[O22] Novel pedagogic and IT approaches to the academic assessment of workplace learning

David Lush and Stephen Gomez
Faculty of Applied Sciences
University of the West of England
David.Lush@uwe.ac.uk

Keywords: work-based learning, e-portfolios, sandwich degrees, accreditation of placement learning

INTRODUCTION

Typically, Sandwich degree programmes are four years in duration with the third year spent on an industrial placement; this structure allows the student to gain valuable work experience within his/her subject specialism and to contextualise their knowledge. Although the placement year is promoted to the students as a valuable and integral part of their degree programmes, it may only receive 'notional' credit that serves to differentiate Sandwich students from full-time students and does not contribute towards credit-accumulation needed for the degree itself. In our dealings with applied bioscience students working in industry, research groups or hospitals, the learning they experience is often equivalent to final year degree study and even postgraduate level in research-active placements. Also, we have demonstrated that the placement experience significantly improves degree performance when the students return for their final year of study (Gomez, Lush and Clements, 2004).

One reason why the placement year often receives only notional credit is that the assessment of workplace learning can be problematic when compared to learning at university. When students attend lectures, practicals, seminars and tutorials at university, the academics can largely determine and control the students' learning environment. Academics, because of their experience working in a learning environment and delivering to large cohorts of students, can have a high degree of confidence in the quality and consistency of assessment of the defined learning outcomes for the award of academic credit.

In the workplace, it is more difficult to achieve the same level of confidence due the diversity of placement experience and the physical separation of placements from the university; the extensive involvement of academics during the placement required to address these problems would be logistically complex, time-consuming and not cost-effective if tackled in the traditional way through visits and paper-based assessments and record-keeping. Nevertheless, the high quality learning that does occur on placement suggests that there are benefits to be gained from designing methods that allow the assessment of student workplace learning with sufficient rigour to satisfy academic procedures for the award of academic credit in a cost-effective manner.

We decided to re-visit the assessment of our Sandwich year and approached the credit-rating of workplace learning by going back to basics, namely to those generic criteria that are used by universities for awarding credit for taught modules. We could then see how these criteria could apply to assessing learning in the

workplace. The fundamental criteria include: the setting of learning outcomes; benchmarks for levels of learning; assessment of learning outcomes; notional learning time and credit value. The highly modular nature of our institution's academic structures means that these criteria are applicable across a wide range of scales, from degree programmes to modules to assignments, in almost a fractal manner. We transposed this structural metaphor to workplace learning; in the same way that different degree programmes are defined by sets of self-contained modules which, in turn, are assessed by discrete assignments, so different work placements were described in terms of distinct groups of self-contained 'tasks', each of which was defined with reference to the five fundamental criteria for academic credit. A significant benefit to this approach is that its generic nature makes it suitable for workplace learning in degree programmes in many disciplines, not just science.

For most taught modules, the learning outcomes and assessments are defined and designed by the academic staff involved in delivering those modules. We took an approach to assessing work-based learning whereby it is the student who, through negotiation with the work supervisor and academic tutor, takes the lead role in defining the learning outcomes and producing the evidence used to assess their attainment. This reflects the paradigm shift from the traditional role of the learner as passive recipient to one where the learner takes active responsibility for, and ownership of, the learning objectives.

Potentially, such an individualistic, detailed approach to the assessment of work experience incurs a significant administrative overhead. However, modelling placements in terms of the 'modular' metaphor described earlier makes their detailed description ideally suited to a database solution and, furthermore, implementing systems to manage this detail via the internet has the potential to address the problems caused by the geographical diversity of the placements.

To take advantage of emerging internet technologies we decided to explore the development of a novel electronic-portfolio (e-portfolio) system to deliver this 'modular' approach to the recording and assessment of placement learning. Portfolios are common means for collecting evidence of learning, and e-portfolios have a number of advantages and are increasing in popularity (Gomez, 2004). With funding from HEFCE (Higher Education Funding Council for England) we have produced such a system and are using it to monitor science students on placement.

Each student is given login access to his or her personal, secure e-portfolio within which s/he completes web-forms in order to develop and describe their unique learning agreement, as well as web-forms to define selected work activities in terms of the criteria for academic credit. To support assessment, evidence of learning (in the form of computer files – ege.g. Word documents, spreadsheets, scanned documents, digital pictures, etc) can also be uploaded and 'attached' to the individual web-forms. The work supervisor and academic tutor can also be given access to the student's e-portfolio, both to view the work and also to communicate with the student through an audited messenger system. In this way, each student's progress can be tracked remotely by the tutor and guidance given to the learning process. For their part, the work supervisor electronically 'signs-off' the web-forms as confirmation that the work has been performed by the student and has reached a satisfactory standard.

The system has a number of characteristics that support scalability and flexibility. It features devolved management in that once appointed, administrators can set up their own completely independent areas for their students. Additionally, administrators can mount their own custom web-forms designed to meet their own particular needs; for example, a set of web-forms designed to manage Personal Development Planning would mean the system would deliver that aspect of the student

experience whereas a set of web-forms in the form of questionnaires could be used to collect and collate information required for aspects of Quality Assurance. The system is available to all higher education institutions and for further information visit www.profile.ac.uk or email profile@uwe.ac.uk.

REFERENCES

Gomez S., Lush D. and Clements M. (2004). Work placements enhance the academic performance of bioscience undergraduates. Journal of Vocational Education and Training, 56, 373-385.

Gomez S. (2004). 'Electronic portfolios in higher education'. Higher Education Academy Resources Update, June 2004. Web-publication.

This work is funded through FDTL (Fund for the Development of Teaching and Learning) Phase 4 and a National Teaching Fellowship awarded to SG, both from HEFCE (Higher Education Funding Council for England).

[O23] Assessment of practical skills – 'I do and I learn'

Peter Klappa
Department of Biosciences
University of Kent
P.Klappa@kent.ac.uk

'Learning by doing' is one of the most powerful forms of education, because various senses are involved. There is no doubt that practical classes have a pivotal role in the under-standing of basic concepts in Biosciences and in the employability of students. However, despite the importance of practical classes, the intended learning outcomes, i.e. practical skills, are very often not adequately assessed: The emphasis of the assessment is often placed on the practical write-up and pays only little attention to the manual competency of the student.

We investigated how practical classes can be designed such that an assessment of practical skills and manual competency of Bioscience students is achieved. To this aim we designed and conducted practical classes for under-graduate students such that subject specific and practical skills were developed. Students' manual competency was monitored throughout the course and formally assessed at the end of the module.

To give every student the opportunity to obtain the required practical skills, students worked individually, being supervised at all times by qualified demonstrators. Students received extensive theoretical background knowledge in lectures and workshops prior to the practical classes and also got a brief introduction to the specific laboratory tasks in 'pre-lab' sessions. We noticed a rather wide-spread range of skills, e.g. some students were very able to achieve accurate data while others clearly struggled. After students carried out a specific task, they were asked to produce a short write-up to summarize their results. This write-up, together with a 'comprehension sheet', which linked theory with practice, served as an 'aide memoir'. It was checked and corrected by the demonstrators, but not assessed.

To ensure that students obtained the relevant practical skills, an assessed practical was timetabled and students were informed in advance about the nature of the assessment. In a workshop prior to the assessment a manual for the assessed practical was handed out (see below) and potential problems and methodical errors, as well as health and safety aspects were discussed with the students.

In the assessed practical students repeated one of the previous experiments with sub-sequent marking of their results. For example, students had to produce a standard curve and determine the concentration of a given protein solution. The marking was mainly based on accuracy, but other factors, e.g. safety, following good laboratory practice, etc. were taken into account. Students who were outside a set error margin and therefore failed the assessment were asked to repeat it. In this case, students were shown again how to use the equipment and potential methodical errors were discussed. On average between 6 and 16 % of the students had to resit the practical, but so far no student failed the assessment.

To evaluate the success of this scheme, students were asked about the usefulness of the practical classes and assessments through questionnaires. In general students commented positively on the organisation of the practical classes and their embedding into the lectures. They thought that the aims were

very well achieved and that they now feel more comfortable with the techniques and the equipment.

CONCLUSIONS

From our analysis of the evaluation forms and informal discussion with students we concluded that the project was successful in that it enabled us to assess objectively the manual skills of students. However, we noticed some points that need to be taken into account when this form or assessment is used:

- *Suitability of the practical class* - Assessed practical classes are a powerful tool in the assessment of manual competence, however, not all practical classes are equally suitable for this approach. The learning outcomes of the chosen practical classes, being of numerical nature were comparatively easy to assess. However, a practical class the main learning outcome of which is the cloning of a gene or the identification of a microbiological specimen cannot be easily assessed in the same way. Careful design of the practical classes and their assessment according to the learning outcomes is therefore mandatory.

- *Link between practical classes and theory* – Lectures/workshops and practical classes must be closely interlinked. A careful curriculum design and detailed plan of work is very important.

- *Differential learning* – We observed a widespread range of manual competency. It is therefore important to address this issue and to provide support for weaker students. This can be done by closer supervision of those students or by giving extra help in the use of equipment.

Assessed practical BI301 – Enzymes and Metabolism

The aim of this practical is to determine the specific activity of the enzyme Fumarase.

Pipette 3ml of Phosphate-malate buffer (0.05M) into a silica (quartz) spectrophotometer cuvette (glass or plastic is UV opaque). Place the cuvette in the spectrophotometer (wavelength setting = 250nm) and zero the instrument. Pipette 10 ml of enzyme solution into the cuvette and mix well. Record the changes in extinction every 10 sec over a 60-180 sec period or use the recorder. Calculate the average extinction increment per min arithmetically or from the slope of the graph of E vs time. Convert your rate (extinction/min) to mM/min (extinction coefficient 1450 1.mol-1 cm-1). Repeat the determination three times and calculate an average rate. Calculate the specific activity value (the concentration of fumarase in your stock will be given to you on the day).

Example calculation (your calculation will be different, since you use a different enzyme concentration):

1. Determine the initial rates (the difference in OD/min) using the tangent on the chart recorder printout:
   enzyme (0.010 ml): 0.02 / 15 sec = 0.08/min

2. Calculate the amount of µmoles / litre /min:
   $E = e \times c \times d$
   $0.08 / min = 1450\ mol^{-1}\ cm^{-1}\ l \times c \times 1\ cm$
   $c = 0.08 / 1450\ mol/l\ min$ = 55.2 µmol/l min

3. Production of nmol / min:
   You produce 55.2 µmol/l min, how many moles are in 3 ml?
   55.2 µmol/l min x 0.003 l = 165.5 nmol / min.

4. Specific activity (µmol/ min mg):
   Enzyme concentration is 180 µg / ml and you used 0.01 ml, therefore you have got
   180 µg/ ml x 0.01 ml = 1.8 µg of enzyme,
   which give you a change of 165.5 nmol / min.

The specific activity therefore is:
165.5 nmol / min / 1.8 µg = 0.092 mol / min g (= 92 µmol / min mg).

COSHH Regulations 1988. This instruction sheet has been subjected to a formal risk assessment.
Safety specs and gloves must be worn at all times.

Signed: Date:

[O24] Formative assessment feedback in pharmacology – encouraging engagement

I. P. L. Coleman, A. S. Watts, P. A. Barrow, C. A. Brown and S. I. Anderson
School of Applied Sciences
University of Wolverhampton
IPLColeman@wlv.ac.uk and A.S.Watts@wlv.ac.uk

Keywords: formative assessment feedback, approaches to study, integration of feedback

The study reported in this paper is a pilot case study which is part of a project entitled 'Improving the effectiveness of formative assessment in Science' in receipt of £250,000 from the higher Education Funding council for England whose support is gratefully acknowledged.

ABSTRACT

Formative assessment feedback is viewed as an essential element in student learning (Black and Wiliam, 1998). This type of feedback was integrated into the learning experience of second year pharmacology students with the intention of improving module performance. Student approaches to study and experience of assessment and feedback were evaluated by means of appropriate questionnaires derived from the (FAST project www.open.ac.uk/science/fdtl/). Students responded well to the experience. There was a clear improvement in overall module performance in terms of both pass rate and quality of grades obtained. Responses to approaches to study indicated that although the students were well motivated towards achievement and demonstrated some characteristics of strategic learning they were prepared to learn more deeply as they perceived 'understanding' to be an important part of their learning. They also acknowledged the value of immediate feedback and the importance of applying that feedback to their learning.

INTRODUCTION

Black and Wiliam (1998), Gibbs and Simpson(2003) (http://www.open.ac.uk/science/fdtl/documents/lit-review.pdf) and Glover (2004) (http://www.open.ac.uk/science/fdtl/documents/SHUfinal_report.pdf) indicate the value of formative assessment and feedback on student progression and achievement. They refer to potential barriers to progress including the gulf in perception between academic views and student views of the use of feedback, particularly in support of learning. This pilot study was undertaken to encourage student engagement with feedback from formative assessment by sharing with students an understanding of the process within the two frameworks of Gibbs' 11 conditions under which assessment supports learning and Hughes' conditions for good feedback and applying the process to support learning (Glover 2004). The module selected for this pilot study, a year 2 module, BM2025 'Fundamentals of Pharmacology', introduces students to the impact of drugs on physiological systems. The key intention of the process was to improve student performance on the module by promoting engagement with the learning process. A direct emphasis was placed on provision of feedback for each weekly formative workshop assignment conducted throughout the module.

METHODS

On the first day of the module, evaluation of student approaches to studying was obtained using an Approach to Study Questionnaire (FAST project www.open.ac.uk/science/fdtl/) which employed a standard Likert scale (strongly agree through to strongly disagree). The learning outcomes of the module were explained to students and the students received an explanation of the emphasis that would be placed on the formative feedback of assignments encountered throughout the module and its purpose in enhancing their learning. The module was conducted on the basis of three contact hours per week for thirteen weeks with a further seven hours of self-directed learning per week required of students. Each session (apart from those used for summative assessment) was conducted in the same way. The first part of the session was an explanation of lecture content which was available to students on the University virtual learning environment well in advance of the timetabled session. This was followed by an extensive session based on knowledge and understanding of the week's lecture content. The final session was a plenary feedback session where students self-marked their workshop exercises and received explanations of methods involved and process as well as required answers. In some weeks the feedback was, quite intentionally, not related to a mark scheme, in order to promote the notion of the workshop and feedback session as a learning experience. Feedback material was made available after each session on the virtual learning environment. To reinforce the emphasis of feedback on learning; students were assured that these workshops were not elements of staff judgement and students' results were not solicited. Summative assessment of student learning was achieved by two staged phase tests, one at the mid-point of the module and the other at the end of the module. At each point of assessment students completed Assessment Experience Questionnaires (FAST project www.open.ac.uk/science/fdtl/) in order to evaluate their views of formative feedback.

RESULTS

Based on their responses to the Approaches to Study Questionnaire (Table1) students demonstrated fairly positive attitudes to their study. Each score is the aggregate of a set of questions designed to assess student attitudes in terms of achieving, reproduction and meaning. Each individual question required a response on a standard Likert scale, ranging from strongly agree to strongly disagree. Many of the students on the module are reading for vocational degrees so it is perhaps no surprise that they have a high orientation towards achievement. Indeed there was strongest agreement with the statement 'It is important to me to do really well in the courses here'. Inevitably students perceive a need to reproduce information, however of the three scores this the lowest, as the response to the meaning orientation questions scores (marginally) the highest with strong agreement with the statements 'My main reason for being here is so I can learn more about the subjects which really interest me' and 'I generally put a lot of effort into trying to understand things which initially seem difficult'.

Staff were encouraged by the initial responses received from the Approaches to Study Questionnaire and subsequently found that a majority of students engaged well with the learning experience on the module. Attendance improved from an average of 65% and 55% in the two previous iterations of the module to over 85%. Use of material from the virtual learning environment was also increased with an 80% engagement. Figure 1 reveals markedly improved module performance by the 2004-2005 cohort of students in terms of average module grade. This cohort averages a grade equivalent to a mid 2.2 whilst the previous cohorts posted the equivalent of third class grades. This distinct improvement is further highlighted by the spread of grades achieved by the 2004-2005 cohort with more students gaining A, B and C grades. Fewer students failed the module in comparison to the two previous years (Table 2)

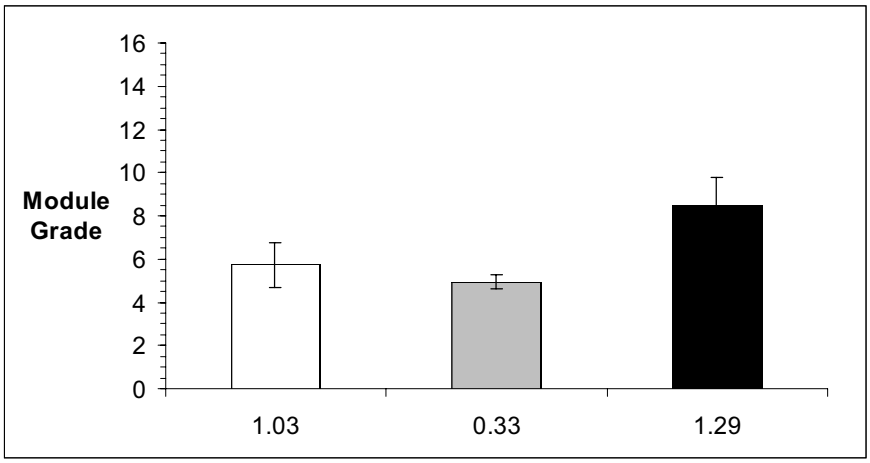
Table 1: Approaches to study questionnaire

	BM2025	National Social Science	National All Subjects
Achieving Orientation: Score out of 24 indicates competitiveness, well organised study methods and hope for success.	17.3	12.7	12.8
Reproducing Orientation: Score out of 24 indicates a surface approach to learning. Students who score high on this scale attempt to memorise and reproduce subject matter and have a desire to accumulate knowledge. They tend to keep narrowly to the syllabus as laid down in the course descriptions and not follow up interests on their own.	15.1	13.7	13.5
Meaning Orientation: Score out of 24 indicates a deep approach to learning, an intention to make sense of the subject, an interest in the subject itself and a desire to learn. Students who score high on this scale follow up their own interests even if outside what is assessed.	17.5	14.2	14.3

and the final results are likely to be improved following resit opportunity later in the year. Whilst cohort comparison from year to year is somewhat equivocal, it should be noted that similar students populate the module each year. It will be useful to compare their performance in this module, set against other modules studied at the end of the second year. Nevertheless, student performance on the module does indicate that encouraging engagement through the medium of formative feedback has been effective in improving student performance.

Students completed an Assessment Experience Questionnaire at two points in the course of the module, immediately after the two summative assessment experiences. The results in Table 3 indicate that there was relatively little difference in student perception between the two different times of completing the questionnaire. In each category relatively high scores are observed, certainly commensurate with those reported by Gibbs, Simpson and Macdonald (2003) for two other institutions. In terms of amount and distribution of study effort, although effort was expended during the weeks of the module students indicated that there was an increase in effort immediately prior to summative assessment with strong agreement with the statement 'In weeks when assignments are due I put in many more hours'. These assignments were perceived by students to be clear and challenging. In a sense this is important as the phase tests experienced by the students are based in style on the format of the workshops that they have been completing each week. The intention was that the summative assessment should reflect the manner of learning and the style of formative assessment encountered through the module. Students recorded strongest agreement with the statement 'Tackling the assignments really makes me think' which was gratifying as staff had designed the assessment to elicit this approach rather than requiring a regurgitated answer.

Figure 1: Module results – mean grade derived from an alphanumeric scale

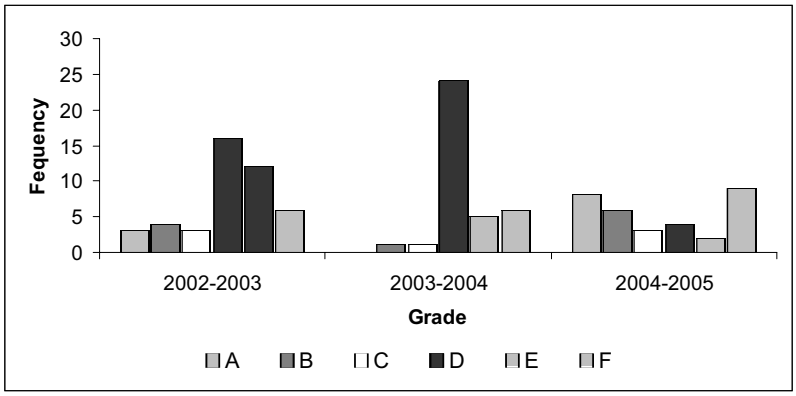


	Mean	SEM	Pass	Fail
2002-2003 (n=44)	5.73	1.03	26	18
2003-2004 (n=37)	4.94	0.33	26	11
2004-2005* (n=32)	8.5	1.29	21	11

*Formative feedback introduced

Footnote: 2002–2003 and 2003–2004 data includes resit retrieval. 2004–2005 resits yet to be taken

Figure 2: Grade distribution of students on the module



Grade Distribution

Year	A	B	C	D	E	F
2002-2003	3	4	3	16	12	6
2003-2004	0	1	1	24	5	6
2004-2005	8	6	3	4	2	9

Table 2: Overall performance of students expressed as number and (percentage)

Year	n	Pass	Fail
2002-2003	44	25 (57%)	19 (43%)
2003-2004	37	17 (46%)	20 (54%)
2004-2005*	32	21 (66%)	11 (34%)

* Formative Feedback introduced

Although a reasonable score is noted for the quality and timing of feedback, students were more uncertain in their responses. Feedback was seen to be immediate and that it provided guidance. Students also agreed strongly with the statement that 'I would learn more if I received more feedback'. In terms of overall quality of feedback, students agreed strongly with the statements 'The feedback helps me to understand things better', 'The feedback shows me how to do better next time' and 'Once I have read the feedback I understand why I got he mark I did'. More importantly for this study the response to questions on what students did with the feedback were gratifying in that they clearly used the feedback to guide their learning. It appeared that students valued the feedback in this context and the fact that it was provided with a strong measure of student independence through the process of self assessment concurs with similar finding by Taras (2003) in a study involving language students. Strong agreement was recorded with the statements 'I read the feedback carefully and try to understand what the feedback is saying', I use the feedback to go over what I have done in the assignment'. The phase test themselves were seen as a positive influence on the quality of learning, students disagreed with the statement 'In the exam you can get away with not understanding and still get good marks'.

In the course of this pilot study, staff have aimed to fulfil Gibbs' (2003) 11 conditions for feedback in that:

1. Assessed tasks capture sufficient study time and effort
2. These tasks distribute student effort evenly across topics and weeks
3. These tasks engage students in productive learning activity
4. Assessment communicates clear and high expectations to students
5. Sufficient feedback is provided, both often enough and in enough detail
6. The feedback is provided quickly enough to be useful to students
7. Feedback focuses on learning rather than on marks or students themselves
8. Feedback is linked to the purpose of the assignment and to criteria
9. Feedback is understandable to students, given their sophistication
10. Feedback is received by students and attended to
11. Feedback is acted upon by students to improve their work or their learning

The module team has altered class practice by moving from a fairly instructivist approach to a more constructivist approach which places the student at the centre of the learning experience and affords them more autonomy. At the same time an attempt has been made to reduce the emphasis on summative assessment though the cohort of students is fairly strategic in its approach in that it does focus on preparation for summative testing. Nevertheless the students clearly recognised that assessment did require deeper learning. Formative self-

Table 3: Student response to the Assessment experience questionnaire

	Week 6 after Phase Test 1	Week 13 after Phase Test 1
1 Amount and distribution of study effort Score out of 30. A high score indicates that students study evenly across weeks and across topics, and feel that they have to in order to do well. A low score indicates that students study effort is allocated narrowly to assessed topics and those weeks where assessment takes place, and feel they can get away with this and still do well.	19.2	19.1
2 Assignments and learning Score out of 30. A high score indicates that students see assignment requirements as clear and challenging, requiring understanding. A low score indicates that assessment demands are perceived as unclear and that assignments are seen as unchallenging and as not requiring understanding.	21.9	24.4
3 Quantity and timing of feedback Score out of 30. A high score indicates that students perceive that they get plenty of feedback fast enough. A low score indicates that students perceive the feedback to be insufficient to support their learning, and too late to be useful.	19.9	22.9
4 Quality of feedback Score out of 35. A high score indicates that students find the feedback understandable and useful, explaining both grades, misunderstandings and how to improve. A low score indicates that the feedback is neither comprehensible nor useful, and only indicates how well the student is doing in relation to others.	21.1	21.7
5 What you do with the feedback Score out of 35. A high score indicates that students use the feedback to guide follow-up learning, to tackle subsequent assignments differently, and to revise. A low score indicates that the feedback has little impact on subsequent studying and learning.	23.5	23.9
6 The examination and learning Score out of 35. A high score indicates that the perceived exam demands had a positive influence on the quality of learning undertaken during the course and during revision and that the exam itself was a learning experience. A low score indicates that the perceived exam demands encouraged memorisation and subsequent forgetting.	22.7	20.9

assessment and noting of the feedback by students was perceived by staff as key to encouraging engagement with the process. Black and Wiliam (1998) clearly state that self assessment is an essential component of formative assessment. During the early part of the module staff took time to explain the process of self assessment and offered guidance to indicate how the feedback related to the assignments. To some extent the process of learning included the formative feedback so that it was not considered as a separate entity, as recommended by Orsmond, Merry and Reiling (2005).

Whilst this pilot study has be effective in achieving its aims, the module team will be reviewing the feedback currently given in order to extend its scope in terms of subject content and, perhaps more significantly its value in feeding forward. The study has served as a pilot for a larger study on a first year module in Human Physiology where an additional element of reflective diaries has been added in order to support the students' engagement on that module with the feedback given.

CONCLUSIONS

The introduction of dedicated formative feedback which was integrated into the students' learning experience has had a positive influence on student performance on the module. More effective engagement with the learning process has been noted and students indicate a positive view of their experience of formative feedback.

REFERENCES

Black, P. and Wiliam, D. (1998) Inside the blackbox: Raising standards through classroom assessment. *Phi Delta Kappan* 80 pp139-148.

Gibbs, G. and Simpson, C. (2003) (http://www.open.ac.uk/science/fdtl/documents/lit-review.pdf)

Gibbs, G., Simpson, C. and Macdonald, R. (2003) EARLI Conference Padova http://www.open.ac.uk/science/fdtl/documents/earli-2003.pdf

Glover, C. (2004) http://www.open.ac.uk/science/fdtl/documents/SHUfinal_report.pdf

Orsmond, P., Merry, S. and Reiling, K. (2005) Biology students' utilisation of tutors' formative feedback: a qualitative interview study *Assessment and Evaluation in Higher Education* 30 pp369-386

Taras, M. (2003) To Feedback or Not to Feedback in Student Self-assessment Assessment and Evaluation in Higher Education 28 pp549-565

[O25] Enhancing the development of experimental design skills in life science undergraduates: the link between confidence and engagement

Jane Mackenzie* and Graeme Ruxton†
*Teaching and Learning Service, University of Glasgow
†Institute of Biological and Life Science, University of Glasgow
j.mackenzie@educ.gla.ac.uk

Keywords: experimental design, small group learning, student engagement

BACKGROUND

Project work is seen as an essential component of most Bioscience degrees and this is perhaps most significantly demonstrated by the level of importance put on the final year project, which often contributes significantly to the student's final mark. Further, the subsequent success and direction of a student's research career does, to some extent, depend on the outcomes and subject area of the final year project. Currently, there is some debate within HE regarding final year projects as a key element of most bioscience degrees evidenced by the existence of a special interest group hosted by the HEA Centre for Bioscience. Concerns include the resourcing of projects, the impact on supervisors' time as well as the value placed upon these projects in terms of final degree mark.

It has been reported that the way students approach projects has a major impact on how supervisors perceive this academic 'chore.' As Ed Wood pointed out at the Making the Most of Final Year Projects event in 2004, 'Poor or poorly motivated students may just be throwing expensive chemicals down the sink' (Wood (2004)). We feel it is fair to conclude that not all students are wholly prepared, at this stage in their career, to engage with independent project work and therefore, there are currently gaps in supporting the acquisition of the skills necessary for successful experimental project work in many bioscience programmes. These skills include the ability to design, plan, conduct and critically analyse experimental investigations and projects. These skills are not only essential for the successful biology graduate but are also, central to the practice of research biologists and therefore should be developed in our degree programmes (Lederberg (1995)).

Most bioscience degree programmes do contain elements designed to develop students' experimental design and data analysis skills. Often these consist of lecture courses introducing elements of experimental design (e.g. the use of controls and appropriate sampling) and data analysis (with an emphasis on statistical analysis). However, most bioscience programmes offer students little opportunity to design and criticise experiments in a low risk setting, i.e. the vast majority of their practical work experience will be participating in controlled exercises and highly structured investigations (Hazel and Baillie (1998)) with little opportunity to truly 'experiment' prior to the final year project itself. In an attempt to address this gap, the Zoology/Aquatic Biology degree programmes at the University of Glasgow piloted a new course component in the 2003/04 session designed to aid the development of the skills necessary for effective project work in its students.

PILOTING OF THE EXPERIMENTAL DESIGN SESSIONS

3rd year students (of a 4 year Honours programme) participated in a series of facilitated discussions. The sessions were supported by a recently published book on experimental design for biologists (Ruxton and Colegrave (2003)) and a specially designed series of supporting questions and experimental design problems. The sessions took place early in the first semester and were delivered to groups of ~ 15 students; within these sessions the students worked in smaller groups to design experiments to answer a number of 'real-life' research questions. An example of these mini-projects is shown in Box 1.

Box 1. Sample mini-project in the Experimental Design Sessions

Devise a scheme for categorising a person's hair colour. Your scheme must give fine-detailed information but have very low levels of inter-observer variability. Demonstrate the effectiveness of your scheme by presenting data collected independently by several group members on a sample of people passing this building.

Throughout the academic year these same students had a number of opportunities to test and be assessed on their experimental design skills. The last of these is a short-term lab or field-based group project, the 'Insect Project.' As part of the Invertebrate Biology component of the course, the students choose from a range of topics on aspects of invertebrate biology. The projects are supported by a series of lectures on invertebrate taxonomy, anatomy and physiology. Students work intensively for 3 weeks in groups of 2 or 3 to design and carry out experiments to address a research question or questions. The projects are assessed by means of a group presentation and have been running with few alterations for over a decade. In the past, the success of the Insect Projects has been highly variable with some student groups engaging successfully and running the projects in a fairly independent manner; other groups have been less successful, requiring a great deal of input and guidance from the supervisor.

EVALUATION OF THE EXPERIMENTAL DESIGN SESSIONS

The effectiveness of the use of small group discussions to teach experimental design skills was (and is being) evaluated using a number of methods. First, a detailed questionnaire was used to obtain feedback from students at the end of the series of discussions. Analysis of this questionnaire, completed by participating students (52 students), indicated that over 90% of them believed they would be better at designing their own experiments after the sessions than before and 88% believed they were more able to criticise the design of others' experiments. In addition 80% of the respondents believed that this method of learning was effective and preferable to a lecture format.

Later, four of the six Insect Project supervisors were interviewed, using semi-structured interviews, after completion of the projects and presentations. These supervisors were chosen because of their long-term involvement with the projects, a minimum of 5 years. The interviews were designed to gauge their overall perceptions of their students' performance. The interviews were recorded, transcribed and analysed. The main findings from this analysis were that the supervisors were unanimous in believing that the majority of students engaged more successfully with the projects, required less direct guidance and supervision and that the outcomes of the projects were more successful than in previous years. These comments were reflected in considerably higher marks for this part of assessment than in previous years. Some of the comments from these interviews are shown in Box 2.

Box 2. Insect Project supervisors' comments in interview

Students engaged more effectively with the projects

'they were very focused and "let's get proper samples" so that we can really answer the question'
'I mean they were all motivated'
'they were . . . showing evidence of thinking about what they were doing quite deeply, which I don't think I'd seen before'
'there was evidence of a greater understanding of what an experiment is'

Students required less direct supervision

'*They were pretty well self-sustaining and they were critical of the data'*
'I was incredibly impressed at how they just went away and did the thing, and did a very good job'
'significantly less [supervision] than in the past, and they did significantly better'

Students conducted the projects more successfully than any previous cohort.

'I'm more encouraged about the way that things went this year than I've ever been'
'I thought this is the best year we've had for the quality of the science'

We will complete our evaluation of the outcomes of the pilot experimental design sessions by gathering data of student performance in their final year. For those students continuing to 4th year, a major part of their assessment, the honours research project along with the experimental design and data analysis paper of the final degree exam, will also draw on the skills learned in the discussion sessions. We will gather this data and correlate it with their level of attendance at the sessions. We will then compare this with the students' relative performance in components of their assessments not directly supported by the experimental design sessions.

REFINEMENTS OF THE EXPERIMENTAL DESIGN SESSIONS

A number of the Experimental Design sessions were observed by one of the authors (JM) and based on her observation and the reflection of one of the facilitators (GR) a number of refinements to the design of these sessions have been made for the current session.

These are:

- Room layout – the use of small group tables as opposed to a boardroom format
- Formal assignment of student to sub-groups for the duration of the discussion sessions
- Reduction of the number of sessions from 6 to 5, with sessions lasting 90 minutes instead of 60
- Inclusion in each session of at least one practical task where students work in small groups of 3-4 to design and perform an experiment, feeding back their experiences to the larger group. This is to allow the students to experience putting an experiment they've designed into practice. It will involve the students leaving the building in which the sessions take place to gather some data through on-the-spot interviews or observations/ classifications.

We are currently repeating the session evaluations performed in the pilot year in light of the alterations made to the format.

DISCUSSION AND FUTURE WORK

For us, the most surprising outcome of this pilot was the increased levels of student engagement and confidence as evidenced by the supervisors' comments. It is well known that for students to be successfully motivated they need 'to find challenge, stimulation, satisfaction and meaning in the work they do' (Seifert (2004)) and it has long been recognised that experimental project work where students have a level of autonomy is highly motivational and that there is an additional level of engagement if the student attains a sense of ownership of their work (Bliss and Ogborn (1977)). Students report that project work is one of the most enjoyable elements of their degree programme (Boud et al. (1986)). This does not explain why, in the pilot session, the Insect Project supervisors reported a greater degree of enthusiasm and engagement in their students than in previous years.

It has been suggested that 'students cannot conduct meaningful enquiries in areas in which they have no background'; courses should offer opportunities for students to learn the necessary skills (both conceptual and practical) to undertake project work effectively (Boud et al. (1986)) Many courses, especially at honours level, do teach experimental design including essential concepts like hypothesis generation, the use of appropriate sample sizes and controls. These rarely offer students the opportunity to practice these skills and concepts prior to an exam or piece of assessed project work.

Learning in small groups develops students' confidence and communication skills (Griffiths et al. (1996)) and we believe that the structured discussions piloted last year are an effective way, possibly the first the students have experienced, of allowing the students to practice their design skills, in a 'low risk' (i.e.unassessed) setting with immediate feedback whilst simultaneously allowing them to practice the 'group' skills which will be utilised later in the year. So we propose that one contributing factor to the reported improvement in performance in this project work was the additional support the students received through participating in the experimental design sessions. It is well known that confidence or self-belief (self-worth) is highly linked with performance (Covington (1984)) and we feel that the opportunity to practice designing experiments in the discussion sessions will have allowed most students to engage with their projects with a higher than previous level of confidence

We do not believe this was the only factor which influenced the outcome of last year's Insect Projects. Successful, independent project work cannot be achieved by students adopting a surface approach to learning. We believe that there are elements of the Insect Projects as they operated last year that encouraged a deep or at least strategic approach to learning (Biggs (1987); Entwistle (1997)) and that the perceived improvement in student performance last year was not wholly due to the fact that students were better equipped to design experiments.

We are therefore extending our study to examine the factors that motivated students to become more actively engaged with these projects than previous cohorts of students. In addition to the impact of the experimental design discussion classes, factors we will examine will include the timing of the projects, the impact of the implicit value placed on project work/experimental design by placing a formal teaching element into the 3rd year curriculum and the levels of student confidence. By identifying the elements of the projects which contribute to the students adopting such approaches it is hoped that such factors will be maximised in the presentation of the projects in future years and

may be used and applied to other elements of the curriculum. These factors will be examined by conducting semi-structured interviews with a panel of this current 3rd year students (15-20), shortly after the conclusion of their Insect Projects and presentations.

CONCLUSIONS

We have developed and evaluated a novel teaching resource in the form of a series of structured questions and 'real-life' mini-projects supported by interactive discussion sessions. We have shown that these resources have apparently equipped 3rd year students to engage more successfully with small group projects and would envisage that this will also be reflected in their performance in their final year projects. We believe these teaching resources could be applied and adapted to other Bioscience degree programmes. However, more crucially, the identification of factors that influence student engagement, and thus success, in project-based learning tasks within the biosciences might have serious ramifications for the way that project work and perhaps in particular, the Final Year project is presented and supported at present in most universities.

REFERENCES

Biggs, J. (1987) *Student approaches to learning and studying*. Hawthorn, Victoria: Australian Council for Educational Research

Bliss, J. and Ogborn, J. (1977) *Student Reactions to Undergraduate Science*. London: Heinemann

Boud, D., Dunn, J., and Hegarty-Hazel, E. (1986) *Teaching in Laboratories*. Milton Keynes: The Society for Research into Higher Education

Covington, M. (1984). *The self-worth theory of achievement motivation: findings and implications*. Elementary School Journal 85, 5-20.

Entwistle, N. (1997). Contrasting perspectives on learning. In: Marton, F., Hounsell, D., and Entwistle, J. (EDS.), *The Experience of Learning: Implications for Teaching and Studying in Higher Education*. Scottish Academic Press, Edinburgh, pp. 3-22.

Griffiths, S., Houston, K., and Lazenbatt, A. (1996) *Enhancing student learning through peer tutoring in Higher Education*. Coleraine: University of Ulster

Hazel, E. and Baillie, C. (1998) *Improving Teaching and Learning in Laboratories*. Milperra: Higher Education Research and Development Society of Australasia

Lederberg, J. (1995). *Sloppy research extracts a greater toll than misconduct*. The Scientist 20, 13.

Ruxton, G. D. and Colegrave, N. (2003) *Experimental design for the life sciences*. Oxford: Oxford University Press

Seifert, T. L. (2004). *Understanding student motivation*. Higher Education 46, 137-149.

Wood, E. (2004) *Why offer final year projects*. Higher Education Academy Centre for Bioscience Conference - Making the Most of Final Year Projects: ftp://bio.ltsn.ac.uk/events/cardiff/wood_files/frame.htm