OrganicERs Newsletter Fall 2014, Volume 1, Number 1

Organic Education Resources

A cCWCS Community of Scholars

# Another Flipping Organic Course

by Vince Maloney

The What, How, and Why of Flipping a Course

Since I've just finished the year having "flipped" my entire two semester organic chemistry sequence, I have been asked to relate my year long experience for the OrganicERS website. It's been both an enjoyable and stressful year. Over the course of the blog posts, I'll explain why it turned out to be both. In this inaugural entry I'll address the what, how, and why. If you have already decided to flip your course, you may want to skip the "What" and "Why" sections and scroll down to the "How" section and also watch for future posts.

## The What

Despite the amount of discussion that has occurred over the past few years, the phrase "flipping the course" probably still needs a definition. Like nanotechnology some years back, flipping means different things to different people. Also, like nanotechnology, it really can be applied to many things. In fact, using a broad definition, many have partially flipped their courses already. As long as there is some type of active learning going on in your classroom, then you can tell your institution's administrators that you have done some flipping. All facetiousness aside, it will be best to describe it by comparing it to the "traditional" lecture.

In a traditional lecture, students are assigned readings from the text, which they read before the face-to-face class (maybe). Then during the class, the instructor provides a 50 to 90 minute description of the material from the text. The instructor may pose a few questions, which are answered by one or two individuals and/or answer questions asked by some students during class. Afterwards, homework is assigned that students work on either individually or collectively. Often misconceptions and misunderstandings are first observed in the quizzes and exams where it is too late from the student point of view.

One description of the flipped classroom changes the temporal location of these activities and uses peer-to-peer learning. The same lectures are now recorded ahead of time, and the students are required to watch them before class. These are posted online. They complete some sort of assignment which may also be online that assesses whether they have watched the lectures. Then in class, the students work on the "homework" or review problems together taking advantage of peer-to-peer learning. The instructor checks on how they are doing by having the students respond with clickers for

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**OrganicERs Newsletter** **Fall 2014, Volume 1, Number 1**

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## Participate in Survey

This newsletter has a short survey with questions about textbooks, homework, student DFW rate, and your observations about the website. Some of these topics are conversation starters. Others are intended to help the leadership board improve the website to make it more useful for community members. Please share your opinion with us!

We started with a couple of workshops (Charlotte in 2013, Denver in 2014). In July we had about 70 members. At BCCE, we publicly announced this new community with a gathering at the picnic. BCCE publicity brought 28 new members. Recent social media posts (LinkedIn and Facebook) led to 30 more, many international. Our membership roster is now 134!

example. The instructor can now address misconceptions long before an exam or quiz. The flip then is to move the lecture to an outside of class activity and most problem solving into the face to face class.

## The Why

Of course, no change works well if people feel that they have been forced into it, so I'll merely describe my journey and include a few of the citations providing evidence of the efficacy of active learning. First, "there is nothing new under the sun". "Flipping the classroom" may be a new term, but the general concept has been around for a while and its history may be the subject of a future post. For me serious consideration of "flipping the course" started in 2007 at a teaching symposium at my home institution. Todd Zakrajsek, currently Executive Director of the Center for Faculty Excellence at the University of North Carolina at Chapel Hill, in his keynote talk showed the following figure from Hake.[1] It compares learning gains upon completion of basic physics courses between those taught with traditional lectures and those taught with some component of active learning incorporated into the face to face classes. The study includes high schools, colleges, and universities. In each case, the students were given the Force Concept Inventory as a pre-test and those scores appear on the x-axis. Upon completion, the students were given it again as a post-test and the y-axis shows percent increase in scores. Strikingly, all of the active learning courses (green symbols) had comparable or greater gains than the traditional lectures (red symbols). I had already incorporated a significant amount of active learning into my courses and had been aware of the flipping the course discussion. However, this plot had really caused me to consider whether I should really change what I was doing. Given the amount of work necessary, wondering whether I could pull it off properly, and general inertia, I hesitated.

At a subsequent symposium, Linda Nilson spoke. In reading her book "Teaching at Its Best"[2], I encountered the most familiar version of Bloom's Taxonomy. According to Nilson, traditional lecture only addresses the outcome of Knowledge or Knowledge Transfer. Interestingly, at the 2013 Active Learning in Organic Chemistry workshop in Charlotte, when polled about how many outcomes traditional lecture addressed, most of the participants responded 1 or 2.

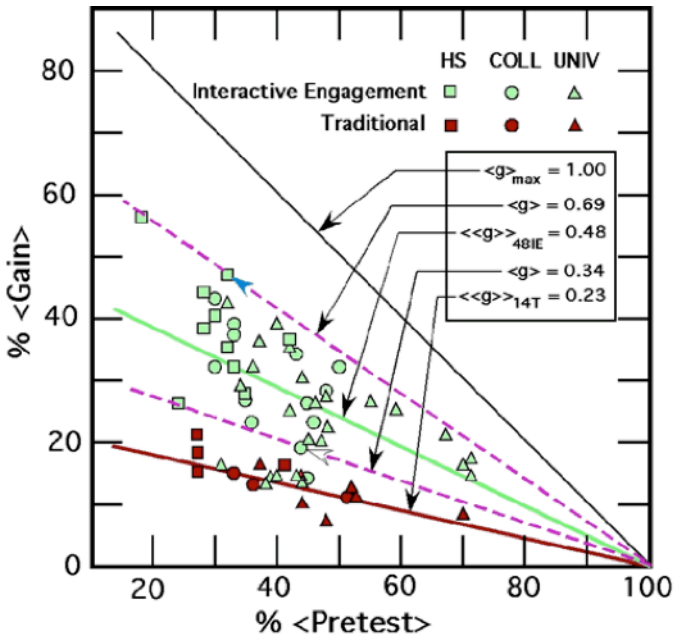


Figure 1. Pretest versus post-test gain for traditional and interactieengagement (active learning) courses.

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However, active learning techniques such as Just in Time Teaching, classroom assessment techniques, POGIL, and other forms of peer-to-peer learning can address the remaining outcomes. Again, I was forced to consider whether I should be doing something different.

The next nudge towards flipping my organic sequence came when I enrolled in Jeffrey Moore's (University of Illinois Urbana-Champaign) introductory organic chemistry MOOC. Once again, a definition may be in order. MOOC is the acronym for massive open online course. The idea is that a "world famous superstar professor" from an elite institution provides recorded lectures, course materials, and assessment software in the form of online quizzes and exams. Students answer each other's questions through crowdsourcing, meet-ups, and so on. Once the superstar material was posted, there is supposed to be no need for any instructor or teaching assistant aid. The course could be taught for free or for a very minimal amount because the expensive part, the human instructors, need only be employed once in recording the lectures and posting course material. This was the innovative disruption that entrepreneurs, politicians, and pundits thought was necessary to lower the cost of higher education to a fraction of what it is now. Predictions were made that colleges and universities would be shutting their doors in the not too distant future and only 50 institutions of higher education would remain. This was the concept in a somewhat exaggerated nutshell. Since those heady days we have moved through the hype and backlash phases as it has become apparent that it won't work like that so easy.

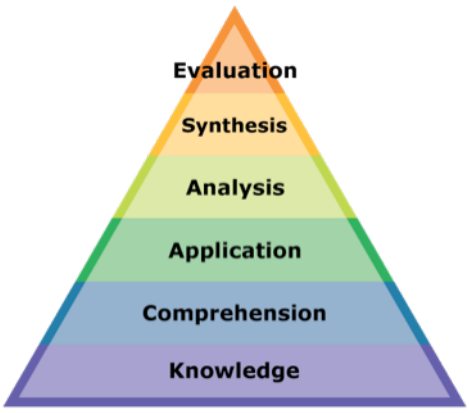


Figure 2. Traditional Bloom's Taxonomy

In those earlier days, I wondered about the future (still do) and took Moore's partial first year course to see what it would be like. Although MOOCs are far from the promised potential at the moment, watching Moore's online lectures did give me pause. They were not only very good but were models of clarity and concision. I found myself thinking more than once that I should really approach a particular topic the way he was doing it. At times he handed over the reins of the recording duties to an enthusiastic graduate/post-doc student with good results. Once the proper content and script was provided, it looked like all you needed was an engaging personality to deliver it like a news anchorperson. If material this good could be made generally available on the Internet, it made me seriously consider whether something different should be done in my classroom.

Finally, the advances of technology in just the past few years have made recording and viewing of online lectures extremely easy. A busy student can access, watch, and perhaps watch again lectures just about anywhere. Given that the lectures could be watched on cell phones, tablets, and the on campus computer labs at all hours, by spring 2013, it really seemed time to "flip" organic chemistry.

Upon completion of my year of the flip, an article in PNAS pleasantly confirmed my decision. Freeman et al. provide a meta-analysis of the greater efficacy of active learning methods over traditional lectures.[3]

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# The How

As mentioned previously, many no longer have just the traditional lecture. Before the complete flip, the same was true for my organic sequence. So I'll provide a before and after comparison. For the past 3 years, I have taught organic to the biology majors with a population of approximately 100 students in organic 1 and 85 in organic 2. Informal peer-to-peer problem solving has been incorporated into the courses by the use of clickers. Prior to this academic year, lecture was interspersed with an average of 3 questions per class where students reflected on material that had been presented that day through peer to peer problem solving. Also there were twice a week voluntary review sessions where I would post problems on the board and then go about the room to see how students were progressing. Approximately 40% of the class would show up to these sessions. Arrangements were made for students who could not attend the reviews. Face to face lectures were recorded and posted online if students wished to watch the lecture again. For nomenclature, lectures were pre-recorded. After students watched them, they took a short quiz at the beginning of class consisting of simple examples. Then somewhat more complicated examples were worked out with clicker questions. Based on the broad definition, the class was substantially flipped.

Yet, after seeing how online lectures with reasonable quality could be prepared without much expertise, I decided to complete the flip. I'll provide more details in a future post, but I recorded my entire year of lecture content. The lectures were recorded based on presenting one or possibly two closely related topics and not length. This practice is known as "chunking" and is a suggested best practice for organizing material. By breaking the material into small chunks like this, the result is to have many more but far shorter lectures. My lectures ranged from somewhat over one minute to 20 minutes with the average being about ten. There were 130 lectures for organic 1 and 165 lectures for organic 2. About a week before the date of a given face-to-face class, students were asked to a watch specific number of the lectures. They were then assigned a short, simple online homework to complete right before class to assess whether they had watched the recordings. Only 4 to 5 questions were asked per homework with 162 questions assigned in the fall and 98 in the spring.

The face-to-face class was devoted almost entirely to peer-to-peer problem solving. Often, but not always, short reviews were given before practicing example problems for a topic. Typically, a question would be posed to the class. The students would work on it in informal groups for 2 to 3 minutes (some questions required much longer or shorter time) and then individually answer with their clicker. What happened next depended on the results. If the class did well on a question, I might briefly explain why some answers were incorrect. With greater difficulty questions, longer and more detailed the explanations were given. If the class seemed to have real difficulty coming to a consensus on a correct answer, I would provide more information about the question and poll again. If there was a more or less even split, then I would ask the students to find someone with whom they disagreed and discuss the question again. The students would then be polled again to see if the class was making progress. It took time to find the right mix of questions. Eventually I took advantage of scaffolding for a given topic. The first question would be extremely simple to see if everyone understood the basic idea. Subsequent questions would increase in difficulty and nuances would be added until the questions were somewhat more difficult than the most difficult exam and quiz questions I intended to ask. In this way, the class would get through 10 – 12 questions per class period. The type, number and schedule of quizzes and exams was otherwise the same as the previous two years.

One important aspect of the flip was the intention to make the class equally challenging in content as the previous years and that it be "time neutral" for the students. For comparison purposes to the previous two years of "traditional" lecture, the class was designed to be no more difficult or easy. Also, the amount of time spent by the students on the course was meant to be the same. In the traditional class, the students spent time doing homework and coming to review sessions besides coming to lecture. When the class was flipped, the lectures occurred outside of class and much of the homework and all of the review occurred inside the face-to-face class. Students of the flipped class should not have had to spend more time on the course than the 'traditional" class students. This is what was meant by "time neutral".

That was how I managed to flip my organic class. In future posts, I'll go into more detail on different aspects of this past year's course. However, you may be now wondering what the effect was. Gail Rathbun, director of our Center for the Enhancement of Learning and Teaching (CELT) counsels that whenever considering and undertaking a major pedagogical change, "do no harm." I can confidently state that no harm was done. You can contemplate flipping your class and not be overly concerned with worst case scenarios. If you stay on top of things, it will work out. However, it should do more than no harm. Although I didn't see the learning gains that I hoped, the students did prefer the new format and there were other benefits to flipping that will be described in the future. Of course, learning gains are the main goal. There are three factors that could be attributed the past year's observation of no apparent learning gains. An area that is coming under study is the effect on learning going from a class with active learning to a complete flip. If there is substantial active learning in a class already, the complete flip may not exhibit much of a gain. As stated in Freeman et al. less gains are observed from active learning for class sizes >50 students. Perhaps the combination of these two factors led to any gains or declines being lost in the noise. Upon reflection over the past year, I believe I have identified some definite areas for improvement in my execution of the flipped class. If the grades are the same, but the experience for the students is better, I'll take that and continue the flip. However, I believe that I have built the foundation for a course that can be improved and hope to see learning gains in the future.

Before finishing the first post, some acknowledgements should be made. I'm thankful that Jennifer Muzyka has graciously asked me to become involved in the OrganicERS community and cCWCS Active Learning in Organic Chemistry workshops. Robert Rossi (Gloucester County College) and Jessica Fautch (York College of Pennsylvania) gave me very useful advice before my yearlong odyssey. Gail Rathbun (CELT) and Ludwika Goodson at my institution (Indiana U. Purdue U. Ft. Wayne) provided advice and support that made the process much easier.

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