Transforming learning in Life Sciences through the use of CeLLS packages at University of Dundee – pilot study

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OVERVIEW

This case study describes a University of Dundee pilot of teaching and learning model for Collaborative eLearning in the Life Sciences (CeLLS) Project. The project is aimed at transforming learning for learner responsibility in the 1st and 2nd year courses by moving away from the traditional formal lectures towards the increase in student-centred activities (theme 1). In the pilot this was achieved by the replacement of 66% of traditional formal lectures with an online CeLLS package. We describe how the existing institutional assessment strategy for early years (theme 2) is combined with new elements to enhance student centred-learning in the pilot. We provide evidence of the effectiveness of the new approach and relate the key components of the CeLLS pilot to the principles of assessment practice identified by REAP.

INFORMATION ABOUT THE CLASS, MODULE OR PROGRAMME

CeLLS Project

The College of Life Sciences at University of Dundee (CLS UoD) in Scotland, UK is one of the five partners involved in the Collaborative eLearning in the Life Sciences (CeLLS) Project (www.cellsproject.org), a part of Scottish Funding Council e-Learning Transformation Programme 2005-2007. The aim of the project is to transform teaching and learning in Life Sciences to a more student-centred approach via the creation and use of online interactive materials covering the core and some institutionally-specific Life Science curriculum at Level 7 and 8 of degree and Higher National streams.

Institutional context

CLS UoD has been encouraging a change in learning and teaching practice to a more student-centred learning in order to counter the challenges typical of the early years' university courses: high diversity, large class sizes, low staff to student ratios, and low student engagement with formal/traditional lectures. Central to the strategy is integration of information and communication technologies (ICT) in a blended approach with face-to-face contact. Good practice in use of new technologies is encouraged and supported by the university's Learning Centre.

All core first and second year modules in the Life Sciences use:
- Blackboard as the virtual learning environment (VLE)
- QuestionMark Perception (QMP) for online assessment

As a member of the CeLLS Project, the CLS is committed to replacing up to 66% of formal lectures for selected topics with interactive CeLLS online packages and shifting the staff and student effort towards more interactive learning opportunities.

The CeLLS pilot described below is one of the pilots implemented to establish the effect of incorporating e-learning material within an actual module and provide examples of best practice to inform CLS-wide change in learning and teaching.

CeLLS Pilot

The pilot was conducted by Dr Linda Morris in the 1st year, second semester module, Molecular Science 1B. The module is the second of the two 1st year Modules which provide a general introduction to and refresh the concepts in chemistry relevant to biological sciences. The student cohort is diverse, taking a Life Science degree in a number of different Programmes. There are 174 students in the 2006/07 cohort. The pilot was conducted over a period of a fortnight (12th Feb - 9th Mar 07) and covered a two-week block of teaching corresponding to one self-contained topic (explanation of theory behind proton NMR analysis technique, practical use and interpretation of NMR results).

This Module is representative of a core Life Science Module at UoD in terms of the student profile and the underlying faculty teaching and learning model. It also employs some innovative approaches. Thus although the material piloted was subject-specific, the generic approach to its embedding is hoped to be one of the ways CeLLS project will transform teaching across the CLS in conjunction with encouraging a wider adoption of the new practices.

DESCRIPTION OF THE CASE

The Module

The module contains following elements (see an example of a typical teaching block in Figure 1A below):

- Scheduled/informal face-to-face contact time:
  - formal lectures
  - practical classes
  - informal drop in sessions
  - *lecture-tutorials* - students solve problems posed by the lecturer in a lecture theatre setting, with the lecturer providing individual and group help and feedback. Some of those lecture-tutorials use personal voting system (PRS or electronic voting handsets which students which allow student responses to multiple choice questions to be summarised instantly and presented back to the class). Lecture tutorials and PRS use are unique to the pilot Module.

- Online activities available 24-hours via the VLE:
  - All of the lecture materials, including PowerPoint slides and other resources
  - Discussion board to for students to ask questions and provide answers to each others' questions with moderation from the lecturers practical

- Assessment:
  - Five formative *online tutorials* are set using QMP at fortnightly intervals throughout from within the VLE. These tests represent 3% of the students' final grade. They are able to access them repeatedly until they are

satisfied with their mark. Importantly the test is created at random from a large question pool including instant feedback is provided to each answer but the correct answer is not revealed. The lecturer has access to the results of the online tutorials as students attempt them.
- o Summative assessment which include:
    - ▪ two QMP-based online exams– one mid-semester and one at the end
    - ▪ online post-practical assessments (delivered in a similar way to the *online tutorials* but with less feedback)

The CeLLS Materials

Each CeLLS package includes:

- Content (*CeLLS materials*) which can be embedded in a VLE with:
    - o prerequisites and prerequisite test (where applicable),
    - o learning objectives,
    - o narrative with interactive content, illustrations, activities and self-assessment questions
    - o glossary

- Assessment (CeLLS *end-of-topic assessment*) which can be delivered in two ways:
    - o embedding in the VLE (completely private, no way to capture results of tests)
    - o assessment engine, e.g. QMP (marks can be recorded and visible to lecturers). This option was used in the pilot.
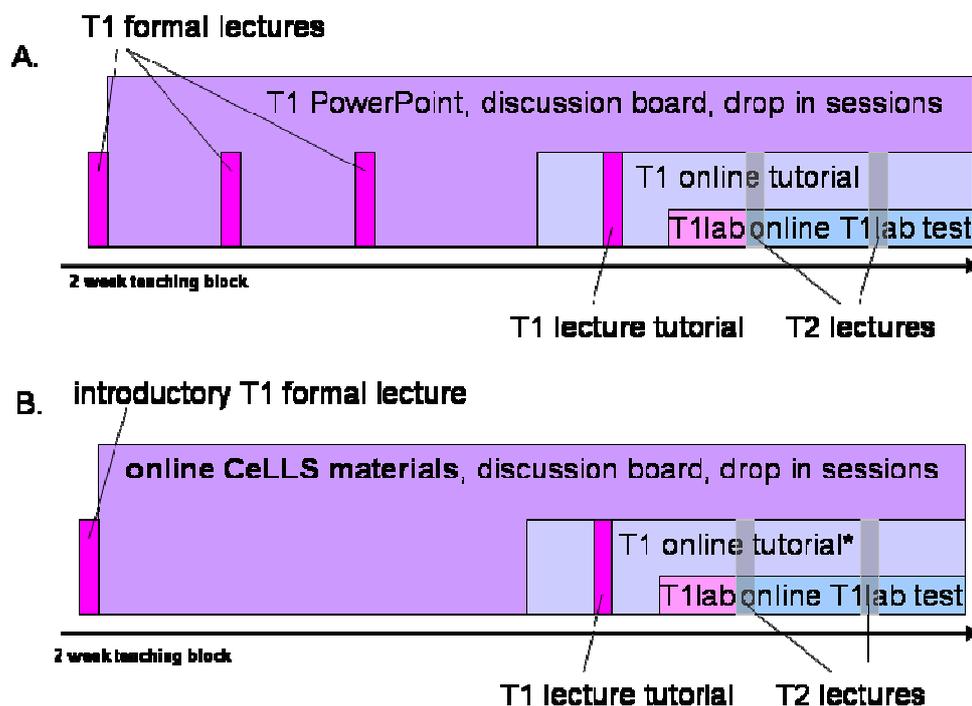
The CeLLS pilot

The pilot involved two major changes in the usual learning and teaching structure within a two weel block (see Figure 1):
- two out of the three formal lectures were replaced by CeLLS interactive material made available to the students via the VLE for one week for self-guided study (see Pilot materials at the www.cellsproject.org).
- questions in the *online tutorial* were replaced by those from the CeLLS *end-of-topic assessment*.

Although formal lectures did not take place, other activities carried on as normal during this time. Most importantly, a PRS supported *lecture tutorial* was held after one week of self-guided study of the CeLLS materials.

Figure 1. Learning and teaching model for the pilot topic (T1).

A. The usual structure of the two-week teaching block for the topic. **B.** CeLLS pilot with two T1 formal lectures replaced by online CeLLS materials and T1 online tutorial replaced with CeLLS end of topic assessment.

RATIONALE IN TERMS OF EDUCATIONAL IDEAS

CeLLS material rationale

Whilst the CeLLS materials are intended to be 'pedagogy neutral' in a sense that they should be reusable in various pedagogical settings, they contain in-built self-assessment opportunities (activities and questions) to support self-guided learners in independent study. These are designed to test concepts as students work through the materials and provide low to moderate levels of challenge in order not to discourage students.

CeLLS end-of-topic assessment provides an overall assessment of the topic understanding, with more challenging questions. Although in this pilot it was deployed as a marked online tutorial, it can also be used as an unmarked 'private' self-assessment task.

In combination, the two elements of the CeLLS package offer the flexibility of online delivery and an increase in individual feedback without increase in staff effort.

Institutional and CeLLS pilot rationale

CLS UoD recognises that learners in the 1st and 2nd year of university courses need both:
- extensive support and guidance from faculty staff and each other and
- development of a sense of responsibility for their own learning.

The broad institutional principles guiding assessment in those early modules are as follows:
- continuous and frequent formative feedback to both students and lecturers

- flexible delivery of assessment opportunities – students can access them 24 hours a day from different locations allowing students to identify and use the best times and places for learning that suit their learning style and obligations.
- variety of assessment opportunities blending automated, peer-to-peer, lecturer-to-learner, self-assessment – to cater for increased learner diversity and maintain learner motivation
- high value active learning experiences in face to face sessions with lecturers – to enhance student motivation and provide 'human' support
- balance between face-to-face and ICT to support those principles efficiently in terms of staff time and more individualised feedback.

Dr Linda Morris and her team also pioneered use of lecture tutorials and PRS in place of traditional formal lectures. These provide an important addition to the underlying assessment strategy by introducing active learning, peer-to-peer feedback and feedback dialogue to more fully engage students in the face-to-face sessions. They also help her to instantly adjust her explanation to address student problems and gauge effectiveness of her teaching and provide encouragement to the students.

For the detailed summary of application of the good assessment principles in the CeLLS pilot see Appendix 1.

EVALUATION

The aim of the pilot was to evaluate the effect of the use of CeLLS package on students and staff. Of particular concern was whether replacing face-to-face formal lectures by online CeLLS materials equivalent to 66% reduction in lecture contact time might have any negative effects on student learning experience.

Evaluation methods

The evidence was derived from:
- usage statistics of CeLLS materials and online tutorial extracted from the VLE
- student marks in the online tutorial
- comparison of student performance on PRS questions in lecture-tutorial between the cohort 1 - 2005/06 (with formal lectures) and cohort 2 - 2006/07 (with online CeLLS materials instead of formal lectures)
- student satisfaction questionnaire for online CeLLS materials (response rate 22% (39/174))
- lecturer reflection

Results

Benefits to students

Most importantly, there was no evidence of negative effect of replacing formal lectures with self-guided study of CeLLS materials on student performance. There was no significant difference in the proportion of students giving correct answers in the PRS lecture session between cohort 1 and 2 (Figure 2). In fact, students tended to perform slightly better and more students gave answers to each question in the pilot cohort.

Figure 2. Comparison of performance of students in a lecture tutorial PRS quiz between last year's cohort (1) and the pilot cohort (2).
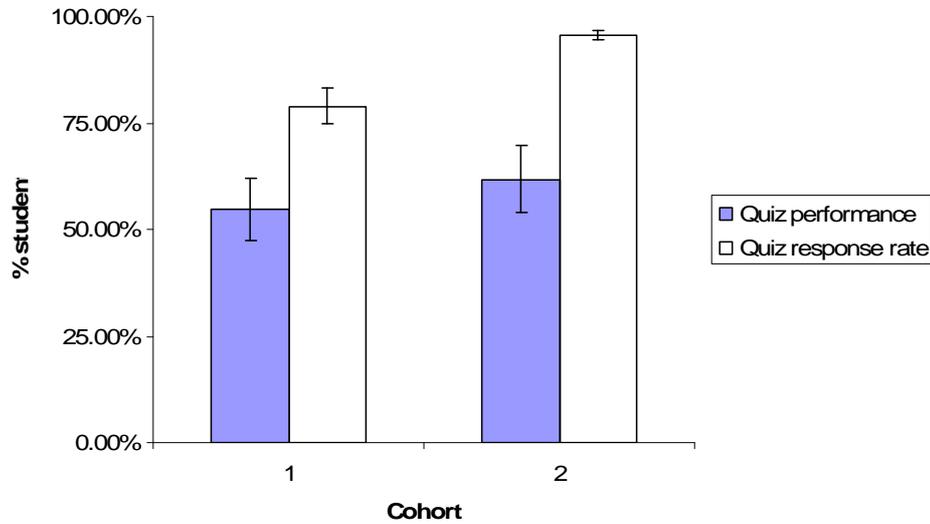
For cohort 1 the material was covered in formal lectures. For cohort 2 2 out of 3 formal lectures were replaced by self-guided study of CeLLS materials. Bars indicate SE.

Positive relationship between marks and the number of times the individual student accessed CeLLS materials and online tutorial showed a positive impact on student achievement (Figure 3).

Figure 3. Relationship between the use of CeLLS materials and formative assessment and students' grades in the formative assessment. Bars indicate SE.
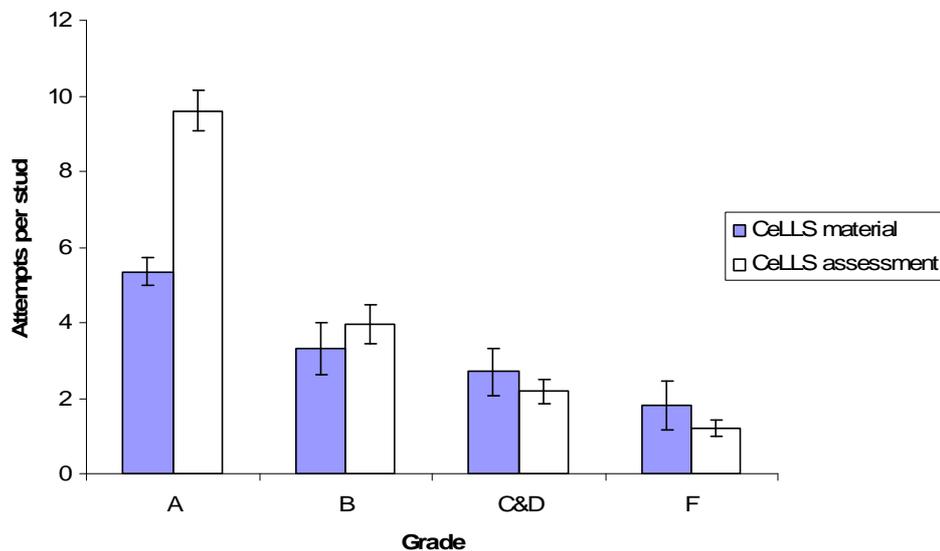
Only 15 (8%) students failed to access CeLLS materials, 134 (77%) students accessing it more than once, with an average overall access rate per student of 4.7 (SE 0.3). This provides a striking contrast to attendance at lectures delivering this material which is usually maximum 50% (90/175). This demonstrated clear gains in student engagement with the topic in the pilot cohort.

Figure 4. Results of the student evaluation questionnaire for online CeLLS materials used in the pilot.
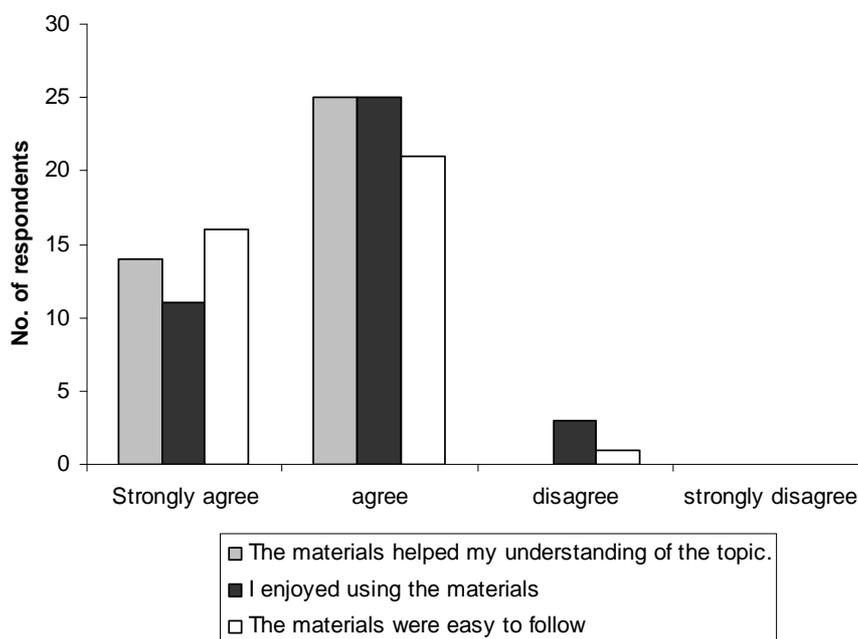
Students were very positive about their learning experience using CeLLS materials in their responses to the CeLLS evaluation questionnaire (Figure 4). In their free comments they said that they would to like to see an increase in use of similar materials for other topics (original spelling):

- "i would like to see more of the same kind of thing for other topics like IR,MS ect because i understood NMR because of this activity."
- "To have similar packages for other topics."

Students also engaged with self-assessment opportunity offered by the online tutorial (CeLLS end-of-topic assessment). Its access rate was high - an average of 7.9 per student, with each student accessing it at least once. This rate was higher than the usage rate for CeLLS materials, indicating higher student interest in pure assessment with feedback. Associating a grade with performance in this tutorial must have been a motivating factor. However, students showed high interest in the type of online self-assessment offered by the tutorial as in their evaluation forms they asked for more tests and questions to be included within CeLLS materials. Their comments also indicated that they appreciate the 'private' aspects of online assessment offered within CeLLS materials.

Students took full advantage of the flexibility provided by the online delivery of CeLLS materials – they were accessed almost 24 hours a day (with a dead period between 4-5 in the morning), 7 days a week and from multiple locations (library, university and home). They were mostly accessed from home (69% of respondents), but many respondents (23%) accessed them from more than one location.

While students clearly valued online learning experience, their interest in the face-to-face lecture tutorial was similar to that in previous years. Their attendance was similar to the previous year and their enjoyment of small group work and PRS use was evident in their behaviour. With PRS lecture tutorial, most of the students actively participated in answering questions (on average 79-96%) as opposed to formal lectures where usually only several reluctant volunteers take part.

Benefits to staff

Two clear benefits to the lecturer were observed:
- freeing up some time from two formal lectures (the lecturer will be able to invest this time in creating more interactive learning opportunities for students)
- information on student performance gained from online tutorials and PRS session in lecture tutorial to guide teaching

Conclusions/recommendations

The evaluation results demonstrate that the CeLLS pilot provides an example of best practice in use of CeLLS packages to change learning and teaching to promote student responsibility for their own learning.

There is no evidence for any deterioration in student learning experience due to replacing formal lectures with self-guided study supported by the online CeLLS package. It also shows increased student engagement with the topic.

We believe that much of the pilot's success was due to the existing institutional framework of assessment and support, including a mix of face-to-face (lectures, drop in sessions, labs) and online opportunities (online tutorials, post-lab assessment, discussion board). We also feel that the lecture tutorial approach and PRS use pioneered by Dr Linda Morris was particularly useful way to support online learning provided by the CeLLS package.

This case study will be used to encourage the faculty to adopt this approach as one of the ways of incorporating CeLLS materials into teaching at CLS UoD.

APPENDIX 1

The assessment strategy of the CeLLS pilot follows most of the principles of good assessment design for promoting student "empowerment" (principles 3 to 7) and "engagement" (principles 8, 9 and 11) as identified by the REAP project (www.reap.ac.uk). We were able to identify an additional principle: *Create possibilities for the students to independently seek assessment opportunities and feedback*. (Table 1)

Table 1. CeLLS pilot and REAP principles of good assessment design. (The new principle added in *italics*)

Principle of good assessment design	Application in the pilot
2. Facilitate opportunities for self-assessment and reflection.	We emphasise multiple and varied opportunities for self assessment: • 'private' tests within online CeLLS materials, • marked CeLLS end of topic online tutorials, • face-to-face PRS sessions in lecture tutorials
3. Deliver feedback that helps students self-correct.	Feedback is provided frequently followed by opportunities to self-correct and improve performance by: • allowing multiple attempts at tasks within *CeLLS materials*, marks in *online tutorials* explaining the mistakes but without providing the correct answers • individualised feedback through online delivery of above • proving low stake assessment opportunities with feedback (CeLLS materials, online tutorials, lecture tutorials) before high stake assessment measuring student performance (exams, post-practical assessment) • targeted explanations in lecture tutorials to address problems highlighted by online tutorials and PRS responses
4. Provide opportunities for feedback dialogue	• Replacement of formal lectures with CeLLS materials and end-of-topic assessment is aimed at increasing opportunities for dialogue, especially in a high value face-to-face setting of *lecture tutorials* where both peer-to-peer and instructor-to-peer interactions can take place. • Because CeLLS materials and end-of-topic assessment are ready-made and delivered 'automatically' via the VLE, staff time is freed up to provide high value feedback dialogue in blackboard discussions, drop in sessions, lecture tutorials etc.

5. Encourage positive motivational beliefs and self-esteem	• low-pressure and private learning settings provided by online tasks, including CeLLS materials and end-of-topic assessment (online tutorials) • maintaining regular access to staff and other students face to face and online • provide fun ways of learning via PRS and interactive CeLLS materials
6. Provide opportunities to apply what is learned in new tasks.	Within a block of teaching there are several steps at which students are presented with new tasks of increasing complexity: • Concept checking through activities and questions within CeLLS materials • CeLLS end of topic assessment in form of online tutorials • PRS lecture tutorials • practical sessions • post-practical assessment
7. Yield information that teachers can use to help shape teaching	• CeLLS end-of-topic assessment, when applied through the assessment engine in the form of online tutorial, provides the lecturer instant information on student progress at fortnightly intervals. • Struggling individuals can be identified and helped via drop in sessions. • Use of PRS system in lecture tutorials allows for instant adjustment of teaching to address knowledge gaps.
Create possibilities for the students to independently seek assessment opportunities and feedback	• Students are encouraged to ask questions to clarify their understanding on the discussion board (it is a relatively safe environment in which they may feel less threatened than in face-to-face contact – they also have an option of anonymous postings) • Flexible delivery of assessment online allows students to access it multiple times during their independent learning process to test themselves independent of the lecturer input – e.g. in preparation for online tutorials, practical sessions and revision for the exams • Drop in sessions allow students to seek individual help
8 Capture sufficient study time and effort in and out of class	This is a very important motivation for the CeLLS project in the face of decreasing student attendance at formal lectures and it is achieved by • increasing flexibility of access to CeLLS interactive learning materials and assessment via online delivery replacing some of the scheduled formal lectures • use of lecture tutorial format and PRS in face-to-face sessions

9. Distribute students' effort evenly across topics and weeks	This is achieved by • Providing regular assessment tasks for students throughout the semester, including interactive CeLLS online materials and end-of-topic assessment. • Flexible delivery of assessment and content online with clear deadlines so that students can manage their workload depending on individual needs.
10. Communicate clear and high expectations to students	Multiple assessment tasks are designed to provide students with an idea of the expected performance levels.

Please reference as:

Hempel, K., Morris, L. & Cross, M. (2007). Transforming learning in Life Sciences through the use of CeLLS packages at University of Dundee – A Pilot Study. *From the REAP International Online Conference on Assessment Design for Learner Responsibility, 29th-31st May, 2007*. Available at http://ewds.strath.ac.uk/REAP07