Introduction of McGraw-Hill's platform for Blended Learning in first year Organic Chemistry – Pilot study

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1. Introduction and rationale

General Chemistry part 2 (CMY 127) is a large first year course in the Faculty of Natural and Agricultural Sciences at the University of Pretoria. The course is classified as a high impact module (HIM) because it is a service module for different programmes in the faculty and other faculties, has high enrolment numbers (average of 1700 students with over 600 in one lecture venue) and low pass rates. The large enrolment numbers makes it difficult to provide reasonable formative assessment opportunities which are important for student learning. The introduction of online tutorials to provide a blended learning environment was an attractive solution.

An authentic e-learning environment can be expensive and time consuming to develop because it requires realistic simulations with multiple possible outcomes (Herrington, Reeves & Oliver, 2010). It therefore made sense to use a commercially available platform. The McGraw-Hill Connect platform that accompanies the prescribed textbook for the course was introduced in this project to provide formative online assessment. The major advantage of the McGraw-Hill Connect platform is that the majority of questions are open-ended, not multiple-choice, using a chemistry drawing application for students to enter their answers electronically in a form that can be graded electronically. In addition, the platform gives feedback at different levels of which we utilized three: (1) correct/incorrect grading with no penalty during assignments; (2) hints with a small mark penalty during assignments; and (3) full answers and worked solutions following submission deadlines. To discourage copying, each individual student gets a unique assignment built by the random selection of questions from a pool of different, but comparable questions. Once submission deadlines have been exceeded, the assignments become available for online self-study.

2. Statement of purpose, aim and research question

The purpose of the intervention was to improve student learning in first year organic chemistry CMY127 by incorporating blended learning for tutorials. This would afford students flexibility in choosing when to do their assignments, gives opportunity for multiple attempts, and provides different levels of feedback to promote learning. Online tutorials have lower resource requirements in the form of tutors and venues, but since the platform is linked to an e-book, licensing is a huge expense.

The aim of the study was to evaluate the teaching intervention and to identify the challenges associated and problems associated with the implementation of the intervention. Based on the evaluation we wish to refine the innovative learning environment to define new design principles according to the model of "Design based research". This mode of research requires iterative cycles of testing and refining the solutions in practise and may be used to optimise teaching in a specific context in order to generate new design principles.

The following main research question guided the project:

What is the impact of the modality of tutorial support on student progress?

The specific sub-questions were:

i. How did student preference for type of learning opportunity shift from the start to the end of this part of the course?
ii. Which tutorial modality (face-to-face versus online) is more successful for each topic in the organic chemistry syllabus?

3. Literature review and Theoretical Framework

Since the intervention is carried out in the context of large classes, the literature investigating the factors pertinent to large classes outlined below form an important background to the project. Lecturers have to deal with a student population in large first year classes that is more diverse in age, experience, preparedness, cultural background and socioeconomic status than before (Biggs, 1999). Large classes require effective teaching and learning strategies to deal with the problems of lack of interaction and exchange between lecturer and students (Carbone & Greenberg, 1998); anonymity that leads to passivity among students (Ward & Jenkins, 1992); high rates of absenteeism; poor engagement with content, little commitment and low motivation (Gibbs, 1992). Students report inadequate facilities, lack of opportunity for discussion and lack of structure in lectures as additional problems (Carbone & Greenberg, 1998). One of the goals of the intervention was to provide feedback in order to promote learning. Boud & Molloy (2013) defined feedback as providing learners with information about their current work to influence the quality of subsequent work. They emphasise the value added to learning when learners have a key role in generating and soliciting their own feedback.

The first theoretical framework that we have used to guide us in this study is activity theory (Leont'ev, 1974; Engeström, 1987) Activity theory employs a methodology that analyse components of a research project, the relationship between them and the aspects that influence the relationships (Bottino, Chiappina, Forcheri, Lemut & Molfino, 1999). This methodology is extremely useful in our case where we want to compare different modalities for tutorials keeping in mind that students have preferences for a modality and that some content matter favours a specific modality.

4. Research methodology (mixed methods)

We made use of a mixed methods design in our exploratory case study. We used the students enrolled for CMY127 as the population and applied our criteria for inclusion. The ones that remained, was the realised sample. Our criteria were that they should be i) first time students (not repeating), ii) agreed to participate by completing the consent form and iii) had completed a pre- and post- intervention survey. Our accessible sample was n=1470, and our realised sample was n=195 for subquestion i. To answer subquestion ii, the criteria for inclusion included clear participation in the prescribed activities of either group A or group B only, giving a realised sample of n=61.

Description of the system of blended learning for tutorials

Limited laboratory capacity has necessitated the assignment of students to A and B practical groups. On alternating weeks, when a group is not involved in a practical session, the scheduled time is re-allocated to a class tutorial. The course structure allows for the design of a pseudo-crossover experiment such that the class is divided into two groups and the two groups alternate between a face-to-face and an online tutorial modality topic by topic as indicated in Table 1. Statistical methods will be used to evaluate how the performance differs for a topic related to the tutorial modality for the group of students. The marks for specific questions in Semester Tests 2, 3 and the final examination were used as a measure of student performance in identified topics.

Table 1: Pseudo cross-over experiment design

Chemistry Topic	Group A	Group B	Common Assessment
			Selected questions from
T1: Orbitals	Online	F2F	Semester Test 2
T2: Conformation	F2F	Online	Semester Test 2
T3: Stereochemistry	Online	F2F	Semester Test 2
T4: Mechanisms	F2F	Online	Semester Test 2
T5: Reactions	Online	F2F	Semester Test 3
T6: Carbohydrates	F2F	Online	Final Exam

5. Pilot study - challenges and first results

A number of technical and administrative challenges were experienced with the implementation of the online learning system during the pilot study. Most problems can be avoided by clear communication of the process or slight revision of protocols. Errors identified in the online content were corrected by the supplier and should not recurr in the second cycle of implementation, but these should be tested.

Table 2: Pilot study results student preferences for learning modality

Preferences		Post: Face-to-face 49% (96)	Post: Online 51% (99)
Prior	Face-to-face 64% (124)	35% (69)	28% (55)
	Online 33% (65)	12% (24)	21% (41)
	Unanswered 3% (6)	1.5% (3)	1.5% (3)

Data given as % total (number of students)

The predicated preferences for online versus face-to-face tutorial modalities and the preferences at the end of the course were assessed from survey responses are given in Table 2. The results indicated an overall shift in preference for online tutorials. The reasons for this shift could be identified through focus group interviews.

When examining performance in the six organic chemistry topics and the overall performance shown in Table 3, the differences between the two groups for each topic appeared to be insignificant suggesting that there was no disadvantage to the student in being assigned one or other tutorial modality for any of the topics.

Table 3: Average marks from the subset (61 students) for the two groups

Group	Phys Chem (Test 1) Exam %	T1 (14)	T2 (14)	T3 (15)	T4 (12)	T5 (35)	T6 (16)	Org Chem Exam %
A	(68) 54	7.0	4.2	4.5	5.7	24.5	9.7	61
B	(61) 57	6.8	3.9	4.4	4.3	26.5	10.3	61

Online tutorials are presented in black; Face-to-face tutorials are presented in blue.

6. The way forward (plan for second implementation)

Procedures for roll out and data capture for the second implementation will be adjusted to eliminate the administrative and technical problems identified in the pilot study. The survey instruments will be improved and incentives introduced to increase voluntary participation in the surveys.

Tutorial structure and tutor training could be optimized to maximise the benefit of the face-to-face tutorial experience. The design should take note of the comments on involving Learners in driving feedback by Boud and Molloy (2013).

The research team has been expanded to include an education specialist and a statistician who can participate in the optimization of surveys and data analysis.

7. Conclusion

Pass rates for CMY 127 are influenced by a number of different factors, but it is gratifying to see the improvement in pass rates following the introduction of this intervention in 2015 (Table 4 shows the pass rates since 2011). We acknowledge the fact that the Hawthorne effect could have played a role, but we are nevertheless enthusiastic to continue of this path of continuous improvement for the sake of student learning.

Table 4: Pass rates for CMY 127 after final, supplementary and summer school exams.

Year	**2011**	**2012**	**2013**	**2014**	**2015**
% Pass	59	57	50	60	66
Comments				Introduction of OWL for Physical Chem.	Introduction of Connect for Organic Chem.

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