

## Encouraging Student Independence – A blended learning model for Organic Chemistry at Wilfrid Laurier University

### Opportunity

As registrations in the Fall and Winter term Organic Chemistry classes at Wilfrid Laurier University in Waterloo increased over a few years from 75 to 300 students, Professor Stephen MacNeil found it increasingly difficult to engage the students in the lectures. Just prior to his 2009-2010 sabbatical, he took a workshop on course design with Laurier's Teaching Support Services and realized that blended learning offered possibilities for more effective teaching and learning. The sabbatical allowed him time to focus on converting the Fall term course for blended delivery.

### Innovation

The course re-design began by looking at the learning tasks – what did he want the student to learn how to do – built around chapters of the text book. Adapting some of the theories of Dr. Ivan Shibley from Penn State University, he then considered which of the learning tasks could be classified as 'lower level', such as the definitional and introductory material from each chapter, that students could be expected to learn prior to face-to-face class time.

Building from this selection of content, Dr. MacNeil produced an extensive library of short videos, with each illustrating a specific concept. For the Fall course alone, over 15 hours of videos, most not longer than 10 minutes each, are available to students. What used to be a class with two 80 minute lectures a week is now one two-hour lecture on Wednesday evening, supported and extended by pre- and post-class online learning as well as in-class activities.

**Pre-class:** After each Wednesday evening lecture, the materials for the next week are released online, including PowerPoint slides, video lectures, and the list of learning tasks. The students have a choice of viewing the videos, reading the text, or combining the use of the resources in ways that work best for their learning. The pre-class assignment is released at midnight on Saturday and due on Wednesday at noon.

**In-Class:** Wednesday night classes are built around the assumption that time can be saved on information transfer as this has been accomplished through the pre-class work, and so the focus is on advanced information and problem solving. All of the professor's in-class work is done on a tablet and two versions of his work are posted after each class – one

presenting all the problems with no answers and the other including all the answers. Students can use these for review.

The pre-class assignments play a significant role in planning the evening class. After these are received at noon on Wednesday, Professor MacNeil generates a report on the number of participants, the average score, the level of mastery, and how long the student spent doing the assignments. He summarizes this information for the students, adds extra focus to the evening's class in areas of difficulty, and posts extra content and optional assignments in problem areas.

The live lecture is over by 9 PM, but students can stay for another half hour if they wish to continue working through problems with the professor.

**Prior Learning Assessment Questionnaire:** Blended learning requires that students take responsibility for their own learning. To set the expectations for this right at the beginning of the course, students are given a 22-question, multiple-choice quiz on key concepts from introductory chemistry. They are not expected to study – rather it is a self-assessment on their already acquired knowledge relative to the basic concepts of organic chemistry. With no points attached to this preliminary assessment, students can see their strengths and weaknesses. Once they submit this assessment, the first two units in the online portion of the course are released – containing largely review material which will not be covered during class sessions. Students can use this material for study according to what the quiz revealed about their individual needs and they then take the prior learning assessment again – this time for 5% of their grade.

Both quizzes are generated from a databank of test questions which are randomly generated, linked to the various key concepts. The quizzes have time limits but students may still refer to resources. At 5% of the grade, this is seen as 'low stakes grades' and students can do as much or as little as they choose. The key is that the quizzes set the tone of student responsibility for self-monitoring and addressing their knowledge gaps.

**Assessment:** The breakdown for assessment includes:

- Online homework – 10%
- Clickers which students use to respond to questions in class – 5% for participation and 5% for performance
- Prior Learning Assessment Quiz #2 – 5%
- Lab – 25%
- Mid-term exam – 20%
- Final Exam – 30%

The importance of formative assessment is integrated as an essential characteristic of blended learning. For each assignment “unit” (which may include 1-3 questions) in the on-line homework, students have three chances to get the right answers. If fewer than 70% of students get the correct answer using clickers to respond to questions in class, they chat with neighbours and try again.

For multiple choice components of mid-term and final exams, students use a system called the Immediate Feedback Assessment Technique (IFAT). On special forms, they scratch an answer slot. If the answer is correct, a star appears – if not, it is blank. Students are then able to try again and earn half a point if they get the correct answer on the second try. They can also get a quarter of a point if their third try is successful. With each correct answer, a student's learning is immediately reinforced. When a student chooses a wrong answer, they have the opportunity to immediately review the question to uncover and correct the misconception that led to the wrong answer. Research has shown that students learn from considering their wrong answers, even in a testing session. The use of these cards for exams has resulted in a 4 – 6% increase in the course average.

The point of each of these assessment methods is to provide students with frequent feedback on their progress and the opportunity to learn while they are being assessed. As an indication that they are motivated to learn when given immediate corrective feedback, the average number of attempts in online homework assignments often exceeds three, meaning that students continue working on the assignment even when grades are no longer available.

## Outcomes and Benefits

Some of the students do not like the pre-class component as they struggle to understand the information; Dr MacNeil sees the student who struggles with the information prior to class as learning much more than a student who is hearing it for the first time in a lecture. The challenges they experience in initially learning a concept often means they pay more attention to the more advanced discussions and explanations offered in-class.

The use of formative evaluation and the availability of materials for class preparation and review put the responsibility on the students for assessing themselves and taking corrective measures. They not only learn more Organic Chemistry, they develop learning skills and self-responsibility.

Student responses on the end-of-term course evaluations were very positive about the blended learning model, and how the increased need to take responsibility for their learning in Organic Chemistry has made them more likely to have the same attitude of self-motivation and self-direction in their other courses.

## Challenges and Enhancements

As Dr. MacNeil describes the situation: “My teaching is now blended, but student learning is not yet fully blended”. Even with 90% participation in the online homework, many of the students are completing the assignments without referring to the pre-class online materials. The message that what is online will not be covered in class needs to be conveyed – and received – more definitively. Otherwise it is very difficult to avoid lecturing to clarify problems students are having because they ignored the online materials before class. The message he wants to convey to his students is that they need to do the work before class or the class itself will sound like a foreign language.

## Potential

In collaboration with colleagues in Wilfrid Laurier’s Department of Psychology, Dr. MacNeil has built a research study around the learning tasks that he outlined as the basis for developing the blended learning course. Because students capable of more accurate self-monitoring and self-assessment usually perform better, Dr. MacNeil has been trying to use Learning Task Inventories (LTIs) to help students develop or improve these skills.

The first year the course was offered, he released the LTIs for each chapter along with all the pre-class learning materials through the course management system. Very few students even opened the LTI documents. In the second year, he converted the LTIs to surveys for the students to use to assess their learning – and each survey had to be submitted before the next week’s materials were released. This increased the use of the LTIs but he suspected that many of the students were not actually paying attention to the survey questions as they completed each LTI. To test this suspicion, he inserted the following statement into an LTI: “Chose 1 if you are reading this”. Approximately 240 students completed the LTI but only half of the students chose 1 for that particular item.

To look at and counter the lack of student investment, a study was set-up with the LTIs put into Survey Monkey and the students randomly divided into five groups. They all had to complete the surveys but with different conditions concerning how much was asked of them and the extent of the feedback they received. This was then matched with final grades to assess correlation with conditions. The results showed that the conditions were not an important factor – but that there was a clear and strong correlation between the number of LTIs completed and the final grade.

Next year’s studies will look at the frequency of the LTIs and whether they might be more effective as preparation for mid-terms and finals or as monthly activities rather than as the current weekly exercises. In addition, Dr. MacNeil and his collaborators will try to

directly measure students' metacognitive skills at the beginning and end of term to see if LTIs have had an effect.

As well as completing the videos to convert the Winter term course in Organic Chemistry to a fully blended model, Dr. McNeil is looking at developing Organic Chemistry as fully online courses to increase their accessibility and flexibility, especially during the Spring and Summer terms. The first step in this conversion will be to seek expertise in online learning available through Teaching Support Services.

## For Further Information

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