[O1] Using an audience response system in lectures: an aid to learning or just more entertainment?

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ABSTRACT

Results of a trial using the IML Audience Response System in first year physiology lectures are described. The lectures provide the core material for a heterogeneous group of students on a variety of in-house undergraduate programmes and service teaching modules. The lectures are supported by additional classes for various groups.

The diversity of the group has for a number of years presented a challenge for teaching staff. Many students are mature with no formal study for sometime; others do not have a science background. Increasing student numbers has made communication between the lecturer and their audience almost impossible. Feedback therefore about how the material is being received and understood by students is hard to obtain.

This year the IML system was introduced as a means of improving communication in lectures and consequently gauging the level of understanding amongst the students. The system was employed every 3 weeks in 1 of 2 lectures given each week. Handsets were provided to groups of 2 or 3 and used to register the group by identifying the course they were studying. After a short familiarisation test the students were asked multiple-choice questions on the material from previous weeks. Answers were logged after a short interval (timed in later sessions) and displayed as a distribution table for each of the options. The answers were then discussed and reasons given for the correct option.

Staff observation notes were collected and student focus groups were established to provide detailed feedback of the process. A questionnaire was also provided for all the class to gather more quantitative data.

The results of the trial may be summarised as follows, using the IML system:

- Promoted discussion about the material
- Made lectures more entertaining
- Improved confidence about what to expect in the exam
- Increased motivation to research, review or learn the material

There is no doubt that the students enjoy using this system although familiarisation is swift and therefore entertainment value is perhaps short lived. The value as a learning aid is less clear but motivated, mature students do value the insight to the assessment process, and appear to benefit form a greater understanding of the material.

INTRODUCTION

The taught material for level 1 physiology at the University of Central Lancashire is delivered in common lectures to students studying a variety of programmes. All students are also given separate tutorials some of which are face-to-face others are on-line. One group has additional laboratories as part of their programme. All of the additional contact with the students is designed to support, reinforce and put into context the material they have been given in lectures.

The diverse nature of this group has for a number of years presented a challenge for teaching staff. On the one hand using lectures in this way has the obvious advantage of efficiency. However the pitfalls are considerable particularly with a novice group. Many students are mature with no formal study for sometime, while others do not have a science background, yet another group are accepted with 3 science 'A' levels with a total of 240 points.

Great care is taken to ensure that the delivery of the classes is as good as it might be: lecture materials are made available before the classes, staff give advice on good supporting text, formative on-line quizzes are provided for students to assess their understanding of the material and they are encouraged to access local web based material that visualises some of the more difficult principles involved.

Despite the support material provided for lectures an inherent weakness with this system is that in large groups of students, individuals are generally reluctant to ask questions or interact with the lecturer even if encouraged to do so. Feedback for the member of staff therefore relies on marks from the on-line quizzes or interaction from the tutorial and laboratory groups. This type of feedback whilst adequate is not immediate and might be rather indirect if different staff are involved in the delivery of lectures and tutorials or laboratory classes. So if problems of understanding do arise they may go unnoticed.

Before the start of the 2004 – 5 academic year the University purchased the IML Audience Response System. The system is based on DECT technology at 2.4 GHz with a 100 metre range for data responses and audio. It consists of a PC, the receiving base station and the handsets. Question Wizard, the software creates quizzes in PowerPoint and provides instant audience responses live on screen. Question Wizard is based on an Access database and provides extensive reporting functions on your responses.

A small number of courses were used to pilot the system and to evaluate its effectiveness. The aims of this pilot were to:

- assess the effectiveness of the IML system to increase student engagement with the material during lectures and
- improve feedback in lectures about the level of understanding of the material.

Deployment

Level 1 physiology lectures are to 230 students for 2 separate one-hour slots each week for the year. Students were given a calendar showing when the quizzes would occur and reminded the week before they were held. The system was employed every 3 weeks in 1 of the lectures. Handsets were provided to groups of 2 or 3 and used to register the group by identifying the course they were studying. After a short familiarisation test on the first occasion students were asked multiple choice questions on the material from previous weeks. Answers were logged after a short interval (timed in later sessions) and displayed as a distribution table for each of the options. The answers were then discussed and explanation given for the correct answer.

Staff observation notes were collected and student focus groups were established to provide detailed feedback of the process. A questionnaire was also provided for all the class to gather more quantitative data.

As statistical analysis was used on the mid year test results, groups were compared from the current and previous academic year. Differences were tested using a one tailed t test.

RESULTS AND OBSERVATIONS

Student focus group responses:
Students were asked about their experience of large classes. For some this was the largest group they encountered:

'Well it's ok. We know a lot of people from the other courses.'

'*(In a small class) If you struggling with your work . . . they'll listen to you and go over that point again just for you but when it's a bigger lecture you're less likely to actually put your hand up and say "excuse me what was that?" '*

Interesting although not unexpected comments came from a discussion of the lecture notes that are supplied to the students:

'*(Students) go to the lecture but then don't really listen that much because you know you've got the back up of the notes on Webt CT.'*

Most students questioned about their thoughts on the IML system replied that they liked it:

'I would really enjoy it if all my lecturers did it – not loads but quite often.'
'I thought it was really useful. It really showed us what we needed to know for the exam.'
'I wouldn't have thought the novelty would wear off because we don't do it that often.'

When asked if they thought the system enhanced the lectures replies varied but consistent themes were:

'I thought it was very good at recapping over things we do and it helps highlight things that we don't know.'
'Yes, if you knew you were having a quiz, you were actually reading your work. So for me it was really useful for learning because I wouldn't have read those notes if we didn't have a quiz.'

A key feature of the quizzes was the use of the groups and the registration of the course. The students appeared to appreciate the interaction and the element of competition between courses:

'It's good because it gets you talking and discussing.'
'. . . everyone was discussing the answer, so it got you working together didn't it?'
'. . . at the end they showed where each of the courses came and I think that made everyone want to get the answers right too.'
'. . . it's like we're teaching each other as well.'

During the quizzes explanations were given directly following the questions:

'You answer the question and then they go over the answer with you and like actually describe why it's wrong or right. It's like a mini lecture itself just going over the answer.'

Staff comments:

As part of a Peer Observation System at the University staff attended the IML quiz sessions and provided feedback. Two of the comments raised are recounted here.

On one of the early sessions it took over 10 minutes for the system to be set up. This raised the concern that the benefit of using the system was outweighed by the time to produce the quizzes and set up at the start of each lecture.

One member of staff was sat amongst the students and noticed that while some groups were actively engaged in the quiz discussing the questions others were not. In the latter case the students were going with a 'gut' feeling about the answer without the benefit of discussion. Strategies to improve the dialogue between group members will need to be considered in the future.

Statistical analysis:

In all groups the mid year results were higher for the 2004 cohort but only those from the BL1403 group were significantly different. This group consists of students whose main degree is physiology or other biological science. The BL1408 group are complementary medicine students studying physiology as part of a wider program. The last group (BL1410) is made of three groups: Sport Science or Sports Therapy and Exercise, Nutrition and Health.

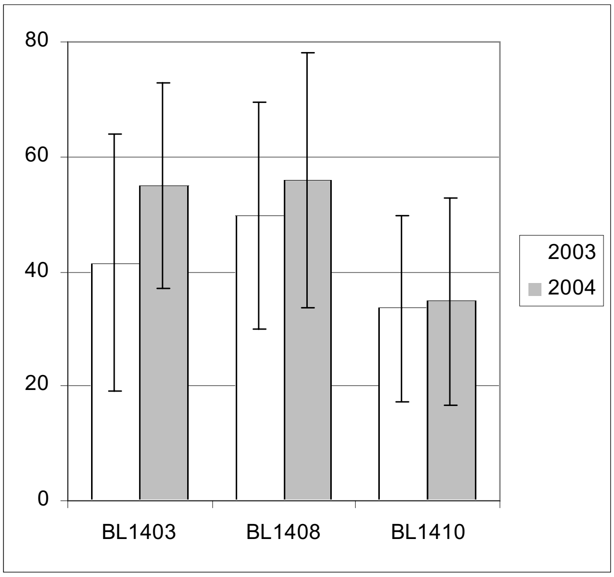

Figure 1. Shows results of the mid year exam for the different groups of students attending the level 1 physiology lectures in the academic years 2003 – 4 and 2004 – 5. Each point is mean ± SD, n= 41 – 79. The difference between the results for 2003 and 2004 in Group BL1403 was highly significant ($p = 0.001$)

DISCUSSIONS AND CONCLUSIONS

There is no doubt that the students enjoy using this system. Familiarisation is swift and therefore entertainment value is perhaps short lived but the comments from the focus groups suggest that students appreciate the benefit to them beyond simple entertainment. The value as a learning aid is less clear but motivated, mature students do value the insight to the assessment process. The statistics suggest that subject majors do benefit from the learning experience.

The results of the trial may be summarised as follows, using the IML system:

- Promoted discussion about the material
- Made lectures more entertaining and improved attention
- Improved confidence about what to expect in the exam
- Increased motivation to research, review or learn the material

[O2] Using e-learning to promote peer learning and assessment

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ABSTRACT

Increasing student numbers leads to escalating pressures on lecturers with burgeoning assessment demands on their time. Peer learning and peer assessment can help tackle these issues to maintain academic quality and provide time savings for assessment processes. In addition, the use of technology in the form of e-learning can also offer more efficient ways of delivering peer learning and assessment.

This paper discusses how an e-learning peer model was adopted at the University of Hull for about 120 first year undergraduate students. There were a number of reasons for adopting a peer learning model along with peer assessment. Academically, there were a number of potential benefits, including helping students develop a better understanding of the topic and improving self confidence. Putting students into peer groups also helped them socialise and make new contacts in the new electronic environment. From a practical sense, peer groups can mean less staff time focussed on face to face support, if organised appropriately and peer assessment can mean less staff time spent on marking.

The results showed that students overwhelmingly liked working online in groups and felt that the peer assessment scheme was fair. Problems arose with the automation of the peer assessment marks and did not deliver the time savings hoped for. This paper will discuss the findings and recommend future developments to refine this model. It is anticipated that from this, such use of technology can be used appropriately to engage students in high quality learning through peer support and assessment, whilst also bringing real benefits and incentives for staff to engage in peer learning and assessment.

INTRODUCTION

Group work has been used in classroom settings for many years and its effectiveness as an aid to learning is based on well established research. Students learn from their experiences and from interacting with each other and this is well documented by researchers such as Piaget (1950) and Vygotsky (1978). There are many teaching methods for engaging students in group work, such as buzz groups or fish bowl exercises (2005) and these are mostly directed by the tutor.

Whilst group work can cover a range of activities involving the tutor and students, peer learning is an extension of this approach where the learning becomes more directed by the students themselves, rather than in class by the tutor (2001). Peer learning relates to the learning that takes place amongst students independent of the tutor and location i.e. the classroom. Students are often able to gain a better understanding of a topic by consulting each other and working together to achieve common goals.

Associated with this is the issue of assessment. The most common form of assessment is when the tutor assesses the students against set learning objectives based on the content taught in class. However, the tutor is not always aware of the work students undertake outside the classroom and can therefore only base assessment on limited learning outcomes. In such circumstances peer assessment can support the efforts of individual students by allowing their peers to offer constructive feedback on their work and give recognition to supplement the credit provided by the tutor.

With the advent of the World Wide Web in the mid 1990s and the subsequent evolution of structured online learning technologies in the form of virtual learning environments and intranets, the practice of learning online or e-learning, has become ubiquitous across education. E-learning is not a new form of teaching per se but simply traditional teaching approaches developed for delivery via a computer. The same principles of learning still present themselves, such as the learning cycle proposed by Kolb (1984) where learning is an iterative process and so teaching and learning still requires interactive involvement.

Early research into the benefits of peer learning and assessment has focussed on student groups that operate in a face to face setting. E-learning however, by its very nature means that students are often not able to meet face to face and so peer collaboration would not seem a viable approach to supporting the learning process. Even if students are based on the same campus it is sometimes difficult to engage in peer work due to other constraints. These may include timetable classes preventing students meeting up or personal circumstances restricting the ability of students to travel to their institution at given times to meet up with their peers if they live several miles away. So the question arises as to whether it is possible to engage students in peer learning supported through e-learning.

Learning can take place in a whole variety of educational settings, such as the lecture, tutorial, field trip, seminar or laboratory setting. E-learning simply provides an additional setting in which learning can take place. The basis of this paper therefore is for the authors to demonstrate how they have developed an e-learning peer model to foster peer learning amongst a large class of students.

BENEFITS OF ADOPTING AN ONLINE PEER LEARNING MODEL

As with face to face peer collaboration, peer learning supported by e-learning offers a number of benefits, both academically related and social. There are some differences however, such as the loss of non-verbal gesturing that takes place when students are physically in the same room and the synchronous communication. On the other hand e-learning offers potentially different benefits such as asynchronous communication or records of work which can be archived and re-visited, unlike the interactions which take place in a seminar for example.

In terms of academic benefits peer learning can promote a greater understanding of a topic since students are often able to articulate concepts and ideas in ways which the tutor cannot. This is no reflection on the tutor as a capable teacher since students who discuss a topic approach it from a common lack of understanding and can derive the answer, whereas the teacher already understands the content so may not be able to transfer this understanding as easily because they approach it from a different level of understanding.

By working together students also improve their own self confidence as they are able to take more ownership of their learning, as opposed to being supported by the tutor. Collaborating with peers also helps improve communication and IT skills. From a tutor's point of view, online peer learning has the potential to save time as the students become their own source of support.

From a social perspective, online peer learning also offers several advantages. By encouraging students to engage with each other the tutor is fostering a sense of community and helps students socialise with each other. Creating online 'ice breakers' for example i.e. ways of getting students to interact with each other, students will mix with a wider circle of peers than normal. Peer groups also foster a better sense of team work ethics and the social issues that this brings with it, such as being able to deal with conflict.

METHODOLOGY

The approach taken by the authors for this study was to introduce an online peer learning and assessment model for students on their first year of a biological sciences course and in the first weeks of the first semester, when they are both new to the university and each other. The module was an IT skills based one supported by the Blackboard virtual learning environment. Students were put into groups of 4-5 during classes and were given a mini group project to undertake in the first few weeks of teaching. Each group had to submit one piece of work for assessment and peer assess each member's contribution to the work.

Ice breakers were introduced online to encourage members of a group – many of whom would not have met each other before as they were all new to the course, to introduce themselves (online) and to meet face to face. Whilst it was planned that most students in each group would be in the same class this was not always the case. This meant that although many groups had the potential to meet face to face immediately, some did not and so arranged meetings outside of class or communicated entirely online.

The framework for the actual project was to give each group a remit for a presentation based on a biological topic. As a group they had to divide the work amongst themselves and collaborate to undertake all the activities and produce a joint presentation file on which they would be jointly assessed. The other aspect of the assessment was the peer assessment based on their contribution to the work. The assessment model used was the one originated by Goldfinch and Raeside (1990) but refined by Li (2001). A marking template was produced which each student completed and submitted online.

RESULTS

Measurable outcomes for the peer work consisted of the actual project submissions from each group, the records of communication archived on Blackboard and student questionnaires. The students were asked to complete anonymous surveys prior to the peer work and then after the projects had been submitted – but before they had been awarded marks. There is an argument about the timing of such post-questionnaires as to whether students answer truthfully for fear of having their results influenced. However, since they were guaranteed anonymity and from the honesty of the responses, this was clearly not the case. The responses therefore, gave a very rich insight into the students' thoughts on the peer work. It is more subjective to measure any perceived outcomes from the quality of the work produced but the archives gave a good indication of overall group communication.

From the student surveys which could be counter-checked by the archive evidencing the level of group interaction online, it was clear that the major problems with the peer work was getting all members of groups to participate with each other. The archives backed this up by showing that some groups worked very well together and communicated often online, whereas other groups did not interact much online. Student survey responses clearly showed that this was the case, where the majority of comments related to a lack of communication from some group members or the fact that some members did not work effectively with the rest of the group, preferring to work independently.

Based on student responses, there were three major themes arising from the peer work which they liked: meeting new people; the ease of communication; and the ability to share ideas and discussions with other group members. Of the things that students disliked the main issues were: a lack of communication from some group members; some people not working as part of a group and; the awkwardness of working online with fellow group members when they hadn't actually met face to face.

In terms of the peer assessment there was very little adverse comment about the procedure. When asked directly whether they understood the marking scheme and whether they thought it was fair, over 92% and 80% respectively, thought it was easy to understand and was fair. One interesting issue that didn't feature prominently was the distinct lack of comment about the actual use of technology. Very few students made comments about Blackboard hindering the actual group work.

For the pre-survey, students were asked about their prior experience and involvement with face to face group work and online group work. The students were then asked about their thoughts on peer work in light of the peer project work. Over 93% of students had worked in face to face groups prior to the IT course. Of these, only 40% had engaged in online group work. The responses showed that student feeling about peer work was positive prior to the Blackboard project and this remained so afterwards, clearly showing that students had not been put off by working online in groups.

DISCUSSION

Based on the results of the work it is quite clear that the vast majority of students felt that the peer groups worked well and there were many comments from students actually saying that they enjoyed the online group work. There were only one or two comments from students suggesting that the use of technology to support peer work inhibited group interactions. Indeed, most of the comments about disliking the peer work focussed almost entirely on the human aspects of peer work. These were issues such as getting all group members to participate actively in the work; to communicate effectively with each other; and to contribute to the workload fairly – issues that also affect groups even when working face to face.

From this initial study therefore, it seems apparent that the use of technology does not adversely affect the potential for students to work in peer groups. Any problems clearly related to well established issues of encouraging students to work in groups at all. These problems surface in face to face groups and are an ongoing problem of trying to foster better group collaboration. On the positive side, the use of Blackboard clearly had a number of benefits such as the asynchronous communication, the ability to meet new people online and being able to share ideas and get peer feedback.

One of the aims of this study was to produce real time savings in administrative and support duties. In terms of student support this was successful as the students became an extra avenue of support for each other, reducing the amount of time the authors had to spend dealing with student enquiries. However, the administration of the peer assessment process proved to be unwieldy as it took much longer than expected. An attempt was made to automate the peer marking, rather than ask students to submit paper sheets with their marks on. Instead the students submitted their marks electronically in Word, using a standard template. This took much longer to collate the marks than if each student simply submitted a paper form.

SUGGESTIONS FOR FURTHER DEVELOPMENT

The outcomes of this study raised a number of issues which warrant further investigation. The thorny issue of encouraging all group members to participate in the peer work and to take responsibility for their part of the assessment needs further investigation. There are a number of approaches which may be considered from existing face to face models, such as a rewards or penalty system; or perhaps induction for students on how to work effectively in groups. Whichever approach may be adopted in future it will be essential to instigate this early on so that all students are clear about the purposes of the peer work, their obligations and the positive benefits of engaging with their peers.

Another outcome of the work was the cumbersome process of collating the peer assessment marks. Since the aim of this work is to promote the use of technology to support peer work and assessment the authors will explore the possibility of developing an electronic tool to automate the process. This possibility is already being actively explored and the authors hope to have a tool developed in the not too distant future.

It is the intention of the authors to promote technology supported peer learning and assessment as a way of enhancing learning which is as effective as face to face approaches. Even with face to face teaching and learning it is difficult to measure how student learning is being enhanced. Even summative assessment through say, written examinations has to be designed carefully to assess whether student learning has been successful. One way to measure this is to allow the student to demonstrate they have understood what is being taught by drawing out their understanding of a problem and analyse and internalise the information.

With the student mini projects, each group is given a biological topic to discuss, a topic which raises conflicting evidence. Students have to discuss the topic and deliver this evidence as part of their presentation and draw a conclusion based on their understanding of the problem. For the problem set, there are generally four possible outcomes: that the argument providing evidence of the biological topic is proven; that it is not; a combination of the both where students address all the evidence but do not draw any conclusions; or that the students simply fail to understand the problem at all and simply report one side of the argument without considering all the evidence available.

Whilst being slightly subjective it may be possible to evaluate whether the peer work has enhanced the learning process by reviewing the degree to which different groups produce a presentation drawing on all the evidence and presenting a well-reasoned argument. The author originally ran this work as an individual exercise so further work would be interesting to review the presentations and reflect on whether there is any evidence to suggest that working in peer groups increases students' understanding of the topic by offering more reasoned presentations.

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[O3] Virtual experiments across the science curriculum

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ABSTRACT

Science is ‘a branch of knowledge conducted on objective principles involving the systematized observation of and experiment with phenomena’ (OED), yet the costs of providing space, time and materials for experimentation are coming under increasing scrutiny. This illustrated presentation will describe how the Open University (OU) has introduced virtual experiments into a variety of science courses that are studied at a distance; some of the virtual experiments lead on to real experiments conducted at residential school, others are stand-alone and form the basis of assignments that contribute to the student’s course grade.

BACKGROUND

The question of how to encourage students to engage with the theory and practicalities of an experiment before entering a laboratory is not new. Nor is the suggestion that computer-based methods may provide a solution. ‘Computer as laboratory’ is one of the headings in the final report of the National Development Programme in Computer-Assisted Learning [1] that ran from 1974–77. But in this area the educational ideas ran ahead of the capabilities of the available technology of the day and the fidelity of computer-based experiments created under NDPCAL was very low.

Digital technology started to catch up with our requirements in the mid 1990s when multi-media PCs with true colour displays and the ability to play video, albeit in tiny windows, came onto the market at an affordable price and in 1998 the Open University started issuing multi-media teaching materials on CD-ROM. While some of these early multimedia developments could be viewed as modern day equivalents of the 1970s simulations with the addition of coloured, graphical, output of the results, others ventured into new fields with virtual microscopes and telescopes showing high quality still images of the very small and very large.

In the four years that followed, digital video technology made rapid advances on many fronts from the capabilities of PCs to the capacity of DVDs and all at a decreasing price. In 2002, our second level course Environmental Science became the first OU course to issue multimedia materials on DVD-ROM and perhaps for the first time, our ability to reproduce experiments with some measure of fidelity became a reality.

By 2004, DVD was established as the OU Science Faculty medium of choice for delivering multimedia materials into the home. The hybrid DVD-ROM/DVD-Video disks that we have produced allow us to integrate all of the learning materials for a course including multimedia, eBooks, TV and video programmes and self-assessment programs into one electronic environment. And gradually a bank of virtual experiments is being created for various courses across the Science Faculty.

WHY A COMPUTER?

Most experimentation is concerned with obtaining evidence from which an underlying theory can be formulated, however the time consuming nature of experiments, costs of laboratory space, equipment and consumables and, on occasion, the potential dangers lead to tightly scripted laboratory procedures that leave little space for real experimentation. The potential afforded by the computer to supply raw data based on an underlying theoretical model offers the potential for virtual experiments to be run on a much faster timescale, at no cost in laboratories, equipment or consumables or in supervision of dangerous procedures. And an incorrect choice of parameters or experimental conditions does not carry the large negative penalties associated with a real experiment that may take a day or more to complete. From this basis the computer can provide an opportunity to involve the student in understanding the underlying theory and planning the experiment that is not so readily achieved in the real laboratory.

VIRTUAL EXPERIMENTS

- allow students to spend a greater proportion of their study time on activities that involve experiential and practical learning, and students will benefit from the close linking of these activities with development of underlying theoretical concepts
- enable students to develop a wide range of skills that will prepare them for, and allow them to make more effective use of, their limited time in the lab or field
- allow students to tackle (virtual) practical work that it would be too expensive or dangerous to provide in laboratories
- encourage deeper learning by enabling a more exploratory approach than the recipe-following that characterises many undergraduate experiments
- provide a vehicle for online collaboration and discussion which will promote peer learning, increase students' motivation and their sense of being part of the student community, and improve retention
- can simulate complex models and thereby enable students with weaker maths and science backgrounds to explore, and develop an understanding of, complex systems
- are more accessible, enabling students with disabilities to engage with parts of the science curriculum that would otherwise be inaccessible to them
- when developed to sufficient quality will enhance students' interest, enjoyment and motivation, and hence improve retention and performance
- consume no chemicals, require no space or specialist equipment, are clean and are reproducible

A MODERN DAY VIRTUAL EXPERIMENT

The defining difference between modern day virtual experiments and their forerunners lies primarily in the quality of the visual imagery that can be produced and the methods that can be provided for the student to interact with these images.

These can include

- high-quality, full screen, video of laboratory equipment or a scientific site
- high-quality still images
- computer-generated images that are realistic such that the student can make choices about their experiment and the computer can simulate the results
- computer-generated 3D images

The DVDs introduced by the OU in 2002 can support all of the above in providing a much closer reproduction of the 'look and feel' of a real experiment. This in turn reintroduces the skills of interpreting how an experiment proceeds; observing, measuring and collecting data can be made more life-like and the potential for learning from incorrect experimentation no longer carries a large penalty. Indeed experimentation can be encouraged within the bounds set by the computer model or video resources.

And the approach is very suitable to individualised learning, either at a distance or in a conventional setting, because as the computer is providing the information for the student to interpret, so the computer can also perform the role of a virtual tutor who can check the observations and calculations, and where required ask the student to revisit and reinterpret certain pictorial, numerical or graphical data.

EXAMPLES FROM THE OU SCIENCE CURRICULUM

While the OU has been using experiments based on computer simulations with graphical outputs for over 20 years, since 2002 we have found that the range of experiments has spread into areas that had not previously been considered suitable. In environmental science we now have extensive virtual field trips to the Teign Valley in Devon and the Sevilleta Wildlife Refuge in New Mexico each supported by over an hour of video and extensive maps, pictures and data from local and national scientific agencies. In chemistry we have a multimedia program that deals with the separation of plutonium from uranium while our Earth scientists have taken the opportunity to bring the study of remote geological formations into students' homes, combining interactive geological maps with virtual reality video of the area. Most recently the biologists and biochemists have devised a series of experiments that are used at home prior to performing the actual experiment in a residential school.

The presentation will show excerpts from the above to convey the quality of representation that can now be achieved.

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[O4] Development of an e-learning resource in support of large class size teaching in biosciences

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Keywords: e-learning; cancer biology; large-class teaching

ABSTRACT

This paper reports on the development of an e-learning resource in the biosciences that supports large class size teaching and enhances student learning. This included 3 main components 1) an online tutorial, based on the cellular processes of DNA replication, damage and repair in relation to oncogenesis 2) formative assessment in the form of multiple choice questions to allow self evaluation and 3) small group follow-up workshops, to encourage deeper learning and build confidence. The results of this study showed substantial improvements in the student learning process by the promotion of self paced learning, using effective teaching practices, reduced assessment load and development of reusable learning objects. This study therefore supports the use of e-resources as a means of improving both the effectiveness and efficiency of large group teaching.

INTRODUCTION

One of the learning objectives of a second year unit on cancer biology involved developing a strong conceptual understanding of the complex cellular processes of DNA replication, damage and repair pathways in cancer. The use of e-learning resources provides a strong tool to stimulate and encourage student learning, especially in the biosciences (1, 2). In this paper, I will consider some of the problems associated with teaching complex cellular processes to large classes and discuss strategies that were successful in improving educational experience for both students and lecturers.

THE PROBLEM

For the past few years, a key module on cancer biology has been taught to more than 175 second year students from both within and outside the department, in a traditional 24x1 hour lecture-based format. The numbers of students taking this compulsory module has been increasing steadily over the years, thereby putting a strain on teaching resources (e.g. large lecture halls were needed), reducing the efficiency of traditional teaching and learning strategies as well as an enormous coursework assessment load. Additionally, this module is also chosen by an increasing number of students from outside the department, including pharmacology, chemistry and natural sciences, who have different levels of knowledge compared to the rest of the cohort from within the department. The resulting heterogeneous population of students, combined with the large numbers, put a severe strain on the teaching, learning and assessment process and made it difficult to identify individual student learning needs.

Alternative strategies were therefore necessary in order to improve both the efficiency and effectiveness of teaching these large classes.

The strategy

The idea was to design a web tutorial on some of the lecture material that was previously delivered in a traditional lecture format. Students would use the online resource and subsequently, attend small-group workshops that would be divided based on the degree cohort (Biochemistry, MCB, Biology or Natural Sciences). A resource package was developed, which included 3 main components

1. An interactive web-based tutorial, based on the cellular processes of DNA replication, damage and repair in relation to oncogenesis, designed to incorporate key concepts in cancer biology using media such as *Flash©* animations.

2. Formative assessment based on multiple choice questions, which was linked to the resource.

3. Small group follow-up workshops to reinforced key concepts and encourage deeper learning.

Anticipated outcomes

The resource was designed to improve both the effectiveness and efficiency of teaching by

- *Supporting large-class teaching*: The use of an e-resource would enable teaching to large class-sizes

- *Self-paced learning*: provide a means by which students could learn outside the classroom environment at their own pace

- *Effective teaching practice*: encourage deep learning by allowing students to engage fully with the topics and promote confidence

- *Embedded assessment*: allow students to assess self-learning using formative feedback from multiple choice questions embedded in the tutorial

- *Reusable learning objects*: develop computer animations of key cellular processes that could be used by the wider academic community

- *Better interaction with learners*: allow a cohort-specific contact time with the lecturer during follow-up workshops in smaller groups.

METHOD

Designing the resource

The fundamental subject of DNA replication, damage and repair that would enable students to understand the wider issues relating to cancer were chosen. The website has incorporated the latest research in the areas of DNA replication, damage and repair. The resource has been created both as a *Flash©* object (to motivate student learning) and a printer-friendly html format. Additionally, *Boxmind©* and *Impatica©* was used to introduce basic concepts of cancer. Care was taken to ensure that students were not inundated with information by embedding interactive elements throughout the tutorial. The university e-learning team were consulted to ensure that the graphics were compatible with student learning. Printer-friendly text versions of the contents were linked to the tutorial and navigation footprints were introduced based on informal student feedback. This resource also contains novel animation material, especially in eukaryotic replication and DNA repair. Formative assessment was also linked to the resource in the form of multiple choice questions.

Follow-up workshops

Students were divided into four groups based on the degree cohort (Biochemistry, MCB, Biology or Natural Sciences). Two workshops per group were set up and a paper outlining key concepts, challenges and linked references were distributed before the session. During the workshop, individual problems, questions and challenges were discussed in depth. Smaller groups also encouraged the less-confident students to contribute to discussions. Classical papers were also disseminated during these sessions to engage and motivate student learning. The students really enjoyed the interaction that the workshops allowed and were able to gain confidence in raising questions.

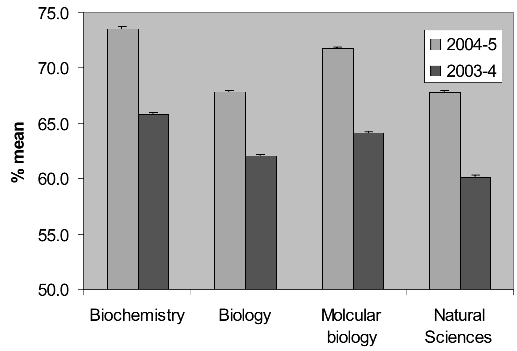
RESULTS AND EVALUATION

Improving effectiveness of teaching

(A) Learning outcomes

Summative assessments for 2003–4 (control group) were compared with the year of introducing the resource (2004–05). The evaluations used were student feedback from previous years, informal teaching observations and end of year assessments. The mean scores of the summative multiple choice test for the two years are shown below (Fig 1). The e-resource which was introduced in 2004–5 resulted in improved test scores. The overall mark for the entire unit based on traditional essay-based examinations also showed a similar trend, although the contents of the resource were not part of the assessment.

Fig 1: Mean MCQ scores of the different cohorts



(B) Feedback

- *Feedback on authoring and development of the resource*: In order to increase effective use of the resource, the e-learning team at the university were consulted. Based on their feedback, one of the major alterations to the site was the creation of a printable web page in an html format. Subsequent modifications at this site were based on feedback from specifically-designed student questionnaires and feedback from colleagues within the department. Based on this feedback, changes were made to improve navigation and access.

- *Feedback from specifically-designed student questionnaires*: Students response to website - related questionnaire (Table 1 overleaf) was collated around week 4 of teaching and the response rate was 89%. Of these, 82% of the students responded positively to using the resource. For the students, one of the biggest advantages was the self-paced learning the resource provided. The use of graphics and animation also rated highly in the questionnaire. On the question of preferred choice of learning, the results were mixed. Approximately 20% of the students still preferred traditional lectures, 75% preferred the web-based format with linked workshops whereas 5% liked a combination of the two.

- *Feedback from peers*: The development and implementation of the resource was a novel one for the department. The format and content was disseminated to colleagues before implementation. Informal feedback was very encouraging and positive. The overlap of some the subject

Table 1: Results from student questionnaire

1. Which method of learning do you prefer?	
Traditional lectures and note-taking	20%
Web-based learning	75%
Combination of both	5%
2. Did you find the web tutorial useful as a study resource?	
Very useful	89%
No difference	7%
Not useful at all	4%
3. How do you rate website navigation?	
Excellent	36%
Very good	28%
Adequate	29%
Weak	7%
4. Did you find the workshops useful?	
Very useful	76%
No difference	22%
Not useful at all	2%
5. Choose any of the following options	
I like to study in my own time and pace	72%
I prefer to take lecture notes and references	10%
I prefer a combination of both	18%
6. I found the self-evaluation MCQ very useful for revision	
yes	59%
no	22%
don't know	19%
7. The use of animations in the tutorial were	
useful	82%
somewhat useful	18%
useless	0%
Comments:	
8. Which degree cohort are you in?	
biochemistry	
mol. Cell biology	
biology	
natural sciences	
other	

N.B. Additional empty lines for comments in each section were also incorporated into the feedback areas covered by the resource also allowed it to be used by other staff members on their courses.

Improving efficiency

- *staff-student contact time*: A significant improvement was observed in the time spent with the smaller group of students. Not only did it enhance student learning (as evident from the in-depth discussion on the subjects) but it also helped in an on-the spot assessment of whether any of the learning objectives were being met.

- *staff time*: The contents of the resource covers ~12 traditional lectures of 1 hour each. The follow-up workshops were in smaller groups using a maximum of 8 hours. The use of an online summative assessment based on the web resource also reduced marking time. The formal end-of-semester essay-based examination has been reduced from 2 to a 1 hour slot. This is reflected in reduced marking time for 175 hour-long scripts (~12 hours).

- *student time*: One of the key points that emerged from the questionnaire was the self-paced learning that the students really appreciated. The reinforcement of key concepts was facilitated by the workshop sessions. Given the diverse backgrounds of the student cohorts, this is probably the main reason for the improvements seen in the learning outcomes for all 4 cohorts.

- *use of resources*: Lesser number of formal lectures meant less use of teaching space (especially large lecture halls). Remarkably, there were no complaints on being able to download the tutorial from home or in the library.

SUMMARY AND CONCLUSION

Overall, the student response to the e-resource was highly positive, with a high percentage of students preferring the current format compared to a traditional one. The huge improvement in student learning, as evident from both the learning outcomes and feedback, also indicates that the project has been a success. Although the effectiveness of animation and narration in student learning is highly variable (3), it is a potentially powerful tool, especially in the biosciences. Complex cellular processes and interactions can be demonstrated effectively using this method. Its use in almost all bioscience textbooks, as accompanying CD-ROMs, testifies to its popularity. An overwhelming majority of the students benefited from its use in understanding key concepts, which are otherwise difficult to conceptualise.

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