

[P21] A virtual institute of interdisciplinary innovation

Tania Burchell

i-Science Centre
University of Leicester
i-science@le.ac.uk

Mission Statement

We aim to provide an active research and teaching institute within a research university for innovating the doing and learning of science via the modern interconnections of its disciplines and society. We network scientists across the disciplines, support interdisciplinary research and innovative teaching methods in the sciences, and host events for businesses and the public to engage with communicators of modern scientific issues.

The University of Leicester's Centre for Interdisciplinary Science is a virtual institute of self-selected researchers and lecturers from our Faculty of Science and the School of Biological Sciences. Members collaborate on innovations in teaching, interdisciplinary research and outreach programmes with schools.

Due to its broad base of representation, the Centre is positioned to tackle wider scientifically-related issues facing the University, such as carbon dioxide reduction mandates and diversity of participation in science.

TWO UNDERGRADUATE INTERDISCIPLINARY SCIENCE COURSES

The Centre hosts two new, and thus far unique to the UK, undergraduate courses in Interdisciplinary Science. The BSc serves students looking for a science path in university that



'I-Science is the future of science and the future of learning.'

*Professor Ken Fogelman, Founder
British Educational Research Association*

prepares them for non-research careers. The MSci is for students who desire careers in cutting edge science research.

These courses are *not* lecture-based but use the strengths of Problem-based Learning (PBL). Centre researchers pose real-world interdisciplinary problems to small teams of undergraduates and give them access to experts, resources, labs and fieldwork opportunities for investigation of the issues within those problems.

After paced and facilitated research, teams deliver a final product in one or more media.

There are continuous and on demand PBL lessons in maths, communications skills and useful software, including Microsoft Office suite.

'This is an excellent initiative that will benefit industry.'

*Cedric Brown
Former CEO of British Gas*

PREPARING STUDENTS FOR CAREERS

Our I-Science students quickly develop as science researchers early in their first year on the course, and they learn to own their time at the University as active, enthusiastic and confident problem solvers. It is inquiry and interest that drive the I-Science students' direction of learning, and therefore we find the students are strongly motivated in their coursework and their professional growth.

This student-centred interdisciplinary science course naturally prepares graduates for jobs not only in cutting-edge science research but also in teaching, management, communications and enterprise. The Centre's partnerships offer added support.

PARTNERSHIPS IN DEVELOPMENT AND INDUSTRY

The Centre has a diverse Steering Committee and Advisory Board and welcomes new members. The Centre is responsible for the development of innovative teaching of physics in modern contexts for one of the University of Leicester's new Centres for Excellence in Teaching in Learning initiatives. Other current partners include Café Scientifique and the UK Resource Centre for Women in Science, Engineering and Technology.

SHARING THE MODEL

The enthusiasm of our members and the quantifiable successes of our students is compelling. We feel that partnerships may help others explore options for teaching

undergraduate science as well as help us to iterate and improve existing courses and develop future postgraduate or Distance Learning options.

If you would like to know more, please contact us.



'I thought before that science was not too much fun, but it has to be done. Now I think it's fun when it's for a real life purpose.'

'I have learnt how to communicate with others and how to state my opinion as well as taking into account others'.

'I-Science is interesting and worthwhile – I feel it is an excellent course!'

Year 12 students from I-Science Taster Day

[P22] Student perceptions of computer-based formative assessments in a semi-distance module

Glenn Baggott and Richard Rayne

OLAAP Project

Birkbeck, University of London

g.baggott@bbk.ac.uk

We used computer-based formative assessments on CD to promote student engagement in a 'semi-distance' taught module entitled *Field Biology*. This module is undertaken by adult students studying part-time in the evening at the end of their first year of university-level study. The major objectives of this module are to introduce students to biological diversity and to apply a basic knowledge of ecology to field investigations. This module also provides students with their first exposure to a project requiring substantive independent data collection. The module consists of a block of five evening sessions (lectures and practicals) followed by a six-day field trip one month later. A summative examination is given two months later; this consists of a computer-based examination (unseen questions in a time-limited invigilated session) and the submission of five written reports. Our strategy was to combine traditional assessment of learning – e.g. written reports on field investigations and problem-solving in a project setting – with computer-based formative and summative assessments.

Formative assessments were constructed to address the common student question - *how have I gone wrong – and how can I improve?* To promote student understanding of the topic, we employed a variety of feedback strategies, ranging from partial to total disclosure of question solutions with additional tutorial material always available. These 'e-tutorials' were provided in two batches. The first were provided at the start of

the module and contained five different assessments of ten questions each; they focussed on the basics of ecology and were structured to address essentially matters of recall and comprehension. In addition, they provided essential information for small group oral presentations at the end of the lecture block. The second CD was distributed on the field trip. It contained five new assessments of ten questions each, but these now focussed on material directly related to the field activities. This second batch of 'e-tutorials' was structured to include more items testing higher cognitive levels, mainly comprehension and application. The mix of items within an assessment, and the feedback strategies employed, were intended to promote self-improvement. Both summative assessments (the computer-based summative assessment and the written reports) addressed all course materials (lectures, practicals and field investigations) and detailed feedback was provided on both.

We evaluated student opinion of all teaching resources at three points during the module:

- one week after the delivery of the first CD 'e-tutorials' and after their use for the oral presentations
- after the computer-based summative assessment, and
- after the return of the feedback about the written assessments.

We constructed evaluations to canvas opinion on all forms of assessment in an attempt to avoid biased responses towards the novel form of the learning materials. In the second and third evaluations we used reliable questions from the Assessment Experience Questionnaire (Gibbs and Simpson, 2003). In addition to a section in which to supply free-form comments, the questionnaire consisted of:

- four items asking whether the assessment promoted learning
- five items soliciting views on the nature, utility and quality of feedback provided
- three items asking about the usefulness of all learning resources as preparation for the summative assessments.

In these evaluations exactly the same questions were used irrespective of the form of the assessment (computer-based examination or written field reports).

For both evaluations, student opinion divided almost equally into two categories. One view was that the formative assessments helped to develop understanding of the topic, doing so by: providing an opportunity to repeatedly practice application of knowledge, reinforcing key concepts, providing a structure for organising information and understanding, and by prompting further learning. For this group the focus was not grades, but learning, and so could be categorised as 'conscientious consumers' (Higgins *et al.*, 2002). The opposing viewpoint was that the formative assessments were exclusively useful in assisting the student to pass the summative computer-based assessment, doing so by: providing practice questions for test revision, providing the correct answers for memorising, and by helping the student to predict the content of the computer-based examination. This group was focused on grades and evidently examination 'cue-seekers' (Miller *et al.*, 1998). From the free-form comments there was no evidence that students appreciated the 'e-tutorials' solely because of their novelty.

We conclude that the evaluation approach described here apparently circumvented a possible distortion of student's perceptions. It did this by shifting the focus of the evaluation away from the novelty of the 'e-tutorials' by evaluating the overall assessment experience. Interestingly, the evaluation revealed that students' perceptions fell into two clear categories. One group of students felt that the computer-based formative assessments were useful only as training for the computer-based summative assessment; the other felt that 'e-tutorials' were truly formative, assisting their understanding of the topic and promoting self-improvement. It is apparent that different groups of students had constructed two different meanings for their learning activities (Biggs, 1999); further work should concentrate on assessing whether this is related to students' learning approaches and their performance in different forms of assessed work.

REFERENCES

- Biggs, J.** (1999) Teaching for Quality Learning at University. Buckingham, Open University Press.
- Gibbs, G. and Simpson, C.** (2003) Measuring the response of students to assessment: the Assessment Experience Questionnaire. *11th Improving Student Learning Symposium*. pp. 1-12.
- Higgins, R., Hartley, P. and Skelton, A.** (2002) The Conscientious Consumer: reconsidering the role of assessment feedback in student learning. *Studies in Higher Education*, 27: 53-64.
- Miller, A. H., Imrie, B. W. and Cox, K.** (1998) Student assessment in higher education. A handbook for assessing performance. London, Kogan Page.

[P23] Evaluation by first year cell biology students of a formative computer-based assessment incorporating feedback

C. Bax*, **E. Howey†**, **C. Pellet-Many†**, **G Baggott†**, **R. Rayne†**,
M. Neonaki*, and **C. Branford White***

*Institute of Health Research and Policy, London Metropolitan University

†OLAAF Project Team, School of Biological and Chemical Sciences, Birkbeck,
University of London

c.bax@londonmet.ac.uk

Cell Biology is a first year module at London Metropolitan University and is taken by students from widely differing academic, socio economic and ethnic backgrounds. The module is currently taught via a series of lectures, tutorials and practicals and also by asynchronous web-based delivery. We sought to extend the scope of the on-line provision by introducing formative CBA with feedback in order to encourage students to engage with taught material. The test was devised using existing and new material together with feedback which was written for each possible student response, and was incorporated into Authorware using the TRIADS engine. Scores and response times were filed remotely. The test was evaluated by students in an anonymous questionnaire in relation to ethnicity and entry qualifications regarding question design, student learning and operational aspects (1). In general, students viewed the assessment favourably, and indicated that they felt that the use of feedback in the test helped them to learn. Using a mixed ANOVA there was found to be no significant difference ($p > 0.05$ in each case) in the evaluation scores between Caucasian students and those of students from ethnic minorities, nor between those of students who gained entry to their degree course on the basis of A level results as opposed to those who had studied on Access courses or London Metropolitan's BSc Sciences

Extended Degree Programme which is one of the largest of its type in the UK. This strongly indicates that students found the assessment useful regardless of ethnic or educational backgrounds. We would like to develop this system for modules that are delivered both on- and off-site, and anticipate trialling this type of assessment as a tool for distance learning on an active degree programme run in China (Shanghai).

REFERENCES

1. Bull, J. and McKenna, C. (2001). *A blueprint for computer-assisted assessment*. CAA Centre.

[P24] On-line delivery of foundation degrees in land-based subjects

J. Youngs* and P. J. Lumsden†

*Myerscough College and †University of Central Lancashire
jyoungs@myerscough.ac.uk and pjllumsden@uclan.ac.uk

Keywords: on-line learning material, learning styles, tutor support

Despite the potential of on-line/distance learning, progress in this area has not been as rapid as was once envisaged. Indeed, the demise of the e-University is testimony to this. Provision of lower level courses is available through LearnDirect, but degree level courses are only offered by a few institutions, and these are often overseas, such as the Australian Correspondence School.

At degree level, material delivered through electronic means is limited in the extent of its inter-activeness, often being essentially word documents placed on a platform such as Web-CT or Blackboard. In the area of plant-based sciences, learning experience in terms of practical work would appear to be necessarily curtailed. A further issue for Foundation Degrees is that they should have a degree of employer involvement.

Myerscough, an associate college of UCLAN, is a specialist land-based college, which has developed on-line courses in Arboriculture and Turf grass science. This development required dedicated staff to convert material, and to devise interactive material. The result is a variety of approaches, probably more varied than is often delivered to a full-time student. Material is available in word format, and is widely illustrated; moving images have been developed, together with illustrated 'draw-down' snap tests, and regular multiple-choice tests. An example of practical work is a soils analysis where students send in samples;

these are analysed 'in-house', and the results are sent back to the student, who then constructs a report. The process of carrying out the analysis is thoroughly illustrated using digital photographs.

Tutor support has also been adapted, creating an empathy between student and tutor. On-line tutor support can be quite high; one tutor estimates one hour per day. However, this compares favourably with the 'standard' time which would be required to deliver material 'live' and to provide support.

Here we show some examples of the interactions which can take place in these subjects.

[P25] Computer based learning and assessment packages in genetics and cytogenetics: pedagogy and andragogy

J. Stephenson, W. B. Morris and D. K. Griffin

Department of Biosciences
University of Kent

HIGHER ORDER LEARNING SKILLS IN GENETICS

Tackling problems is a well-established means of teaching genetics, requiring skills of analysis and application. Difficulties can arise however in setting large numbers of similar questions; also collusion impeding learning can occur when students are left to do problems without supervision. To circumvent this we have developed a bank of genetics problems where each question has a number of equivalent variants. Use of computer-aided assessment permits the use of more innovative presentation styles. Student learning patterns will be assessed.

KARYOTYPING IN THE CURRICULUM

Many biological degrees have karyotyping as an integral part of the curriculum. Karyotyping is an essential skill for chromosomal biologists and the usual method of teaching it involves cutting and pasting photographs. This results in much time being wasted at the expense of the learning process. KaryoLab is a computer based learning and assessment package that replaces the need for a 'wet' practical class. Opinion surveys suggest that students prefer the computer based approach and evidence shows that marks are not adversely affected although exercises take significantly less time. There is also the added bonus of portability, i.e. students can complete the exercise in a time and place of their own choosing.

AN E-LEARNING SOLUTION TO A BIOLOGICAL PROBLEM

~10% of breeding boars have reduced fertility and, of these, ~50% have chromosome abnormalities. It would therefore be financially beneficial for the pig breeding industry to adopt chromosomal screening of boars before embarking on insemination programs. Such screening however is often thought to be only within the capabilities of highly skilled individuals. In this study we attempted to dispel this dogma by modification of the KaryoLab programme using pig chromosomes. Initial investigation has shown that users' ability to karyotype increases dramatically resulting in abnormalities being spotted in over 80% of cases post-tutorial.

[P26] Replacing a formal examination question with a problem-based assignment: effect on student learning

John Green

School of Life Sciences
Napier University, Edinburgh

INTRODUCTION

The purpose of this study was to assess the effect on student learning at Masters level of replacing assessment of a topic by formal written examination with a problem-based assignment (continuous assessment). The project was undertaken as part of the FAST (Formative Assessment in Science Teaching) project.

THE TOPIC

The topic centres on the microbiology and technology of production of potable water. The topic comprises one third of the module *Water and waste treatment* in the Masters course *Aquatic Ecosystems Management*. The topic involves ca. 40 hours student work and assessment of it equates to 5 SCOTCAT points.

THE PROBLEM

The original learning outcome was *Critically evaluate the unit processes used in potable water treatment* and assessment of the topic was a question (1-hour to answer) in a formal written exam. Although such an outcome was consistent with corresponding benchmarks (SCQF Level 11) it was hard to justify that in answering the one-hour exam question (phrased along the lines of *Critically evaluate the unit processes used in potable water*

treatment) that students were in fact critically evaluating. Simply put, outcomes and assessment strategy were not aligned.

THE CHANGES MADE TO LTA STRATEGY

The learning outcome was changed to: *Recommend an appropriate strategy for producing potable water for a given population from water in a given reservoir*. The LTA strategy was modified to include analysis of reservoir water for quality indicators and examination of the reservoir catchment area, and the one-hour written exam question was replaced with a problem-based, continuously assessed assignment.

THE PROBLEM-BASED ASSIGNMENT

The assignment closely reflecting the outcome, was based on a realistic situation, was designed to engage students in independent research and integration of unfamiliar topics, and it involved students in recommending, predicting and critically assessing.

THE AIM OF THIS PROJECT

The aim of this project was to evaluate whether or not replacing the formal exam question by the problem-based assignment:

- promoted achievement of high-level outcomes consistent with SCQF Level 11 benchmarks;
- promoted development of generic (employability) skills;
- delivered a more formative experience to students.

EVALUATING THE EFFECT OF THE CHANGE

The effect of the changes was evaluated using:

- my professional judgement;
- a questionnaire of my own devising, comprising mainly open questions;
- SOLO analysis (Biggs and Coulis, 1988) of students' responses.

DID THE CHANGE PROMOTE ACHIEVEMENT OF HIGH-LEVEL OUTCOMES CONSISTENT WITH SCQF LEVEL 11 BENCHMARK?

My professional judgement was that it did. Successful completion of the assignment showed that students had applied critical understanding and had made informed judgements. My judgement was that such was not the case when assessment had been by formal exam.

Students' responses by questionnaire supported my own judgement. An example of a comment was *the assignment gives you plenty of time to explore the topic and think about the answer, whereas in exams time constraints rarely make this possible.*

SOLO analysis of students' responses showed that the greatest proportion of work (75%) was at the *extended abstract* (highest) level, which is characterised by hypothesising,

deducing and qualifying conclusions. The remainder was at the *relational* level, the next level down the scale, which is characterised by understanding and using relevant data and their interrelationships. My judgement was that in the exam answers on the topic students had worked mainly at the *multistructural* level (the next level down from *relational*), which is characterised by linkage of isolated data (supplied data only), and generalising without deduction and induction.

DID THE CHANGE PROMOTE DEVELOPMENT OF GENERIC (EMPLOYABILITY) SKILLS?

My professional judgement was that it did. Successful completion of the assignment involved aspects such as making informed judgements in the absence of complete information and developing original responses (which had not been the case with the exam question), and was more like to have developed skills such as exercising initiative and taking responsibility for one's own work. All of these generic skills are benchmarked by SCQF at Level 11.

Students' responses by questionnaire supported my own judgement. Students agreed that the exercise: increased their confidence in learning independently; increased their confidence in coming up with their own ideas; promoted their ability to think about a topic from different angle; increased their ability to integrate subjects; improved their ability to time manage.

DID THE CHANGE DELIVER A MORE FORMATIVE EXPERIENCE TO STUDENTS?

My professional judgement was that it did. It was not our policy at the time of this study to give formal feedback on exam performance to successful students, and it is hard to see what new generic skills students at masters level would have gained from formal examination.

Students were given comprehensive individual feedback on the exercise (in the form of positive comments, criticisms, and suggestions for improvement) written on their work, as well as gradings, marks and comments relating to each assessment criterion put on a marking proforma. In addition a model answer to the exercise was provided to each student. Subsequent informal discussions with students indicated that they had taken time to read comments on the marked exercises, and had integrated these comments with feedback given in the model answer.

Students' responses by questionnaire supported my own judgement. Students considered that the exercise had helped them with subsequent assignments, and they expected that it would help in future assignments. An example of a comment was *it taught me how to think about a problem deeply and widely, and from the feedback given I became aware of my shortcomings.*

CONCLUSION

Evaluation showed that replacing the formal exam question by the problem-based assignment:

- promoted achievement of high-level outcomes consistent with SCQF Level 11 benchmarks;
- promoted development of generic (employability) skills;
- delivered a more formative experience to students.

LESSON LEARNED

Reappraisal of alignment of benchmarks, learning outcomes, teaching strategy and assessment strategy can have a positive impact on student learning.

[P27] Teaching problem solving in biochemistry: a blended learning approach featuring computer-based formative assessment

***Les Jervis and Loretta Jervis**

School of Biological Sciences

University of Plymouth

*l.jervis@plymouth.ac.uk

Developing students' problem solving abilities is a key part of higher education in science disciplines and in higher education in general. Problem solving is often defined as a key 'skill' that is valued highly by employers of graduates. However, the definition of problems by employers is rarely specific and can range from the banal to the highly complex. Within the context of individual disciplines, such as biochemistry, it is usual to consider a hierarchy of 'problems' according to the level of academic development of students. Individual students will take very variable lengths of time before they become familiar with particular types of problems and develop a facility for working through them to solutions. Providing students with workbooks has long been an established approach to dealing with the different rates at which individual students progress. The development of on-line materials allows flexible access and immediate feedback to support student progress on problem solving. When faced with a new type of problem, students usually have few ideas about how to approach them. After they have been guided through to solutions, they can then deal with similar problem types by application of an appropriate algorithm. By using on-line problems with feedback, staff-student contact time can be focussed on the initial introduction of students to new problem types after which students can improve their abilities to deal with those problem types on-line. In this poster we will summarise the

approach we have been developing using the TRIADS/Authorware system and present an evaluation of its effectiveness.

[P28] Computer-assisted and computer-based testing to assess procedural and conceptual knowledge in bioscience undergraduates

Richard C. Rayne and Glenn K. Baggott

OLAAP Project

Birkbeck, University of London

r.rayne@bbk.ac.uk

We have used TRIADS-based CBA (see Mackenzie, 1999) in several undergraduate biology modules for a number of years. Here, we will report on work undertaken in a first-year, BSc-level molecular cell biology module of ca. 60 students. This module features a regime of frequent CBA which has proved especially beneficial for students whose first language is not English, as we reported previously (Baggott and Rayne, 2001). CBA presented early in the module are targeted to building foundational knowledge, comprising items primarily designed to assess recall and comprehension; as the term progresses, the proportion of items assessing application and problem-solving increases. On the computer-based final exam, in addition to items assessing understanding of key concepts presented throughout the module, a block of additional items focus on students' understanding of a 'classic experiment' (Meselson and Stahl, 1958).

Also in the same module, we have extended our assessment approach to include what is probably best-termed a computer-assisted (rather than computer-based) technique. Over the past 3 years, we have made use of the freely available (for academic use) CaseIT! simulation package (Bergland *et al.*, 2004) in a practical test. CaseIT! includes a component in which basic DNA manipulation techniques are simulated, including restriction digestion, DNA electrophoresis and Southern blotting. Using the software, it is possible to simulate an experiment to determine the genotype of

individuals (the 'case') with respect to a given genetic disease (e.g. sickle-cell anaemia, Duchenne's muscular dystrophy, and many others). About 1 month after a class-based session using CaseIT!, we administered a computer-assisted test. This involves presentation of an unseen 'case' on a paper-based test. Students must analyse and solve the problem using the CaseIT! software to generate the data; they use this data to answer the paper-based test items.

These approaches, we believe, tap cognitive processes in test-takers that draw upon conceptual and procedural knowledge relating to reasonable mimics of 'real-life' scientific problems. We will present our analysis of the student responses (over three academic years) to these new assessment approaches and will describe the principles we followed in constructing these assessments, e.g. through application of logical task analysis (cf. Shavelson *et al.*, 2002).

REFERENCES

- Baggott, G. K. and Rayne, R. C.** (2001) Learning support for mature, part-time, evening students: providing feedback via frequent, computer-based assessments. In: Proceedings of the 5th International Computer-Assisted Assessment Conference, 2001, Loughborough University. M. Danson and C. Eabry, eds. pp. 9-20.

- Bergland M., et al.** (2004) DNA Electrophoresis Module for CaseIT!, version 4.0.2. <http://www.uwrf.edu/caseit/caseit.html>
- Mackenzie, D.** (1999) *Recent Developments in the Tripartite Assessment Delivery System (TRIADS)*. In: Proceedings of the 3rd International Computer Assisted Assessment Conference, 1999, Loughborough University. M. Danson and R. Sherratt, eds. For information about TRIADS, see: <http://www.derby.ac.uk/ciad/>
- Meselson, M. and Stahl, F. W.** (1958) The replication of DNA in *Escherichia coli*. Proceedings of the National Academy of Sciences, USA, 44 (7), 671-682.
- Shavelson, R. J., Li, M., and Ruiz-Primo, M.A.** (2002) Evaluating new approaches to assessing learning. Keynote address to the Joint Northumbria/EARLI Assessment Conference, Newcastle, UK. August 2002. <http://www.stanford.edu/dept/SUSE/SEAL/Presentation/Presentation.htm>

Notes

