[O18] The integration of problem-based learning into a traditional teaching framework – lessons on mixed economy models of education

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ABSTRACT

Many medical undergraduate courses have moved towards problem-based learning methods. This is in contrast to many UK HE undergraduate pure science courses where tutor-centred approaches still predominate. The model used for undergraduate medical courses may be successful due to several factors such as the motivation and prior achievement of the students. This may discourage tutors on courses, which recruit with the philosophy of broadening access, from attempting to integrate PBL into the curriculum.

The authors have integrated some problem-based learning into the standard curriculum of a second level undergraduate biochemistry module, looking at proteins. The typical cohort for the module is quite diverse, including full-time undergraduates in biochemistry, molecular biology as well as HNDs in biochemistry. A small cohort of part-time HNC students in biology and biochemistry also access the course.

We have replaced the teaching of two areas of the curriculum, enzyme kinetics and protein purification by problem-based learning. Basic principles have been articulated in keynote lectures and the students have then been set a related problem-solving task using published software. The tasks are set as assessable parts of the module and a key to the formulation of this approach has been to use assessment criteria that ask the students to demonstrate understanding at a deeper level than the lectures and then apply that understanding to solve a problem related to enzyme purification and the determination of kinetic parameters. Threshold grade criteria for borderline first class and pass grade work are articulated to the students to emphasise the need for a deeper understanding of the physico-chemical principles underpinning the application of the methods to be learnt. The use of texts, internet sources and published literature to support the work is encouraged.

Assessment of understanding is made via the assignment and also in formal time-restricted tests. The approach has met with limited success and has pointed the way to interesting questions around tutor and student centred approaches to teaching.

INTRODUCTION

McMaster University in Canada introduced problem-based learning (PBL) into medical school curricula in 1963 (see Neufeld and Barrows, 1974). The driving force in PBL in medical degree courses was a desire to contextualise learning in supporting disciplines, to move to a student centred approach and to develop team-working skills. Student Motivation was seen to be improved by this approach. However, the extensive use of regular small-group tutorials makes the medical approach expensive and difficult to manage with large cohorts.

One way of resolving this dilemma is to utilise technology to support the problem-based learning aspect of this course. This has the advantage that tutor input is reduced, as the student makes more use of the IT interface. There are several considerations in adopting this approach. One is the need to ensure that the student is engaging sufficiently with the curriculum in order to achieve learning. Two, is that there is an enormous input in creating suitable high-quality IT-based teaching materials to support the student. This may involve not only creating text for learning but self assessment materials to check the achievement of learning by the student. Three, must be due consideration in making sure that collusion between students has not taken place in the preparation of materials for assessment.

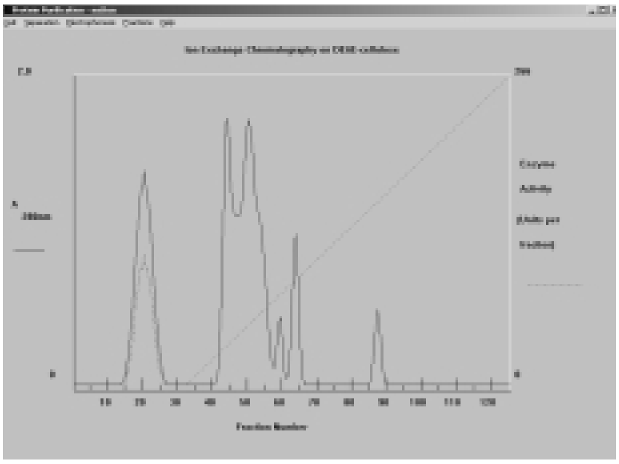
These issues can be addressed by creating situations within a student cohort where tasks such as case studies and problem solving are made individual to the specific learner. With the conventional case-study approach to PBL this would require an enormous input into the development of a bank of case studies that could individualise learning. Software that is designed with end user interfacing to create banks of similar case studies can allow for this. Simulation software is one of a range of tools that can contextualise learning, test understanding, and apply knowledge. The combination of the use of simulation software with assessment as a driver for achieving understanding can create a powerful tool for PBL.

The ProteinLab software that is part of the eLABorate series of programmes, written by Andy Booth, was used as the basis for delivering the PBL. The approach described here differed from the facilitator-led methodology and case-study approach that has been successfully applied to medical degrees. The ProteinLab software allows the user to simulate a protein purification. The advantages of simulation software in undergraduate programmes include the reduction of real-time by the student than could be achieved by practical hands-on experience of the methods, thus experiencing of a wider range of techniques than would be possible to provide within the standard undergraduate curriculum and the development of experimental planning and application skills. In the past this area of the undergraduate biochemistry curriculum has been taught as part of a module in a traditional lecture / tutorial format.

The software is well designed with extensive help pages on purification strategies and each of the separatory and analytical techniques that can be utilised to purify a protein from custom-designed mixtures. Students can learn how to purify a protein by reading the strategy page. They can then learn about the use of each individual purification technique by studying the pages describing the use of that technique. The student can then set up a purification using one of the techniques. The results of each separation can be expressed as an electrophoretogram or chromatograph and the location of the protein that the student is trying to purify identified using immune or enzyme assay. A typical result of such a purification step is shown in figure 1. The progress of a purification protocol can be followed, using either SDS PAGE coupled with immunoblot identification or specific enzyme activity.

The two main reasons for adopting a different approach are, that there is a need to reduceto reduce the staff loading implied by PBL and that TSL could be used to develop independent learning by the individual. Despite these differences, the approach described here emphasises the responsibility of the individual as an independent learner. This approach meets nearly all of the PBL precepts in Kivela and Kivela (2005) but does not concord with all of the characteristics described in Rosing (1997). Comparative aspects of this are discussed later.

Figure 1: Screen dump of ion exchange chromatograph from the ProteinLab software package



SOURCES OF PROGRAMMES

The proteinLAB part of the eLABorate software suite is available to educational institutions from: http://www.york.ac.uk/depts/chem/staff/elaborate/packages/obtain.html.

The enzyme kinetics is part of the biochemical simulations suite of software from DAB computing via d.bender@ucl.ac.uk.

METHODOLOGY

The PBL approach was integrated into a module largely delivered by the standard lecture/tutorial approach. This second year undergraduate module, entitled 'Proteins' covers protein and enzyme purification, structure and function to biochemistry and biology students. Typically the class size is about fifty students.

A short introductory session on the basics of the software showing how students could access the programme and some of the main analytical features was placed at the end of a lecture session and at the same time a list of criteria used in assessment handed out. The assessment criteria were expanded with some guidance as to what would be expected in an exemplary piece of work. Each student taking the assignment was given a different protein from the mixture to purify to reduce the possibility of collusion between students. Students were given five weeks to work through the strategies and produce a final report that was to be written up in the style of a practical report. The students were given free rein to approach the tutor if they needed reassurance on the progress that they were making.

The software has the facility to make banks of mixtures of proteins with up to 20 proteins in any one mixture. A file bank of three mixtures of twenty proteins was created each with parameters that allowed observation of the mixture. Thus, an individual protein could be made of one or more polypeptides with any stoichiometry desired. For the purposes of the learning experience the molecular weight range of the polypeptides must fall between 6 and 80kDa and isoelectric points must lie between pH 4 and 9. The use of this software by the student was linked to an assignment where the explicit criteria for marking underpinned a philosophy that used assessment to drive the necessary learning needed in order to successfully complete a protein purification. For example, some of the assessment criteria relate to the student using the method appropriately:

(i) Explain the tools used to analyse the outcome of each stage of the protein purification protocol in your methods section.

(ii) Use the techniques of protein purification appropriately to purify an individual protein from the protein mixture.

Each of the criteria was assessed by using a grade to describe the student performance. An example of marking criteria related to assessment criteria (i) described above is

Table 1: Grading criteria used to match to assessment criterion 1

Criterion	E/F	D	C	B	A
Description of Purification Techniques	Criteria for a D grade have not been met.	Principles of one technique is described showing some understanding of the method *or* material is largely transcribed showing limited understanding.	Principles of some techniques used are described in the student's own words showing good understanding of the method.	Principles of all techniques used are described in the student's own words showing good understanding of the method.	Principles of all techniques used are described in the student's own words showing clear understanding of the method.

shown in table 1 overleaf.
A is equivalent to a first class performance in the criterion being assessed. This transparency in the assessment process serves as an initial motivating factor for the students.

The module timetable was then redesigned to remove all but a basic introduction to the programme delivered in one of the lectures. In this topic no coverage of appropriate purification strategies was given by lecture with the space created by the removal of the lecture and tutorial used to allow students the time to achieve learning and undertake the assessment task.

In the final report students had to write, in their own words, an explanation underlying the physico-chemical principles of the purification methods that they had used. The methods section guidelines were that all parameters in choosing the separatory technique were described. Students were expected to show chromatographs of their purified protein and use SDS PAGE to calculate the molecular mass of the subunits of their protein. The students were asked to include in an appendix descriptions of separatory methods that had been discarded. This was related to the discussion section of the report in which a justification the choice of purification protocol used was required.

The design of the assessment parameters mirrored these assessment requirements closely. The mixture of knowledge required in the introduction, practical design and justification were used as basic indicators of learning achieved.

In addition to check that scientific principles learnt in this exercise were retained in the long term the principles of some of the methods were assessed using a formal time-restricted test.

EVALUATION

The way in which students learnt could be assessed by their success in applying the techniques. In the three years that this approach has been adopted no student has failed to purify their protein from the mixture and no student submitting an assignment failed the assignment. These marks compare favourably with the average marks achieved when this syllabus area was assessed using conventional time restricted tests. This implies that the correct methods must have been learnt from the help pages in the programme. The student view of this approach to learning was obtained by means of questionnaires and interviews. The students all complained about the workload. Comments such as 'Learning stuff yourself is very hard' or 'I had to spend a lot of time reading and rereading the help pages' were common. In module evaluation questionnaires, the module was rated as difficult when compared to other modules

Table 2: Task based PBL vs. the traditional PBL as described in Kivela and Kivela (2005)

Task based	Traditional
Curriculum/syllabus as experience	Curriculum/syllabus as experience
Student/learner-centred	Student/learner-centred
Coherent and relevant	Coherent and relevant
Teaching as facilitating information	Teaching as facilitating information
Learning as constructing	Learning as constructing
Flexible learning environment	Flexible learning environment
Low tutor input	High tutor input

being studied at the same time. However, grades for the problem-based learning exercise were well above those obtained for most other coursework items on this module and on others.

One of the aims of this more student centred approach was to encourage deep learning and the students were asked to compare their feelings about the learning using this approach with those that had taken place on other parts of the module taught by traditional means. The typical comments were ‘I found that I really understood what separation techniques could be used for whereas with other stuff you learnt it for the test and then it was quickly forgotten’ or ‘although learning by this approach was hard you felt you had really got to grips with this by the end of the module’.

Tutor evaluation was attempted through a qualitative appraisal of a range of student grades to see how well the full ability range of students coped with this learning method. Those students obtaining good grades down to second-class showed no lack of understanding in their use of separation tools. Typically, the learning of weaker students exhibited superficial responses to parts of the assignment. This was manifest in the level at which the assignment was attempted with less than full description of the methods used and in some cases not all methods being applied appropriately to a purification step.

OUTCOMES OF THE APPROACH

A main feature of the approach to PBL is the use of TSL to replace tutor support in the learning process. The rationale for this is two-fold; firstly the reduction of tutor-directed input allows the tutor to address other aspects of the learning experience within the module and secondly it encourages students to work independently. The other main difference between this and the PBL approach adopted in medical faculties is that the learning was linked to a simulated practical rather than a case study. Thus the approach could be described as Task-based PBL rather than Case-study based. In many other respects the approach adopts similar values to those espoused in traditional approaches. If we compare table 1 in Kivela and Kivela (2005) with ours we see concordance (see table 2) and a great deal of commonality to the characteristics of PBL described in Rosing (1997) and shown in table 3 on page 106.

In terms of the approach to integrated PBL that has been extensively described (see Jervis and Morris, 1996; Harris *et al*., 1997) this approach differs in that it can be integrated into a conventional curriculum with little need for adaptation of the other teaching methods used on the module.

In some ways it more closely follows the case study approaches that are described in Rivarola and Garcia (2000) and Rosenblatt (2003) and the problem-based learning approach of Whitely (2000) as applied to enzyme kinetic analysis.

Table 3 Comparison of general characteristics of task-based and case study learning programs as outlined in Rosing (1997)

Task-based	**Case study**
Student centered	Student centered
Students need little input from tutor	Teachers work closely with students
Learning objectives	Learning objectives
Teachers provide scenario	Teachers ask questions
Short-term memory	Long-term memory

PROJECT DEVELOPMENT

The scope for broadening this approach is very much based upon being able to resource the development of software. The advantage that we had was to beto ablebe able to use the sophisticated software developed by Andy Booth. We have expanded this approach into the teaching of enzyme kinetics using a similar approach to the one described above. However, in the kinetics tasks the problem-solving approach was based upon David Bender's kinetics simulation programme. Individualisation was a little more difficult as there is no facility with this software to custom-design a larger range of enzymes for kinetic analysis. However, at least ten different kinetic analyses could be tried with this software. Another limitation of this software is the lack of being able to do multi-substrate kinetics making its use beyond second level biochemistry courses limited.

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[O19] Student authored questions encouraging a deeper learning in physics

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INTRODUCTION

In this study, we started with the assumption that the best questions are those that students pose themselves. We would like our students to be continually asking themselves questions about the material, but the confines of the class often limit this enquiry to a common syllabus and to questions set by the teacher, not by the student. Any subject does need to be clearly defined, but a danger with an over-defined course is that self-enquiry is not encouraged and that student experience can be curtailed. Particularly in the early years, students are seldom given the freedom or encouragement to think about their own questions, or to think about the value of asking their own questions. A lack of independence in studying is characteristic of a shallow approach to learning (1).

When worded carefully and engaged by a mature student, multiple choice questions can be a superior learning tool as they can tease out the conceptual misunderstandings students have. However, less-mature students tend to overlook the benefits available in multiple choice questions and look only for the quickest path to the ‘right’ answer. A way around this, as shown by Mazur (2), is to use ConcepTests in the tutorial/lecture environment to create an opportunity for students to choose an answer and then convince each-other of whether one answer among many is correct. The dialogue created by this exchange is a form of peer learning and leads to deeper understanding of concepts (2).

This study was aimed at more active involvement by students in the design and usage of such forms of questioning. We used peer interaction to encourage questioning of novel problems. It was considered that working in groups on novel problems, less experienced students would be able to interact with more experienced programs to refine their questions. If the problem was rich enough, then the group of students would be able to come up with a range of answers. If students got into the spirit of the game, they would be able to come up with a range of answers that would be enough to baffle a group of their peers, but which would still allow the correct answer to be found. This games theory aspect to their learning might increase the students’ motivation.

METHOD

In 2004, we undertook a project to investigate the ability of students to follow through on their own questions. This involved two cohorts of student; a first year engineering class studying electricity as a service physics subject, and a second year class for Physics majors. The latter was an intermediate level course involving advanced Mechanics (including non-inertial reference frames) and Lagrangian Mechanics.

As an assignment, students were asked to devise their own questions and come up with suitable answers. The format chosen was multiple-choice and each student had to formulate their own question and suggest an answer. Working in small groups, their peers would then consider the question and propose their own answers. If all the students arrived at the same answer, then it was suggested the question was too easy and that it should be reconsidered. If it was too 'difficult', such that students felt they could not adequately answer the question, then it was suggested that the question should be clarified or simplified.

Students were asked to use the on-line discussion capability in BlackBoard so that we could monitor the process undertaken by the students. Students were given a week to devise their question and a further week to discuss the other questions in the group.

Significant time was devoted in class in setting the ground work for this assignment with the students, as none had undertaken a similar form of assessment. The importance of this exercise in promoting self-directed study was stressed. Students were encouraged to think about where they were at in their understanding of the subject material and to then probe beyond that point.

The importance of thoughtful posing of questions as well as of the creation of credible detractors was talked about. We stressed the need for questions which teased out some aspect of the underlying concepts, rather than ones which required simply the correct substitution of numbers into a given formula.

Consideration was also to be given to the clarity of the questions; they should be concise and should not contain large amounts of unnecessary detail or red herrings.

MONITORING PROGRESS

We were able to read the students' postings on Blackboard but did not interfere in their progress. At the end of the period, we marked their assignments according to the criteria discussed with students in the preparatory period. As well as the quality of the final questions and answers in the final assignment, we took into account student's input and involvement in the on-line discussions.

We took the best of the students' questions and answers and used them in a Weblearn test given to the whole class. Weblearn is multiple-choice on-line testing facility.

ANALYSIS OF QUESTIONS

We analysed the type of questions that were put forward, the pertinence of the detractors as well as the explanations that students proposed for the answers.

The quality of the problems and answers was measured by both the complexity of the concept underlying the question and by the degree of effort required to arrive at the correct answer. This can be shown, for example, in the question written by a Physics student:

A person is riding a merry go round travelling at a constant speed. He is seated on the outermost seats, of the circle. As he is going around, he decides to throw a tennis ball he is carrying. As he observes, the ball appears to be travelling outwards, but as the ride is turning, the ball also appears to be falling behind his line of sight. From the rotating frame of this person (this is) due to which force or forces:

A. Centripetal Force.
B. Inertia.
C. Centrifugal Force.
D. Coriolis Force.
E. Both Centrifugal and Coriolis Forces

This is a good quality question as it delves beneath the simple recall of what the three non-inertial forces are and seeks an explanation of what is happening. The detractor answer of 'Inertia' has the correct physical meaning but due to the way the question is asked it is not the correct answer.

We categorised the questions and answers roughly according to whether they were:

- deep or shallow; Did the question ask for a simple recall of the concept?
- abstract or real; Did the question relate to a real situation?
- numeric or conceptual. Did the question involve a calculation?

These are not mutually exclusive attributes but define a continuum with most questions falling somewhere between the two extremes. The attributes of questions had been discussed with students in the preparatory period.

For the both groups, the ratios within each classification were as follows:

	First year engineering group	**Second Year Physics group**
Deep/Shallow	1.4:1	1:1
Abstract/Real:	1.7:1	1:1
Numerical/ Conceptual:	2.2:1	1:2

Although students were asked to think primarily of testing concepts through their questions, many in this engineering cohort still chose problems whose solution primarily required a numerical approach. Many of the detractors were variants on the numeric answer such as due to simple transcription errors, without involving different conceptual mistakes.

In the first year cohort, the majority of questions were more abstract, in the sense of problems not being strongly applied to realistic situations. This mix of results does accord with students thinking of variants of text-book problems. It might be argued that first year level electricity has fewer novel concepts than those in a second year level mechanics course and that students might see more opportunities for numeric type problems. However both areas are rich in conceptual problems.

In general, the second year discussions were demonstrably deeper. The involvement described answering each-other's questions, identifying misunderstandings and explaining concepts. For example, students in the second year class commented 'Just because I wrote the question doesn't mean my answer is correct', 'If you could post the answer that would be sweet . . . I'd like to know if I got it right', '(your question) had me going to the text book' and 'I think I got caught in my own trap'. Overall the timbre of comments was very positive and constructive in both groups.

The use of a discussion board for group interaction was new to both groups of students However most in the first year group (80%) participated and 80% of those did more than one posting (average of 5 per individual discussion board) while in the second year group 90% participated and 96% did more than one posting.

FOCUS GROUPS

At the end of semester, the first year Engineering group was invited to attend a focus group to discuss the experience. There was a mixed response from students; from those who could appreciate the purpose behind the assignment, to those who thought 'there was not much point and didn't really like it'.

The most relevant questions that were asked are given below along with some of the more telling, informative responses.

1. What did you think was the objective of the 'question writing' activity?

a. It forced us to study more and understand the material in order to set the question and its answer;

b. Helps determine where we are having difficulty and so helps with exam prep;

c. Helps understand MCQs better, especially detractors – this helps for exam prep;

d. To try and find the hardest possible physics question and then answer it;

e. So Ken wouldn't have to write questions.

As answer d suggests, it is difficult to guide the student to the level of difficulty that should be attempted. Being able to come up with a question which has the right degree of complexity yet is 'manageable' by students in the class, is difficult for the teacher, far more so for a student learning the subject for the first time.

For those that were not enthused about the assignment, the cynical answer, e, may have been quite genuine.

2. What did you learn about physics?

a. It's not all calculation based;

b. Didn't help understand physics because in physics everything is related and one question can't help out on the whole thing.

Answer b was somewhat unexpected. Although each student was asked to devise just one question, they were in groups of four or five students whose questions the student was also asked to address.

3. What did you learn about writing questions?

a. Didn't really write the question. I took it from a book;

b. It's hard;

c. Learnt how to trick and deceive using MCQs;

d. Physics is stupid and fun and useful;

e. How much understanding you need to write a question.

The answer, a, is obviously an 'easy' way out for student. Although some questions seemed very similar to those found in text books, it is impossible to always tell which question has been truly devised by the student. However most appeared to be genuine efforts at devising question that they wanted to address and that were novel to them.

If the respondent at c has learnt to analyse questions more thoroughly, then it was a useful exercise. Hopefully, the physics understanding of respondent for e has also improved.

4. What did you like about the activity?

a. Freedom and choice of what we could do;

b. Easy marks, better than doing a test;

c. Feedback from group members helped improve your question and so get better marks;

d. Activity is stupid yet satisfying;

e. Self interest, challenging;

f. Had to do some physics;

g. Straight forward assessment task.

Although the method of formulating and discussing the problem was laid out, there was almost no restriction of the question they could pose, provided it kept within the broad topic bounds.

5. What did you have difficulty with in the activity?

a. The activity was a burden;

b. Boring, don't like electrical systems;

c. Working with people I don't like;

d. Finding a concept to apply to questions.

Answers a through c are responses that may be found for any task. However, it is definitely not easy to think of a question in a new field which has just the right degree of difficulty; that helps in the learning process, rather than being 'a bridge too far.' Half the difficulty in learning is properly assessing that which you don't know.

One aspect not discussed in the focus group, was the cultural and language background of the students. There were a small but significant number of students in the engineering class for whom English was not their main language and who had some difficulty in expressing themselves in non-mathematical English ways. They were less confident in putting their ideas forward in common group work. Such students were more likely to have experienced more traditional, structured teaching in physics.

This trial was a single event as far as the students were concerned; an assignment which was novel for them but which was not part of an ongoing method applied to their learning experiences in the course or program. In that regard, it might be expected to have only limited results in changing the learning style of students and indeed there was no significant correlation to be found between the quality of the question posed by individual students and the mark that student subsequently obtained in the Weblearn test.

This particular method of asking students to generate their own questions could become a useful adjunct to the suite of learning activities proffered to students, but it would have to be modified to be more practical. The degree of monitoring of student progress was too time-consuming and this would have to be reduced. In addition, assignments involving the generation of questions would have to be done on a regular basis so that, for students, it became an established normal method. For students involved in this isolated trial, there was no further reinforcement of the method.

CONCLUSIONS

The study has been a useful exercise in determining the response of students to being so openly challenged with the creation of their own questions and detractors. It provided a rich group interaction and got students to articulate a question which they believed was interesting or important to their area of study. Each student came to terms with why they believe a particular answer to a question was right or wrong.

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[O20] Responding to changes in pre-entry qualifications

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ABSTRACT

The STAR project is concerned with the identification and dissemination of good practice in dealing with the transition of applicants with attributes derived from their current educational experiences to Higher Education students with those attributes thought desirable of graduates. Recent trends in the qualifications presented by traditional students have led to a restricted content and more defined assessment schemes with detailed outcomes and criteria. In addition, students can repeat aspects of the assessment to improve their grades. This appears to have led to a teacher-dependent, risk-averse learning culture, culminating in the oft-heard phrase 'Just tell me what I need to know to pass the assessment'.

Transition processes include considerations of the attributes acquired by students prior to entry and those that are thought desirable at the end of the first year at University. Some attributes and attitudes depend on current teaching and assessment methods in AVCEs and A level examinations as well as common practice in Higher Education. Appropriate responses include aspects of communicating with applicants prior to entry to better prepare them for HE, induction procedures which are sensitive to the rapid changes experienced by new students, and changes in the first year curriculum and assessment which may be necessary to adapt students to the learning culture at University. Although this work is rooted in the Biosciences the learning from the examination of this exemplar is generic.

INTRODUCTION

The STAR (Student Transition and Retention) project is concerned with the transition from one part of education to the next. These transition processes are conceptually simple. We need to know the start point and the end point of the process and then design a way to get students from one to the other. For the first year curriculum this implies knowledge both of the desirable qualities in students progressing to year 2 and also the attributes and ambitions of students on entry.

Recent pressures on schools to perform to a set of targets has inevitably led to an improvement in standards at school measured as exam success. Each year more students are gaining higher grades and it is becoming more difficult to discriminate between applicants on the basis of grades alone. As a greater proportion of the 18-year-old population is admitted however, we have also gained a problem of understanding what it is they know and can do when they present with Cs and Ds at Advanced or with Advanced Vocational Certificates of Education.

Transition then requires knowledge of the destination and the point of departure and involves the activities of teachers, pupils and examining boards prior to entry and those of students and academic staff in year 1 at university.

THE DESTINATION

Most academic staff could list the sorts of qualities they deem desirable in students entering year 2 of a degree programme. Such a list would undoubtedly include aspects of independent learning including the ability to find and interpret information and of being highly motivated. There would also be a component of subject expertise so that a particular knowledge base could be guaranteed when teaching in Year 2. Added to these would be some notion of students being socially well-adjusted so that they could participate effectively in group-work and have a mature attitude towards an appropriate work-life balance.

The destination however, should also include positive student attitudes towards, for instance, plagiarism, resits and attendance.

THE POINT OF DEPARTURE

The attributes of students on arrival at University are much less well defined. Although University staff may know how they might like the new intake to be, new students seldom conform to these standards. Students enrol with a variety of qualifications and these themselves have changed rapidly over recent years. Further, new students respond in a range of different ways to the new freedoms that they acquire in higher education. Differing styles of teaching, learning and assessment in the various pre-entry qualifications also add to the diversity among incoming students. While diversity in itself is not a problem, changes in pre-entry qualifications are resulting in these differences often being unrecognised among those delivering the first-year curriculum in Higher Education.

Assessment Schemes

Changes in the ways in which 2nd level qualifications are assessed have led them away from the pattern common in Higher Education.

In A level Biology (NI) (CCEA 2002) about 80% of the marks are awarded for examinations. There are a total of 6.75hrs of examination time spread over two years with the maximum duration of an examination being 90 minutes. Distributing the marks over the available time indicates that a candidate should spend no more than 18 minutes on any one question. In the examination a total of 17% of the marks are awarded for answers written in continuous prose. Even allowing that most candidates will be taking three A levels, this examination schedule represents approximately half the intensity of examination typically experienced in Higher Education (3 hour examinations and fewer questions).

In the AVCE Science (Double Award) 4 of the 12 modules are externally assessed by examination representing 33% of the marks. Each of these four examinations is 90 min. Again this represents an intensity of examination much lower than that commonly experienced in Higher Education.

The coursework in A level Biology represents about 20% of the available marks. Coursework can be repeatedly refined and re-submitted to improve the grade awarded. Thus one teacher commented:

> *'Teachers ensure at all times that pupils remain "on message". All pupils submit at least two drafts. Some enter their coursework project in January and re-submit in June to secure an improved grade.'*

In the AVCE Science (Double Award) (Edexcel, 2000) eight of the 12 modules are assessed by portfolio. Portfolios are written to an assessment grid which dictates the content and the marking criteria for each grade. Thus in the module Investigating Science At Work (Edexcel), students prepare their portfolio including detailed reports on:

'Two local (regional or national if not available locally) organizations you have studied that use scientific knowledge or processes (one must be involved in manufacturing or production, and one provide a service). The reports must describe the type of scientific work, including the number and type of people who work in the organization.'

To achieve a grade A their work must show 13 qualities, 3 examples of which are:

- *a survey of organizations and two reports describing the type of work that takes place in two organizations;*
- *an identification and use of the main source of information and, where appropriate, additional sources of information to support your findings;*
- *an outline of the basic economic costs and benefits of the science used in the two organizations, and the ways in which the organizations and their product's impact on the local community.*

Edexcel (2000)

There is much to be commended in the level of explicitness in secondary assessment but when students arrive at a typical University there is often not the same level of advice and support. In a University system there appears to be a greater assessment load; there is more coursework (certainly it is required more frequently) and a greater examination load. There is much less support; student groups tend to be larger and individuals can become anonymous. Furthermore since the teacher is also the assessor, the appropriateness of staff assisting students directly with assessment is questionable. This can result in confusion leading to the student comment:

'I did not know what was expected of me in some assessments'.

University of Ulster student

Thus the intensity of both examination and coursework is much higher at University than in secondary education and the availability, even sometimes the propriety, of tutor support for assessment is limited.

Teaching and learning methods

Prior to entry, teachers largely manage pupils' learning. Thus information about methods from teachers include:

- *'Past examination questions are unpacked and pupils taught to select and highlight key words.'*
- *'Targets are set by teachers.'*
- *'Pupils are taught to focus their learning when reading.*
- *Pupils are issued with the syllabus requirements and the marking criteria are highlighted to raise pupils' awareness of the standards required.*
- *Pupils and staff feel that they belong to a community. We are mutually dependent. For this reason staff will support learning, recognising pupils' difficulties with study demands. Pupils are, in turn, motivated by a sense of belonging.'*

Secondary School Teacher

In a target driven system in which school performance is judged by the examination performance of its pupils, teacher centred teaching is to be expected; little should be risked for attributes that are not measured.

Independent learning

Most higher education staff would claim the promotion of independent learning as a major goal. Students will have to be independent at the end of the course and that transition tends to start early. In secondary education, independence, although desirable, is not a major goal. Thus in discussing independent learning by pupils one teacher commented:

> *'Most teachers feel that there is less independent learning now than in previous years. The reality is that learning is structured and focussed. All pupils are encouraged to think and work independently – but there is a strong element of guidance.'*

And in discussing transition to University:

- '*Pupils have been accustomed to teachers issuing examination specification and marking criteria. They still need this guidance to continue at university.'*
- *'To date, their learning has been structured and supported, with heavily supervised study and parental involvement.'*

And in discussing transition to University:

> *'Pupils have been accustomed to teachers issuing examination specifications and marking criteria. They still need this guidance to continue at university. To date, their learning has been structured and supported, with heavily supervised study and parental involvement. What happens when all of this is suddenly removed?'*

The role of the examination boards

Examining boards produce syllabuses and a wide range of supporting literature. This indicates not only the syllabus content and assessment tools but also the level of treatment expected. Past papers and associated mark schemes are published, as is a chief examiner's report which comments on the performance of the year's assessment. Teachers welcome such openness and explicitness since it helps frame the way the syllabus is delivered and it is welcomed by pupils since it helps define how much has to be learned.

There is obviously a close relationship between the syllabus, the teachers' guidance, the examination questions, the mark schemes and the chief examiner's report. Tracking through the evolution, marking and candidate performance on a question is informative. Most of what a candidate needs to know is in the guidance notes for teachers and clear guidance to teachers becomes advice to candidates about how little to learn. There is also some indication that where information is contained in more than one section of the syllabus then it confuses the candidates.

THE STUDENT VOICE

Students clearly know that there is a significant transition from school or college to University. Most manage it successfully but some find it difficult while others falter and drop out. When asked what was most difficult when joining the University few students put the difficulties of work first. Comments included the following:

- *Moving from the country to the city*
- *Transport to the university*
- *Getting lost in the university*
- *Making new friends since home friends tended to be of long-standing*
- *Language problems (international student)*
- *Adjustment from working (mature students)*

When directed towards more academic matters they cited:

- *Group working is difficult to achieve successfully – more training needed*

- *A lot is expected in presentations at an early stage e.g. use of PowerPoint – again more training needed*
- *Getting notes from WebCT is not always straightforward – needs to be clearly explained and demonstrated*
- *Intensity of continuous assessment*
- *Tend to leave all assessment until the last minute*
- *Not being chased for submission of work*

Their difficulties are in adapting to the University infrastructure and in dealing with assessment.

APPROPRIATE RESPONSES

University teachers need to communicate their expectations more clearly to schools and new entrants and to adapt their practices in year 1 to effect a smoother transition between secondary and tertiary teaching and assessment methods. The STAR project has identified a number of instances of good practice in promoting such a transition.

Information sent out prior to entry influences student attitudes. This can be in the form of workshops to give students better insights into the expectations of Higher Education and improve their decision-making or in better, more accurate, literature. Student mentoring around the time of entry also helps convey the information that incoming students need.

Once on campus students need to adapt rapidly to their changed circumstances since their first summative assessment may be only weeks away.

Extended induction processes tend to achieve three important functions. Firstly they help form rapid social contacts between students and between students and staff. Secondly they can communicate, in an immediate and practical way, the expectations of staff as far as academic standards are concerned. This can be re-assuring for many students who are uncertain about their competence. Thirdly induction can convey some of the excitement in studying a subject in an open and investigative way and reinforce the intrinsic motivation students will need to be independent learners. Other practices which can ease the transition include the modification of assessment schemes to encompass, at least in year 1, some elements of the secondary system such as repeating assignments for better grades, the submission of drafts etc.

Finally it is important that teachers in higher education know and understand the changing nature of the teaching and assessment methods in appropriate pre-entry qualifications as well as the subject content since the student attitudes formed through the seven years of secondary education will far outlast their knowledge of the syllabus.

CONCLUSION

The schools, pupils and the examining boards form a triangle of success. The boards tell the teachers precisely what it is that the pupils should know, the teachers ensure that the pupils know it and the boards then test to see how *well* they know it. This target driven approach is leading to the syllabus and the information produced along with it *becoming* the subject. Many candidates are learning only what they need to know to get a good grade in the examination. The best candidates are as they ever were, - enthusiastic, interested and intrinsically motivated. The poorer candidates are however, able to gain relatively good grades by learning without great understanding, doing without knowing (or asking) why and repeating assessment until successful. They depend on teachers and parents for their motivation.

This appears like a good arrangement; it ensure good outcomes, the students know what they should know and the schools perform well against the performance criteria that they are set. It does not necessarily however, prepare students well for a higher education experience during which they will live independently, many for the first time, and be left to organise their own learning.

Teachers in Higher Education cannot conspire with the candidates to outwit the examiner because the teacher *is* the examiner. What we can do however is to develop transitional arrangements in year 1 which incorporate features of second level teaching and assessment as a means to ease new students into year 2. This will become increasingly important as participation is widened.

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[O21] Distance education in elementary physics without face-to-face sessions: the design of problem-solving and laboratory content for a web-based course

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There is a strong prejudice among physicists, and specialists in other mathematically intensive disciplines, that effective distance education is not feasible in their subject because of the impossibility of teaching 'problem-solving' without strong one-to-one interaction and because of the necessity to conduct meaningful laboratories which require expensive apparatus. For these reasons, it is widely held that some face-to-face sessions are essential. Where students in a course can be truly remote, and travel to a central site is difficult and expensive, issues of fairness arise when some local students have access to instructors and remote students do not. The advent of the versatile and interactive Internet provides a means of addressing these issues. The ubiquity of the personal computer and a fresh approach to simplifying the laboratory exercises addresses the problem of experimental work.

1. A suite of interactive lessons (applets) is being developed at the Universities of Calgary and Alberta (in western Canada) with careful pedagogical design to address basic concepts in Elementary Physics. These highly interactive tutorials mimic a private seminar experience, combining student exploration of a physical principle with instructor 'explanation at the blackboard'.[1]

2. At the University of Guelph we have emphasized the development of teaching tools to assist students in their problem-solving skills. The 'Socratic Problem Solution' (SPS) supports students in individual problem-solving by stepping them through typical multi-path problems. By working through more complex problems that are broken down into small steps, students are helped through the solution process bit by bit. They receive enriched feedback about correct – and incorrect – interim choices to ensure that they are applying the correct principle and accurately solving each step of the larger problem. SPS on-line tutorials have been created for every major concept which is emphasized in this course. The SPS problems are taken from the student's textbook, and keyed to the exact place in the Study Unit where it is relevant. It is important that the developing solution be an example of a students own notebook with an accumulating solution on every 'page'.

3. While some lab experiments, e.g., electricity, have proven intractable without specialist apparatus, several meaningful, quantitative experiments have been designed in mechanics and optics using mostly items found in the normal household. Since the course cannot be taken without a computer connected to the internet, it is included in the list of 'household' items. These 'do-it-yourself labs' contrast with the high-tech use of the computer simulated experiments. Physical

[1] The pedagogical approach might fairly be compared to the activity oriented style of SToMP without the latter's continuous narrative linking one activity with the next.

principles that students find difficult to conceptualize are demonstrated using common objects, turning 'esoteric science' into something they encounter in everyday life.

4. To provide the on-line equivalent of unstructured help sessions, two 'Supported Learning Group' (SLG) sessions are held each week. In these, a student who has successfully taken the course in the previous year convenes and moderates a 'chat-room' group. The student is not expected to be a tutor; he functions as a leader of the group to find their own way through problems which they bring to the session by collectively contributing to the discussion. To help in the visualization of the problem the student facilitator has been supplied with a shared graphical palette.

The clientele of this course is as difficult as any group can be since it is for those entering the University without high school Physics. This lack can be for various reasons but the most common is that the students avoided Physics as being too difficult. On entering university they are confronted with the fact that all students in any science must take Physics so the course is offered in a face-to-face version to about 200 students each Autumn (Sept – Dec) semester. It is only offered as a distance education course in the Winter (Jan – April) semester, so that students who fail in the Autumn, and are granted permission to repeat, also are part of the clientele – about 50%.

Utilizing these four sets of tools and strategies, an award-winning [2] course, offered entirely at a distance, has been constructed which has had considerable success compared with previous 'paper and videotape' versions and whose results in both student persistence and performance rival those of the traditional residential course offerings.

[2] The OPAS (Office for Partnerships and Advanced Skills) Excellence for Teaching with Technology Award (2004).