10 minutes).
- Students work assigned class problems in groups, either at their desks or at the classroom whiteboards (~40 minutes).
- End of class quiz as needed (~15 minutes).

The basic idea is that if the students come to class prepared, they will have some idea of what the class is going to be about. If they then work more problems during class, those concepts that they saw during their pre-class work will be reinforced. During the problem-solving sessions the students are working together, bouncing ideas off each other as they attempt to solve the assigned problems. In this way, the effectiveness of student-student interactions is maximized. The students become active participants, rather than passive observers, in the class. Frequent feedback, in the form of daily or weekly quizzes, serves as a motivating factor for continued work throughout the semester.

The instructor's role in this type of flipped classroom becomes more of an observer and facilitator than in the traditional lecture classroom; after the initial Q&A session is completed and all students' questions have been answered, the instructor typically either stands in the center of the room or walks around, directing students as needed, answering questions as they come up, and advising student groups if the answers they are developing do not look correct. In this way, the effectiveness of student-instructor interactions is maximized.

The main goal of this method is that more students are more actively involved in the classroom material activities than with a traditional lecture approach. Success in many chemistry courses requires strong problem-solving skills, so it makes sense to spend a large portion of class time perfecting this skill. As students work together in groups, they are communicating more effectively with each other, and are taking more ownership of their work than they would otherwise.

Difficulties with the flipped classroom

The most positive aspect of the flipped classroom approach - that student learning happens, at least partially, before class - is also its biggest potential disadvantage. Most students taking Organic Chemistry are sophomores, so are used to classes involving the traditional lecture method. They think they can learn well by taking notes as the instructor talks, although it has been shown that passive lecture (without any supplemental activities) is ineffective with respect to student comprehension and retention (Halloun, 1985). Also, it is well documented that students do not like being pushed out of their comfort zone, and are resistant to change (Felder & Brent, 1996). Resulting student pushback to change, and the possibility of declining course satisfaction and potentially poor course evaluations are some of the most common reasons for instructors not sticking with the flipped classroom approach

(Allen, Wedman & Folk, 2001). Instructors may also struggle with change, as it can be tough to let go of preconceived notions of learning based on an instructor's own learning experiences (Korthagen & Kessels, 1999). In many cases, it is easier for the instructor to simply drop the flipped classroom approach and go back to the more comfortable, more familiar lecture approach.

Echo 360 videos as class prep aids

Use of videos as class preparatory aids has previously been reported (Smith, 2013; Fautch, 2015; Flynn, 2015; Seery, 2015) in the literature. These videos have ranged from 50 minute videotaped lectures to much shorter, more focused videos lasting less than 5 minutes.

The videos described in this article vary from 5 minutes to 25 minutes in length, with an average running time of just over 10 minutes. Currently the author has recorded 43 preparatory videos for the Organic Chemistry I class at GGC. Smart Notebook was used as the canvas and drawing tool. Videos were recorded using Echo360, and were recorded specifically to hear the author's voice and only show the movement of the stylus icon. The choice was made to not show the author, as it was felt that this would be a distraction from the chemistry content being discussed. Screenshots of three of these videos are shown in Figures 1-3. These three screenshots illustrate the variety of Organic Chemistry content that can be conveyed in these videos, from real-time drawing of and discussing reaction mechanisms (Figure 1), to illustrating sample organic synthesis problems (Figure 2) and illustrating sample nomenclature / structure problems (Figure 3).

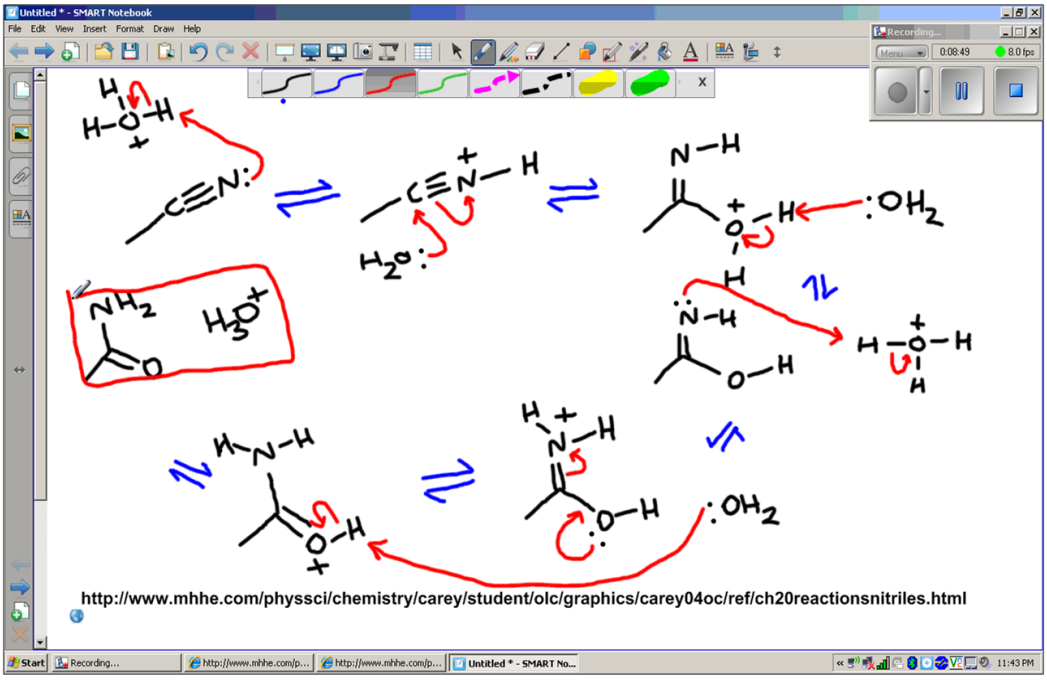

Figure 1: Reaction mechanism prep video screenshot

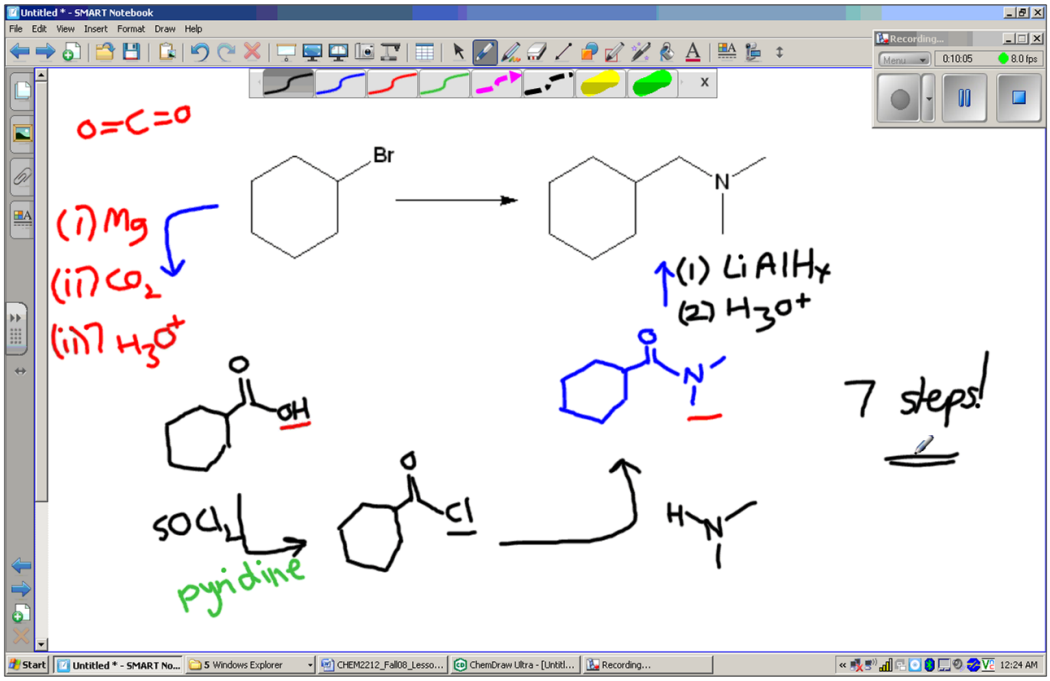

Figure 2: Organic synthesis prep video screenshot

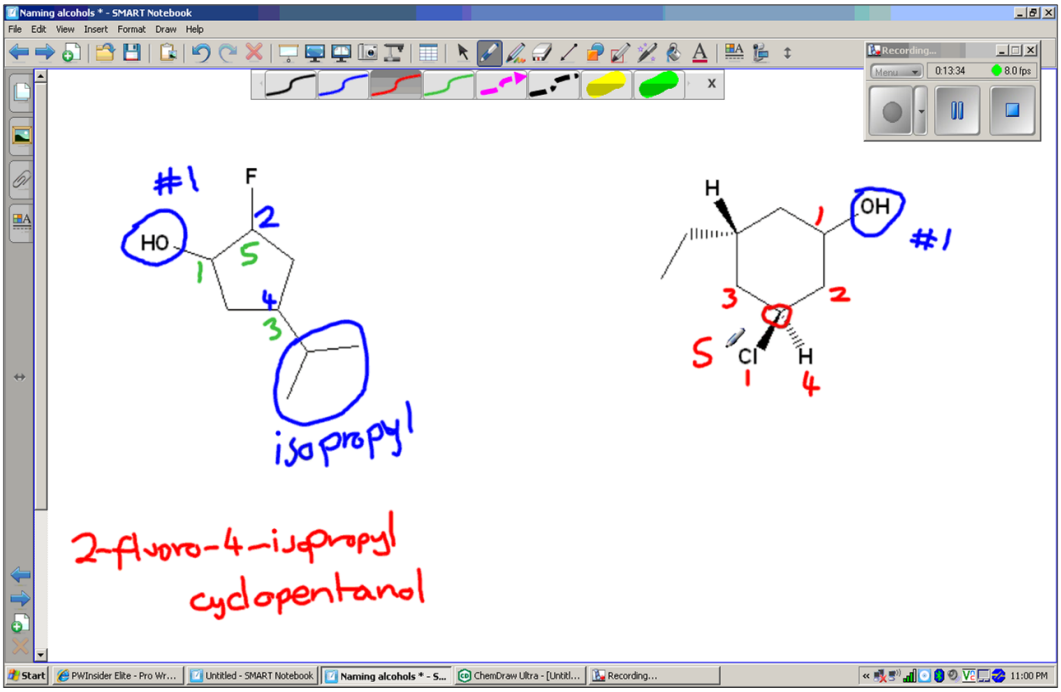

Figure 3: Nomenclature / structure drawing prep video screenshot

Echo 360 is a video-capture software program that allows for recording of whatever is shown on the computer screen (in a similar vein to software such Camtasia), as well as audio recorded via an internal or external microphone. Echo 360 was chosen for use at GGC for its ability to make the user's video output available as a variety of links (rather than the user having to deal with potentially large video

files, that many course management systems do not play well with)—these links could then be placed anywhere accessible by the students. Links to either stream or download videos are available through Echo 360, so if the faculty member chooses to do so, he can make the videos available to students in both of these formats.

A Wacom bamboo tablet with wireless stylus was used as the writing tool, and audio was recorded using a Snowball Blue microphone. There is something of a learning curve to using a tablet to create videos, simply because writing on the tablet while watching the work appear on the monitor takes quite a bit of practice to get used to, requiring specific hand-eye coordination skills that take time to refine. However, once the user is comfortable with this setup, creating videos becomes quite simple.

Virtually every student nowadays has access to a laptop, tablet or smartphone. All the student needs to play these videos is an internet connection, as the videos play directly from their locations on the Echo360 server. If the students choose to download the videos, they are in the .mov (quicktime) format, which is playable both on pc and mac. Apple devices will play these format videos with no problems, as will Android devices using a variety of free video player apps, such as MX Player. Our goal was to make these videos accessible for all GGC students, so they could be watched anywhere and at any time.

The videos were available during the entire semester, from both the instructor's internal GGC faculty webpage, and from the instructor's Youtube.com page.

Results

Student surveys and responses

Students were surveyed at the end of the Spring 2015 semester to gauge the frequency of their use of the Echo 360 videos. They were also asked to provide qualitative feedback about their use of the Echo 360 videos as pre-class preparatory tools.

The surveys were limited to a single 24-student section of Organic Chemistry I; as a result, the sample size was small (n = 21; 3 students had withdrawn from the class before the end of the semester, and so did not participate in the survey). The survey questions, as well as the student responses to them, are shown in Table 1, below:

Table 1: Student Survey Response Data

Survey Question	*Yes*	*No*	*n*	*%*
(1) Did you use the Echo360 videos?	16	5	21	76.2
(2) Did you watch the assigned videos before every class?	14	2	16	87.5
(3) Did you watch any Echo 360 videos more than once?	12	4	16	75.0

The survey data show that by no means was use of the Echo 360 videos universally popular, with only 76.2% of the class actually even attempting to use them (16 of the 21 students surveyed). This data

point is perhaps unsurprising, as it backs up the previously reported literature evidence of students being resistant to change (Felder & Brent, 1996), and highlights this as a potential problem with the flipped classroom method (as previously discussed in the "Difficulties with the Flipped Classroom" section of this article). Qualitative student feedback on the survey also highlighted the student pushback issue.

The students who answered "no" to question (1) on the survey were directed to skip questions (2) and (3), hence the n = 21 for (1) decreasing to n = 16 for (2).

Students were given a daily lesson plan at the start of the semester which laid out all the goals for each class meeting during the semester, as well as the videos to watch in preparation for each class. With this in mind, question (2) asked the students if they watched the videos assigned before each class during the semester. 87.5% of the students responded "yes" to this question (14 out of the 16 respondents), indicating an encouraging response rate which showed that the large majority of students had got on board (at least to some degree) with the idea of watching these videos pre-class.

Question (3) asked if the students watched any videos more than once, also had an encouragingly high positive response. 85.7% of the 14 students (12 of the 16 respondents) indicated that they had. Whether these extra viewings were pre-class or post-class was not surveyed, but the fact that multiple viewings occurred backed up the encouraging response to question (2).

One qualitative question was asked at the end of the survey: "Describe what you liked / did not like about the use of Echo 360 videos as pre-class preparation tools." Considering the answers to the survey questions (1) - (3), it is perhaps not surprising that the answers to this question were mainly positive. Of the 16 responses to this question, 14 were positive and two were negative. Four of the positive responses and the two negative responses are included below.

Response #1
"The prep videos do an awesome job at putting the fundamentals of the material into perspective. The reactions with the stepwise mechanisms are thoroughly explained and make me feel like I am one on one with my professor. Taking notes while watching the videos makes matters even more beneficial. I use the video notes to help me get through the assigned problems more often now, instead of peeking in the solutions manual."

Response #2
"I love the videos for several reasons: 1. They are extremely informative and explain the material better than the textbook. 2. I can view them at anytime, like having a professor "on call". 3. I use them as learning tool. First I watch the video in its entirety, then I watch it again using the "pause" mechanism to see if I can perform the "next step" myself so I have an immediate confirmation (or not) that I understand the material. 4. They are also entertaining which makes learning Organic Chemistry 'fun.'"

Response #3
"The videos are an excellent aid in my preparations for class. I usually watch them, taking notes along the way, before I do the assigned reading and problems in the textbook. It just helps my reading go along faster since I have a better understanding of the material to begin with. The videos also allow me to focus more on the course objectives, because they summarize what to expect in lecture and on

quizzes. Sometimes I watch certain videos, or parts of videos, again to prepare for quizzes. The videos are very convenient too. I can access them whenever I need to and learn at my own pace."

Response #4
"The prep videos help me understand the material much more than the book. For visual learners, this is exactly the thing that we need. I read through the book but often find myself trying to understand what I just read with not much luck of actually comprehending the material. When I watch the video, I can see how the reaction goes and it helps to see why. This technology would be very beneficial for other subjects too, especially the ones that have a lot of material to get through. The video lets the instructor take his or her time through the material that they would not normally have in class. It makes it easier for students to prep for class and come prepared with questions."

Student #5
"I found the first few videos to be way too long, and I had a hard time focusing on the material. I didn't feel that they helped very much, as they took too much time to watch before every single class. A lot of times the video would just stop playing, and it could be a few minutes before it started playing again—that was really annoying."

Student #6
"I did not find the videos helpful at all. I didn't know I was going to be in a class where I had to teach myself. I learn best if I can listen to a lecture and make notes as the instructor talks. Organic chemistry is really difficult, and I need someone to teach it to me, rather than just having to do it on my own."

The positive responses (#1 - #4) highlight several very specific benefits that students discovered while using these videos before coming to class: the propensity for augmented conceptual understanding, allowing for easier note-taking than during a traditional lecture, being less reliant on the solutions manual when working problems (hinting towards the student being more confident in his/her own ability to solve assigned problems), the ability to instantly re-watch an explanation if it was not understood the first time, and ease of access. However, potentially the most important positive outcome from these comments is described in comment #1, as it relates directly to student engagement—the ability to come to class *prepared with questions*. Students who come with questions ready to ask are always going to be more actively engaged than those who don't.

The two negative responses highlight a potential issue not previously described in this article - that of using videos in an online format (student #5's comment about the video that would "stop playing" presumably describes a buffering issue related to a poor internet connection), as well as the previously described reluctance of some students to get on board with a learning method that is new to them (student #5 was the only one who mentioned that the videos were too long, and student #6's negative comment doesn't describe anything about why he/she thought the videos were not helpful, other than as a backup for the fact that he/she did not enjoy the flipped classroom method). Student #6's response in particular agrees with previously reported data (Fautch, 2015) that some students feel the flipped classroom simply means that they have to teach themselves.

Conclusion

For this admittedly very small data set, student survey data and responses show that students who are willing to get on board with the method and the "flipped" workload that it involves, the flipped classroom method, involving use of videos as pre-class preparation tools, can be effective at allowing for more effective class preparation, and the subsequent effects of augmented student engagement from students who are better prepared for class.

Future research

The results of the survey described in this article suggest many areas for expansion in future surveys, such as quantifying the number of times videos were watched, as well as perhaps the devices they were watched on. Trends in video watching habits, such as detailing which particular videos were watched multiple times (in comparison to those that were watched predominantly just once) could allow for improvement of the videos that were not watched again.

A study of any correlation between frequency of watching Echo360 videos and class performance (not yet studied at GGC) would be of benefit, as would a study of any correlation between student performance and the number of pre-class problems attempted or completed. between; the act of simply watching the video is only part of the class preparation process, and so studying this correlation will be of future consideration in Organic Chemistry classes at GGC.

An expansion of the study to cover all the sections of organic chemistry I (and organic chemistry II) would also be valuable.

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