COMMUNITY DIRECTIONS

Multimedia Resources for Teaching Chemistry

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Abstract

A series of short, focused multimedia resources was developed based on areas of the chemistry degree course with which students often have difficulty. The resources were generated by undergraduate project students using Microsoft PowerPoint and Adobe Connect. Incorporation of animations and other interactive elements was found to be difficult. Evaluation of student attitudes towards the resources revealed that they were appreciated by students and were particularly useful for distance learners and for examination revision. A number of improvements were suggested such as the inclusion of more in-depth content. The development of these types of resources can be carried out by final year undergraduate project students.

Keywords: Multimedia resources, Screen capture, Chemistry, Adobe Presenter, Peer teaching

Background

One of the main difficulties in teaching science to undergraduate students is ensuring that the thought process behind key concepts is communicated effectively. Whilst such information is usually given in lectures, it is often not recorded by students, who tend to focus on the result rather than the process. In a workshop environment an academic may have to explain the strategy for solving a particular problem separately to a number of groups of students. This means that students still only receive a limited amount of help from the academic. In addition, when revising, students have often forgotten the explanation of the process and have to rely entirely on printed resources (such as lecture notes, printouts of lecture slides or textbooks); hence they often resort to rote learning

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and find it difficult to apply the principles to 'related questions' in examinations and tests.

The use of multimedia resources has become increasingly significant in chemistry teaching in recent years. A number of implementations have been demonstrated, ranging from full lecture capture (Andrews *et al*. 2010) to screen capture video clips (Currell 2007, Lancaster 2011, Lancaster & Read 2011, Seery 2010). As well as the obvious advantage to student revision that this type of resource provides, video resources also permit instructors to make better use of contact time by utilising multimedia resources to communicate the theory, allowing the contact time to be used for interactive activities (Read & Lancaster 2012, Sadaghiani 2011).

Project aims and objectives

The aim of this project was to address the above issues by developing a series of short, focused multi-media learning and revision resources explaining concepts that students often find difficult and illustrating approaches and solutions to a variety of problem types. The multimedia resources (hereafter referred to as 'clips') were designed to be made available through Blackboard (the University's Virtual Learning Environment) in order to allow students to access content in a way that suits their individual pattern of learning. Another key aim of the project was to develop a platform for final year project students to gain a greater understanding of the theoretical basis of chemistry education by producing a series of peer-teaching eLearning resources.

Project outcomes and achievements

Pilot project

In order to select the best approach for developing these resources, a short pilot project was conducted during the spring term of the 2010/11 academic year. This consisted of the development and evaluation of two short clips (around 5 minutes in length) together with an interactive tutorial resource. The resources developed for the pilot project were embedded in the Blackboard course site for the third year module 'Metals in Organic Synthesis'. The pilot project was evaluated by surveying students on the resources as part of the standard course questionnaire, and by reflecting on the video production method. These resources were used for a second time during the 2011/12 academic year.

The resources were developed by preparing presentations in Microsoft PowerPoint and adding audio by using the Adobe Presenter plug-in. It soon became obvious that even an experienced lecturer would need to produce a script. Two types of resource were produced: (i) a conventional PowerPoint presentation with synchronised audio; (ii) a similar PowerPoint presentation but with interactive questions and different routes through the resource depending on student responses to the questions. The production of the problem solving clip was more complicated as it required a number of multiple choice questions to be added to the presentation, and for a number of different paths through the clip to be defined using the Adobe Presenter software. Adding interactive components to clips using Adobe Presenter was not particularly intuitive and it was felt that this would significantly increase production time. The non-interactive clips required 60–90 minutes to record and edit whereas the interactive clips could take two hours or more.

Evaluation of the pilot project ('Metals in Organic Synthesis' 2011)

The pilot project was run with a small group of Year 3 students in a module on 'Metals in Organic Synthesis' in the spring term of the 2010-11 academic year. The total number of students taking this module was 52 (26 BSc students and 26 MChem students), including 7 distance learning students. The availability of the developed resources was publicised by in-lecture announcements as well as email announcements. Student engagement with the resources was evaluated by adding three questions to the end of course questionnaire. Of the 30 students who responded to the course questionnaire, 70% had looked at the resources. When asked if they found the clips useful (on a 5 point Likert scale from strongly agree to strongly disagree), 86% of responses were positive (out of 21 responses in total). When asked to comment on the new resources some students, particularly distance learners, responded very positively: "Audio lectures were brilliant, really helpful for the auditory learners. Able to understand notes more. Recommend to carry on with it. Thanks Dr Davies", "The audio lects were the best thing since sliced bread! If only all distance learning modules had them" and "I thought that the audio lecture was extremely useful and think that if every lecturer was able to produce these it would be extremely helpful for the distance learners". One student also suggested recording audio live in lectures and adding it to lecture slides: "it would be better if the audio was recorded during a lecture or in lecture form where it explains ideas in detail instead of just reading lecture out". Students were also asked about the interactive question (using the same Likert scale as for the above question). Of the 16 students who responded, 87% of responses were positive.

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When the recording and editing processes were reflected upon, it was felt that the production of non-interactive clips was relatively straightforward, requiring between 60–90 minutes work, whereas production of an interactive needed considerably more work. Due to the difficulties in producing interactive clips it was decided that the main focus of the project would be the production of non-interactive resources.

Key points from the pilot phase:

- it is essential for a script to be written for all clips;
- non-interactive clips were much more straightforward to produce than clips with interactive elements;
- a timespan of 45–60 minutes should be allowed for the recording and editing of each clip.

Main project phase

The main phase of resource development took place during the 2011/12 academic year. At the end of the 2010/11 academic year it was decided that BSc project students would help to produce the new clips. Three BSc project students (two from chemistry and one from interdisciplinary science (IScience)) were assigned to this project with the aim of developing a suite of resources focused on the chemical concepts with which students often experience difficulty with in these two degree programmes. The students researched the pedagogical background of this approach to teaching as well as existing examples of good practice using similar modes of delivery (e.g. The UEA 'Chemistry Vignettes' resources (Lancaster 2011)). All of the clips developed during this phase of the project were branded as 'Chemistry Clips'.

Resource development commenced in the autumn term of the 2011/12 academic year with the production of nine clips for Year 2 of the chemistry degree programme and four clips for the IScience degree programme. The clips were prepared in the same way as the pilot phase apart from one clip for 'Bifunctional Molecules' which included an animated mechanism that was recorded using Jing (www.techsmith.com/jing.html) and embedded into the PowerPoint presentation as a Flash file. The nine chemistry clips were developed for the second year modules 'Bifunctional Molecules' and 'Molecular Spectroscopy'; some of the themes for the clips were selected by staff involved in the teaching of these modules. Additional selections were made by undergraduate chemists in their third year of study at Leicester, who were asked in an online poll to state the concepts that they had had most difficulty with in these two modules. The selection of clips for the IScience course was made by the module leader based on the areas of the course with which Year 1 students often have particular difficulty in examinations. Because of the different structure of the chemistry and IScience BSc projects, development of resources for the IScience course continued in the spring term of the 2011-12 academic year.

The three project students working on the production of these resources analysed the usage of the resources, and student attitudes towards them, and this formed the basis of their dissertations.

Evaluation

Bifunctional molecules

Evaluation of the main phase of the project was conducted in the same way as the pilot phase but Blackboard usage statistics were also collected. An additional questionnaire was specifically designed to gain further insight into attitudes towards these resources and was deployed after students had completed both of the first semester modules for which the clips were used.

Usage statistics indicated that 63 students out of a total class size of 104 had used the resources deployed in the 'Bifunctional Molecules' module. The resources were accessed a total of 289 times and were used most during the revision period leading up to the examination in January (see Figure 1). This suggests that students find the clips useful as revision aids.

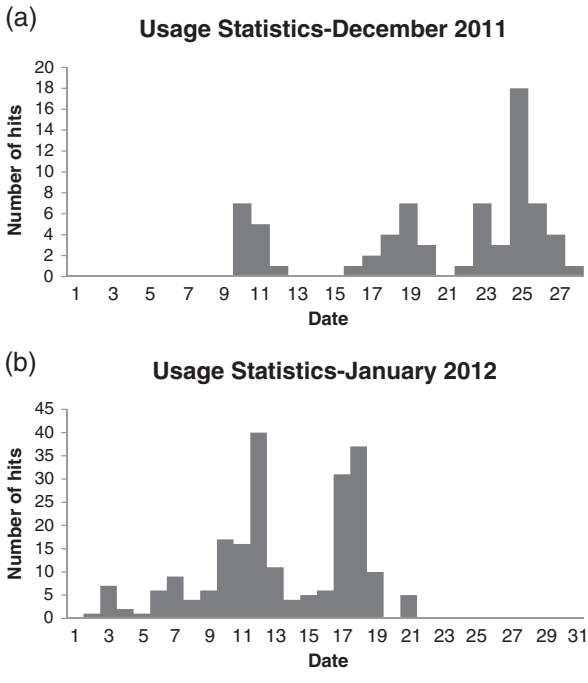

Figure 1 Usage statistics for the 'Bifunctional Molecules' clips in (a) December 2011 and (b) January 2012

Analysis of the course questionnaire revealed that only 31 out of 47 respondents had looked at the resources (at the time when the questionnaire was answered). Of the 31 who had looked at the resource, 22 agreed that the resource had been very useful. (On a 5 point Likert scale from strongly agree to strongly disagree, 22 students either agreed or strongly agreed with the statement 'The resources are very useful'). A total of 27 students said that they would use the clips during revision (see Figures 2 and 3).

Students were also given an opportunity to comment on the clips. From their responses it appears that many students found the clips useful: "Very useful indeed. I wish all other modules had some sort of chemistry clip/animation that will help visual learners like myself.", "On the whole it was a great asset to my revision" and ". . .they were easy to follow and understand. Also the layout of them was very clear and concise." Other students requested more curly arrow mechanisms (i.e. chemical reaction mechanisms) in future clips and that more background information to course material be given.

Molecular Spectroscopy

Usage statistics for this module reveal that the clips were accessed by 73 out of 104 students. It is possible that the greater use of these clips reflects the more problem-based emphasis of this module compared to 'Bifunctional Molecules'. There were two peaks in the usage statistics sorted by date, one in the first week after the resources were made available and one in the week leading up to the examination. Usage statistics, by time of day accessed, reveal that the resources were accessed 27 times between midnight and 07:00. It is perhaps significant that this resource provides additional support for students to study at a time that suits them. A total of 21 out of 27 students who had looked at the resource, and responded to the questionnaire, agreed that the resources were very useful and 26 out of 37 students said they would use the clips during revision. (See Figures 2 and 3 for a comparison of the responses to these statements in both Year 2 modules.)

Comments on the resources included "Helped to reinforce the understanding of the representations, by the time I wrote my exam on the module I felt confident in this subject area" and "The chemistry clips are help [sic]". Student suggestions for improvements focused on the greater integration of animations and the inclusion of more 'unseen' examples rather than examples based on the lecture content.

Comparison

Both sets of clips were watched by the majority of students, but more of them watched the 'Molecular Spectroscopy' clips than watched the 'Bifunctional Molecules' clips. One possible explanation for this is the fact that the molecular spectroscopy clips focused on topics such as symmetry and assigning point groups, concepts which students often find hard to visualise. It is possible that students required more help with these concepts than with those taught in the 'Bifunctional Molecules' module. Responses to the course questionnaire also suggest that students found the 'Molecular Spectroscopy' clips slightly more useful, although it should be noted that both clips were well received. The outcomes from this study appear to suggest that the choice of topic for the clips may have an impact on how useful students find them.

Distance learners

The resources developed for the 'Metals in Organic Synthesis' module in 2011 were used for a second time in the 2011-12 academic year. Distance learners were invited to submit feedback on the usefulness of these resources. When asked what they liked most about the resources responses

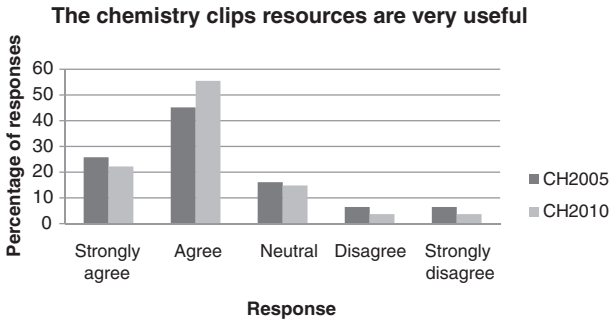

Figure 2 A comparison of responses to the statement 'The chemistry clips are very useful' from the course questionnaires of the 'Bifunctional Molecules' (CH2005) and 'Molecular Spectroscopy' (CH2010) modules

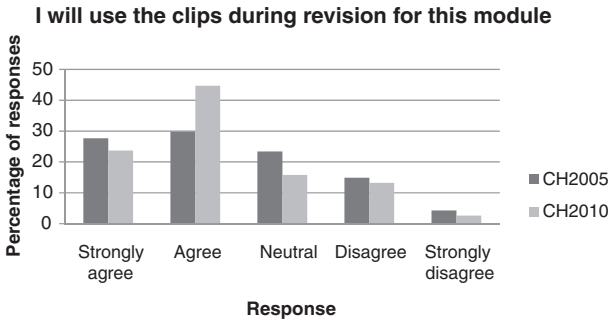

Figure 3 A comparison of responses to the statement "I Will use the clips during revision for this module" from the course questionnaires of the 'Bifunctional Molecules' (CH2005) and 'Molecular Spectroscopy' (CH2010) modules.

included: "The fact that the you get the extras that the lecturers say in lectures, but don't always put in the slides!" and "When I went back to read the lecture notes, I understood them better compared to other modules with no audio, when it takes a couple of reading to get a good understanding. I wish all modules had an audio version for distance learners". Students on placement years seem to appreciate the availability of these resources and there appears to be demand for further resources to be developed for other modules that are studied via distance learning.

Focus group

A focus group was conducted with five undergraduate students (three Year 2 students and two Year 3 students). The students who participated in this focus group watched each clip an average of 3.1 times. When asked why they found the clips helpful, students commented that they found the peer explanations of concepts useful and that they appreciated the opportunity to listen again to explanations of some of the key concepts from the lectures. One of the general themes that came across from the focus group was that students benefit from simply listening again. Some students felt that sound was more helpful than simply looking at documents. One student commented on the potential advantages of these resources for dyslexic students, especially for those who "can't keep up taking notes in lectures". When asked what they would like to see in future clips, the students stated that they would like to see the inclusion of more interactive questions between slides and the use of animations to explain difficult-to-visualise concepts.

Students were asked whether they believed this type of resource could eventually replace face-to-face interaction. The student response to this question was unequivocal: "Nothing replaces the lecture unless teacher is totally boring" and that we "can't substitute a 5 minute ChemClip for an hour lecture".

When asked to sum up their feelings about the clips, most comments were positive ("I'm surprised they didn't do this earlier! I remember in first year saying to myself 'I wish they had clips'. . . and next year we have this!"; another student commented on how useful the clips would be for distance learners), although some students felt there was still scope for improvement. (One student commented that the clips were too similar to the content covered in lectures; another stated that the clips suffered from being 'too scripted").

General findings

At the end of the first semester, students were asked to fill in a follow-up questionnaire which went into greater detail about attitudes towards the resources than the questions included in the course questionnaires. When students were asked what they would like to see improved in future clips, replies included: "More in depth discussion/careful explanation of mechanism steps" and "The clips didn't go into further depth on the subject to further aid understanding". Several comments indicated that some students didn't like the change in the person delivering the commentary. Other comments suggested that more background information could be given in the clips. Interestingly, some students feel that the resources are of limited use if they merely repeat or summarise examples covered in lectures; this suggests that these same students would have similar criticisms of the lecture capture approach.

The time required to record and edit the three different types of clip featured in this project are summarised in table 1 (times given exclude production of the PowerPoint file or the script).

Undergraduate students worked on this project for the equivalent of two full working days per week for seven weeks. The first semester project students produced nine resources in a seven week period. It is felt that this project has been a successful way of producing student generated content which can be easily integrated into the undergraduate degree course.

Availability of the Adobe Presenter software remains an issue. Although University of Leicester staff can use the software freely, students are unable to access the plug in, a situation which has led to students needing to record and edit clips in the office of an academic. In order to ensure the sustainability of this project it is necessary to address the issue of software access and to provide quiet spaces for students to record in.

An additional significant benefit of this project was the fact that it gave the final year students involved

Table 1 Periods of time required to record the various types of resource covered in this module

Type of resource	Length of time (in minutes) to record and edit
Standard clip (3–5 minutes) with no animations	45–60
Standard clip (3–5 minutes) with several animations	90–120
Interactive clip (3–5 minutes) with questions	Up to 180

a greater appreciation of the pedagogical basis of university teaching as well as an insight into how to integrate innovative resources into a course.

The key outcomes from the project are summarised as follows:

- Students like this type of resource.
- Students tend to use these clips mainly for revision.
- Some students access the clips in the early hours.
- These clips are useful for distance learners and dyslexic students.
- This is a sustainable way to produce student generated content (providing some software and recording issues are overcome).
- Students recognise that although they find the clips useful, they are not a replacement for face-to-face teaching.

The main issues with this approach are:

- The clips need to have good sound quality.
- The clips should not simply duplicate lecture content.
- Additional in-depth content should be included in the clips.
- Including animations can be difficult and time consuming using the current approach.

Continuation of the project

The resources developed as part of this project have been embedded in the Blackboard course sites for the relevant modules and will continue to be used in future. The use of project students to plan, produce and evaluate clips will allow further clips to be developed.

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