ENRICHING LEARNING FOR FIRST YEAR CHEMISTRY STUDENTS: INTRODUCTION OF ADOBE CONNECT

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Abstract

The study of chemistry is central within science and other associated degrees. At the University of New England in Armidale academics need to provide chemistry teaching in both a distance and the traditional on-campus mode within science and other degrees. This study explores the contribution that the adoption of Adobe Connect technology can make to support of students and enhancement of their learning. The preliminary response from students has been unequivocally positive with an increased confidence around unit materials gauged by improved student learning outcomes and unsolicited positive comments.

Keywords: Adobe Connect, Chemistry.

Introduction

Prospective mature aged students who seek career change are often restricted through mobility and financial constraints. Alternatives to traditional classroom based teaching are their only option. The University of New England in Armidale, NSW, Australia, is one of the few higher education institution in Australia offering an undergraduate science degree by off-campus or distance delivery in addition to providing an equivalent degree on campus. Of relevance to this paper is the central role of chemistry within science and other degrees and the need at the University of New England in Armidale to provide chemistry teaching in both a distance and the traditional on-campus mode. This has necessitated the development of teaching strategies that are "relevant, innovative, and responsive" (Palmer, Holt & Farley, 2010). The approaches described in this paper were designed for students studying in a distance mode; however it is important to acknowledge that distance education models are also increasingly being adopted for students studying on-campus.

With traditional distance (external or off-campus) education modalities, supported through online learning managements systems (LMS), content is relatively easily presented to students in a number of ways such as lecture presentations in a PowerPoint format, access to library readings or notes. Over the past few years, academics teaching in chemistry units at the University of New England have provided audio recordings of actual lectures presented to internal students to the distance students.

There are limitations to content "delivery" through PowerPoint presentations. The relationship between structure and properties is regarded as an overarching concept in chemistry and there is the suggestion that students have great difficulty in making this connection (Cooper, Underwood & Hilley, 2012). Also PowerPoint presentations are essentially two dimensional. Students undertaking studies in chemistry need to be able to translate two dimensional representations of molecules into three dimensions in order to visualise aspects of the behaviour and properties of molecules such as their stereochemistry, chirality and reactivity. The challenge for chemistry

ISSN 1027-5207

academics is to provide to those students who may be accessing any written or PowerPoint style learning materials for Chemistry units materials which enable students to visualise molecules in three dimensions. Second, a somewhat related issue has been identified by a recent European Union working group summarising the ten key innovations required in chemistry education. The report referred to the "the uniqueness of chemistry" and the notion that academics need to develop visualisation approaches which foster student confidence to constantly shift between the required macromolecular, sub-micro and symbolic representations required (Eilks & Byers, 2010).

More recently, at the University of New England, special purpose recordings of lectures have been introduced that include live screen capture of the lecturer's "pointer" and any written work presented, i.e., real-time working of the problems as provided to the on-campus face to face students during regular lectures and tutorials. These recordings provide a framework, in addition to access to PowerPoint lecture slides and audio recordings, which enables off campus students to navigate unit learning materials as if they were participating in face to face sessions. These recordings therefore have the potential to partly address issues identified in previous Australian work comparing recorded lectures with actual face to face lectures, which highlighted an acknowledgment by students, that students attending lectures have some advantages inherent in the face to face mode including the opportunity to ask questions and be motivated, but also interestingly viewing whiteboard diagrams (Panther, Mosse & Wright, 2011) which could include calculations and worked examples.

University of New England chemistry academics have trialled the introduction of "at the desk" special purpose recordings of lectures and tutorials using Adobe Connect software. This software had been adopted across the university to facilitate synchronous online communication between students and staff and was supported by information technology staff and resources. Adobe Connect software combines audio capture with a webcam stream, document sharing with annotations, a digital whiteboard and screen sharing in tiles that may be dynamically resized to focus student attention. When used in combination with a stylus, tablet and webcam, the program allows preparation of recordings in which key concepts, such as stereochemistry, can be explained and related problems worked through, in much the same manner as academics may do during a live lecture on a white board or with molecular models. Reference to macromolecular, sub-micro and symbolic representations can be developed outside the prearranged structure of PowerPoint slides. Adobe Connect software allows the recording of high quality audio and video, which can be customised to the needs of students and made available as a file download or stream. These recordings do not merely replicate what is done in the lecture but 'value add' to the learning process.

This study explores the contribution that the adoption of Adobe Connect (or similar) technology can make to support of students and enhancement of their learning. The preliminary response from students has been unequivocally positive with a reduction in both the number of questions asking for clarification of concepts asked via online forums and an increase in student satisfaction and confidence with unit material gauged by improved student learning outcomes and unsolicited positive comments.

Project Description

The units that were used for comparison purposes were first year units taught in second semester of 2010 and 2011 at the University of New England, NSW, Australia. There were a total of 258 students enrolled in 2010 and 350 students in 2012 in these second semester chemistry units. The learning and teaching approaches in both years were similar, except for the additional Adobe

ISSN 1027-5207

Connect recordings provided in 2011. The lectures were delivered by experienced university instructors who in the case of Adobe Connect recordings were also responsible for their production. The Adobe Connect recordings provided were of approximately 50 minutes duration each, one recording corresponded to the content in one lecture. Access to recordings was provided to students in an online LMS. On campus students completed a three hour practical class each week; whereas distance students completed practical classes during mandatory residential schools for which students come to classes on campus. Students are assessed on the basis of performance in four online quizzes, four short written assignments, practical class laboratory reports and their final end of semester exam. The LMS for the units support discussion pages which enable questions and answers to be posed by both staff and students. Students are provided support for exam preparation by provision of previous exam papers, questions around the solutions to these previous exam papers are posed and answered on the discussion pages.

Evaluation Methods

The evaluation of the impact of introducing the Adobe Connect resources was carried out by an academic experienced in teaching and learning, who was not involved in the unit delivery or assessment, after the teaching and assessment periods were concluded. The evaluation included measures of student success as determined by accessing overall unit marks for each student, in the second semester chemistry unit on two consecutive offerings of the unit, one prior to the introduction of the Adobe Connect recordings, and one after the Adobe Connect recordings were included in the online materials to which students had access. Assessment for the two units was considered to be of similar standard, with several questions in the final exam almost identical in both years. Marks achieved in the first semester chemistry units and marks achieved in the second semester biology units in the same two years were also accessed. There were no significant alterations to unit delivery in the case of either the biology or first semester chemistry unit. There was no attempt to separate unit marks of distance and on campus students. Both groups of students had access to the same online resources. The evaluation also included comparison of student success on one specific question for each student, in the second semester chemistry unit on two consecutive offerings of the unit, one prior to the introduction of the Adobe Connect recordings, and one after the Adobe Connect recordings were introduced.

The second evaluation approach was to collate and analyse all student and staff commentary from the online discussion hosted within the LMS for the same offerings of the unit. Commentary was analysed through manual coding processes involving sorting; reading through information to make general sense; recording of thoughts about the data and organising material into categories (Strauss & Corbin, 1998). Selected quotes which illustrated these categories were identified.

Results

Mark distributions for second semester first year biology, second semester first year chemistry and first semester, first year chemistry for 2010 and 2011 are shown in Figure 1. The data (Panel B) indicate that student marks in 2011 as compared to 2010 for second semester first year chemistry are shifted such that a greater percentage of students passed the unit and overall marks were higher. No such shift between 2010 and 2011 could be observed for second semester first year biology (Panel A) or first semester first year chemistry (Panel C) in which there were no Adobe Connect recordings.

ISSN 1027-5207

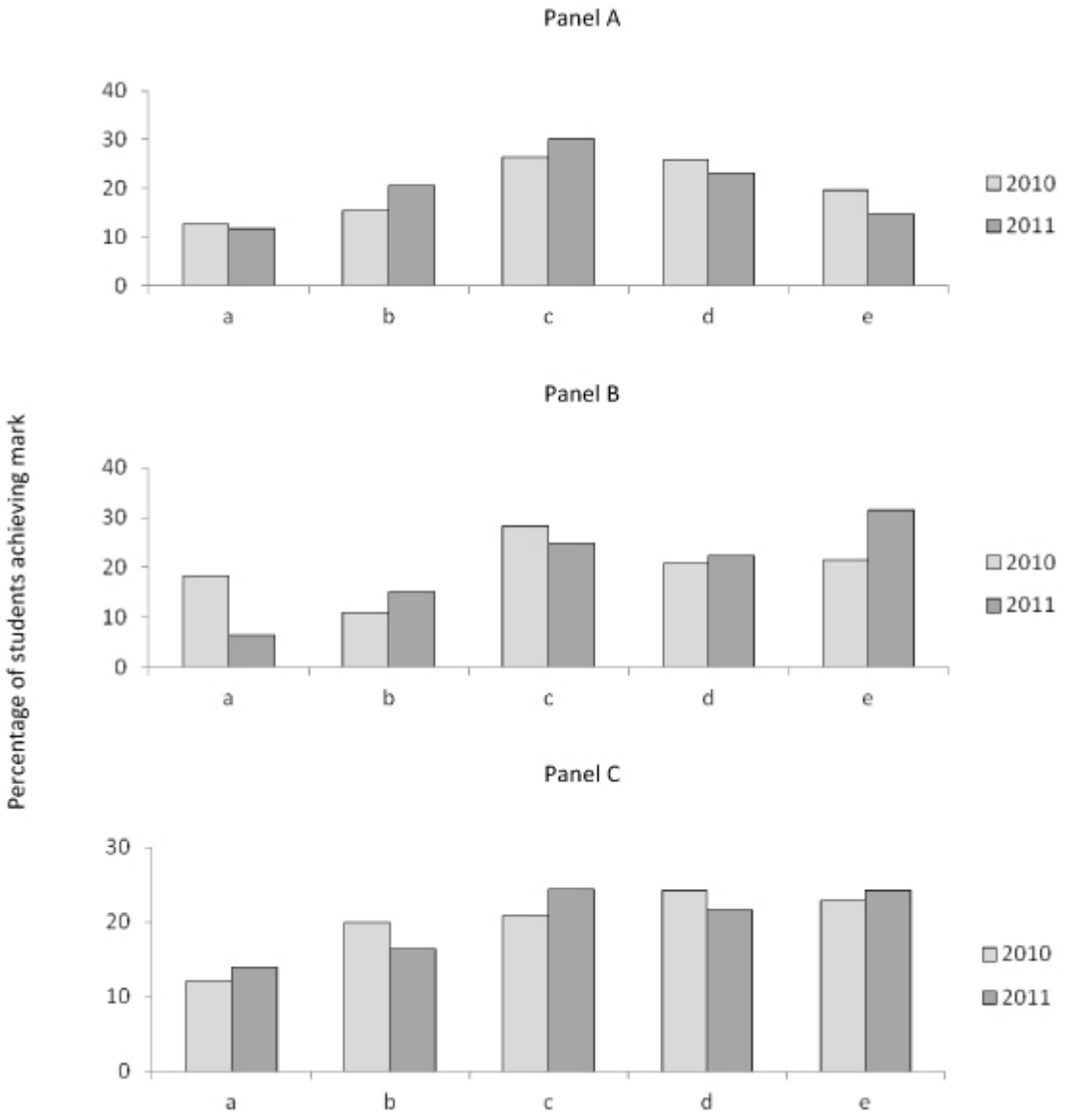

Figure 1. Percentages of students achieving marks in groupings a (less than 49%), b 50-59%, c 60-69%, d 70-79% and e 80% and above. Panel A second semester first year biology, Panel B second semester first year chemistry, Panel C first semester, first year chemistry.

Mark distributions for a specific question, very similar in both years and of a problem solving nature, in the second semester chemistry unit on two consecutive offerings of the unit shown in Figure 2 indicated a shift to a greater percentage of students in the unit achieving higher marks for that question.

ISSN 1027-5207

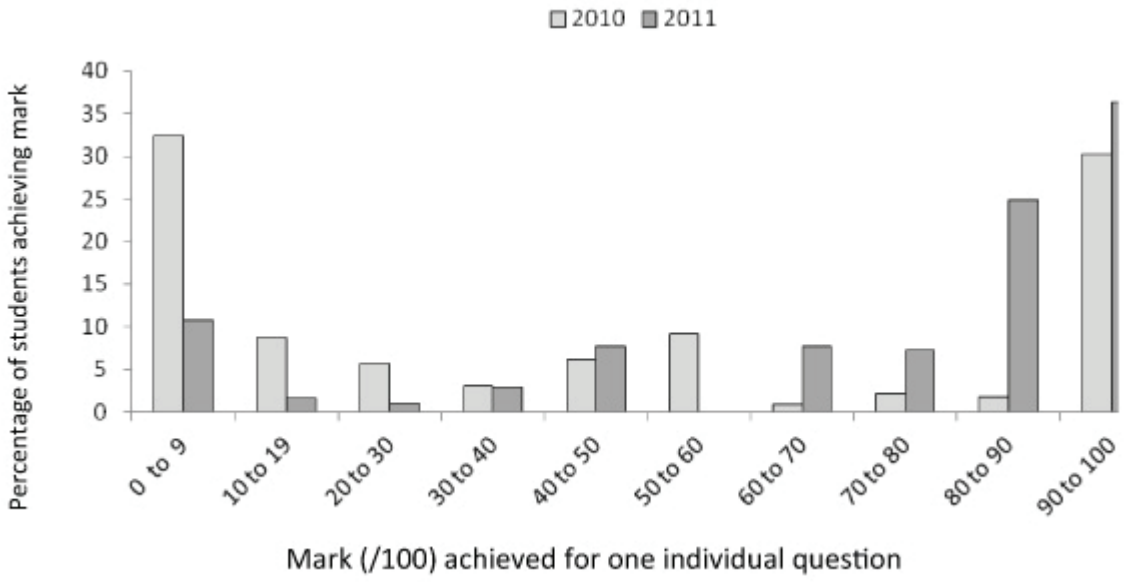

Figure 2. Percentages of students achieving mark (/100) in groupings for one individual (almost identical) question in the second semester chemistry unit on two consecutive offerings of the unit

An analysis of student and staff comments from discussion pages in second semester chemistry 2010, prior to the introduction of the Adobe Connect resources, revealed two categories of questions and comments. The first of these included questions or comments that could be described as "housekeeping" such as dates for submission of pieces of work, or comments such as "*Not meaning to be picky again but I've noticed that the Unit Outline isn't anywhere in the course content... help?*".

In the second category were those which sought clarification of content. The following quote (from one of the academics teaching in the unit) from the discussion page indicates the complexity of answering one of these questions in a verbal format, trying to explain chemistry concepts in words rather than through three dimensional visualizations.

> *"The structure on slide 11 is trans because the methyl and ethyl groups are on opposite sides of the ring structure. The ring on the slide is coming out of the page at you, i.e., it is perpendicular to the plane of the page. So in this representation the ethyl is sticking up and the methyl is sticking down. If the ring is drawn in the plane of the page, then a trans isomer would have dashed lines (into the page) for methyl and solid line (out of the page) for ethyl (or vice versa), and a cis would have either both with dashed bonds or both bold bonds."*

Similarly the following quote also from one of the academics teaching in the unit

> *"Something that might help, when you do a catalytic hydrogenation, the H's add to the same side of a double bond. If you are making a straight chain alkane it has no real stereochemical effect as there can then be rotation about the sigma bond anyway. However if you add them onto a ring, as they add from the same side and you get a cis addition."*

also illustrates this point.

An analysis of student and staff comments from discussion pages in second semester chemistry 2011, post to the introduction of the Adobe Connect resources again revealed two categories of questions and comments. "Housekeeping" questions were focussed on access to the Adobe Connect recordings, such as

ISSN 1027-5207

> *"When the page that asks for my login etc comes up, it also has 'my profile, help and logout' – it looks more like a page that you might use as a teacher."*

and

> *"Currently the computers in the Library are using an old version of Flash. Therefore they are unable to play the lecture recordings. I've talked to the Library IT people and this should be fixed in a day or so." (staff comment)*

The second category were mainly student commentary around the use of the Adobe Connect, such as

> *"I just wanted to offer some positive feedback too. These make a difference to me; they are so much easier to follow. I am sure for those like me who are short of time appreciate the concise presentation too!"*

> *"I am looking forward to using it especially for stereochemistry as it is very 3D oriented ... so I can use the video to show you guys" (staff comment)*

> *"LOVE IT LOVE IT LOVE IT LOVE IT LOVE IT!" (student emphasis)*

> *I find that being able to see things indicated/underlined/circled etc means that I always know exactly what is going on and I don't have those moments of losing the thread……I grasp things much more easily as I get the flow of thought, and not having those mini-moments of figuring out what is being indicated in the lecture theatre allows me to follow the processes and things make sense substantially faster.*

> *Thanks for introducing this. Did I mention I love it?"*

It appeared that after the introduction of Adobe Connect recordings students were able to clarify concepts through review of these recordings. In 2011, in the previous semester the students had studied the first semester chemistry unit without the Adobe Connect recordings and were thus reporting on their view of the difference that the Adobe Connect recordings made. There were only two negative comments, essentially regarding the incompatibility of the Adobe Connect with IPads.

Discussion

The unit's teaching staff had already introduced recorded audio lectures; however these are not always of high quality and may have background noise. Based on the analysis of the mark distributions collected in this study, that is – mark shifts in the unit which had introduced recorded lectures and tutorials using Adobe Connect software as compared to other units which had not; mark shifts for one individual question in the two years being compared and an analysis of all discussion board comments we conclude that the introduction of recorded lectures and tutorials using Adobe Connect software has enriched learning and improved student learning outcomes for students taking those units. The use of the Adobe Connect software and its effects on student learning has also demonstrated to staff how the different design of online teaching can be fed back into improving face to face lectures.

It is acknowledged that clear communication and explaining concepts in multiple ways is associated with student satisfaction in face to face teaching interactions (Moore & Kuol, 2007; reviewed Gruber et al., 2012). The recorded lectures and tutorials using Adobe Connect software provided opportunity for the academics teaching in this unit to provide insights into the lecture

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materials to those students accessing these resources in a manner perceived as being different from those provided through the recorded traditional lectures. The Adobe Connect recorded lectures, provided opportunity for teacher repetition, slow explanations in multiple ways and the opportunity to demonstrate the process of problem solving.

The value of the tutorials and lectures recorded with Adobe Connect requires further investigation. First, nonverbal immediacy, that is "psychological closeness" (Mehrabian, 1968) behaviours that communicate liking, such as variety in vocal pitch, loudness, tempo, smiling, leaning toward a person, face-to-face body position, decreasing physical barriers between themselves and their students were not interrogated in this work, however anecdotally staff members reported preparing the Adobe connect sessions in a comfortable and relaxed manner in contrast to that of recording lectures concurrently being delivered to on campus students. Previous work has shown that student perceptions of teacher nonverbal immediacy were positively correlated with students' engagement in learning (Allen, Witt & Wheeless, 2006) and have suggested that high levels of teacher immediacy function as a means of increasing the motivation of a student to learn, and that such motivation may increase the cognitive mastery of material. Similar results have also been demonstrated in distance environments (Ni & Aust, 2008).

Second, the presentations recorded with Adobe Connect provided a number of additional resources through screen capture, such as close up representations of molecules in three dimensions. Using a program such as ACD/ChemSketch Freeware or Avogadro which allows the manipulation of models, aspects of the behaviour and properties of molecules can be visualised. As opposed to providing a static link to a web object, the lecturer may demonstrate and discuss aspects of any internet or commercial animation adding another dimension to these resources. It has been reported that use of animated stand-alone learning modules for face to face first-year chemistry students has increased student satisfaction however without translation into increased performance in associated tests (Schmid, Yeung, George & King, 2009).

The value of the tutorials and lectures recorded in Adobe Connect, particularly in the context of the expanding distance learning market, requires further evaluation.

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ISSN 1027-5207