Development of methods for the improvement of performance and retention of postgraduate students.

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Introduction

A problem had been identified with the intake of postgraduate students to MSc courses in SAS. The students became increasingly diverse in terms of origin and previous learning experiences. This presents challenges in terms of what can be expected in generic learning skills and methods, and also subject specific knowledge (genetics in our case). This has led to problems for students during their first semester as they adapt to the new learning requirements, resulting in poor performance. Therefore the team proposed to develop a project which assesses students' basic genetic knowledge, generic scientific skills and learning skills before they start on the course by using formative assessment exercises that give intuitive feedback. We would then follow this up by giving students learning tasks based on their demonstrated knowledge of the subject and learning skills.

Literature Review

Upon commencement of this project it became apparent that two topics needed to be addressed, these being, firstly, the general format of the introduction and questions coupled with feedback of the assessment, and, secondly, the mode of delivery of the test and recommendations for the student. Given the importance of assessment it is not unsurprising that there is considerable literature available on this topic. A substantial piece of work by Black and Williams (1998) demonstrated that feedback produced positive benefits on learning and achievement at all levels of education. Torrance and Pryor (1999) have also confirmed that good formative assessment can make a considerable difference to the quality of learning.

Due to the nature of science education we (within the University of Wolverhampton, and at other institutions, Gibbs and Simpson, 2004) carry out a considerable number of formative assessments, especially in the form of practical write ups. However, these are very often summative at the same time with grades being assigned to the work. This is especially the case at Masters Level. Assignments that are purely formative in nature are rare within the Forensics and Molecular Biology group (SAS) at undergraduate level and almost non existent at postgraduate level. The reasons for this being the case at Masters level maybe due to the concept that the students are well developed before they arrived, and the 1 year nature of the course leading to strict time constraints.

Formative assessment can be defined as a task which is intended to inform students about how to do better (Knight, 2001). Considering the importance of formative assessment it is perhaps surprising that in universities in general we are seeing a decline in formative assessment. Resource constraints are the main factor leading to a reduction in the quantity, quality and timeliness of feedback (Gibbs and Simpson, 2004). Within the Forensic Science and Molecular Biology group these constraints are also being experienced. This has recently been exacerbated at MSc level by growth of the number of students on MSc Microbiology and Biotechnology and MSc Bioinformatics and Molecular Genetics. Cohorts combined on these degrees have normally been between 10-20 students. At present the combined cohort size is 35. Traditionally these courses have attracted students which are UK based. In the last few years we have seen a large increase in the number of overseas students (see results section), such that the vast majority of MSc students are overseas in origin. We have found that this has raised a number of concerns for us beyond the obvious concerns over levels of English ability. The diversity of students means that far more guidance is likely to be required (Gibbs and Simpson, 2004).

We have identified that the background of these students is highly varied such that some students' genetics subject specific skills are lacking for MSc modules. Additionally for some students the learning styles they have experienced have been very proscriptive. This means the students are not adept at identifying weaknesses in themselves and taking independent action to correct it. Sadler (1989) has argued that often teachers give feedback information on how their performance compares to the required level, but often fails to facilitate the means of bridging the knowledge gap. We therefore proposed to develop a formative assessment that identified their weaknesses and also provided them with strategies to make up their knowledge which was suitable to the individual student. Hence a review of the current literature on good practice in education and formative assessment was made

In 1987 the American Association for Higher Education published the Seven Principles for Good Practice in Undergraduate Education, which is a good starting point for the development of any educational package. Given that we wish to develop this as a computer based assessment it would be important to put the seven principles into an ICT context. An analysis of the implementation of the seven principles using technology was performed by Chickering and Ehrmann (1996). They stated the seven principles as:

1. Good practice encourages contacts between students and faculty
2. Good practice develops reciprocity and cooperation among students
3. Good practice uses active learning techniques
4. Good practice give prompt feedback
5. Good practice emphasises time on task
6. Good practice communicates high expectations
7. Good practice respects diverse talents and ways of learning

An initial concern was that putting in place a computer based assessment would directly counter the first principle, however, Chickering and Ehrmann (1996) have argued this not to be the case. Putting in place a "distant" non-supervised test can strengthen interactions between students. This may be especially important in newly arrived overseas students who may be reluctant to engage the lecturer directly. An enlightening quote concerned with the third principle is "Learning is not a spectator sport" (Chickering and Ehrmann, 1996). However, the impression we receive from a number of overseas students is this is precisely how they view higher education. Any task and technologies which can get the students to become more interactive with the learning process is to be encouraged.

One particular constraint we find with MSc students is that of time. With undergraduates we have the luxury of three years in which to guide them. It is therefore especially important to develop a system that takes note of principle four. Given the constraints on human resources computer based systems are ideal to ensure this principle. This formative assessment will also help to emphasize the principle of high expectations as it immediately gives the students an idea of what knowledge is required and gives them mechanism by which they can achieve that knowledge.

Juwah *et al.* (2004) undertook to develop a resource for educators who wished to improve their feedback to students. In this they developed seven principles of good feedback practice. To distinguish these from the seven principles outlined above they will be referred to as the seven principles of feedback as opposed to the seven principles of good practice.

1. Facilitates the development of self assessment (reflection in learning).

Generally the students we have for MSc are hard working and committed to their studies and often a high financial commitment has been made by them to study here. Since they have already passed a degree there can be a general perception amongst them they are prepared for an MSc, but often they do not realise how little they do in fact know. We view this assessment as an ideal opportunity to get the students to reflect on themselves so they can determine any weaknesses in their knowledge.

2. Encourages teacher and peer dialogue around learning

As outlined in principle one above this format of assessment may well encourage peer interaction. However if used incorrectly it may distance students from lecturers. If no monitoring of action is undertaken they may be a negative reinforcement of expectations. Hence it is important that a system of communicating results and problems to the lecturer is developed. This could be further reinforced by additional formative tests.

3. Helps clarify what good performance are (goals, criteria, and expected standard).

An essential factor of feedback is that the student understands the expected standard they should be achieving. Slater (2005) states that if learners only receive a single mark for a piece of work, however good or bad that mark may be, the learner is unaware what aspects of the work were strong or weak. Yet Juwah *et al*. (2004) emphasises that some forms and words of feedback may be difficult to understand. These points must be taken into consideration when designing any forms of feedback.

4. Provides opportunities to close the gap between current and desired performance.

Providing opportunities for the student improve their knowledge is perhaps one of the most time consuming aspects of a formative assessment. Hence development of a computer based feedback is envisioned to be the ideal route for this test. But as Yorke (2003) outlines it is important that feedback leads to changes in student behaviour. Therefore as system whereby the lecturer can monitor action taken by the student is essential.

5. Delivers high quality information to students about their learning.

Good quality external feedback is defined as information that helps students close the gap between intent and effect (Juwah *et al*., 2004). To this extent it was felt that a variety of types of advice was given to the students which were suited to there learning style. However, students might also receive too much feedback, making it difficult for them to decide which one to use, or using too many but lacking in depth on any one. Thus the system should hopefully be able to adapt itself to only give the advice that the student will find helpful.

6. Encourages positive motivational beliefs and self-esteem

It is essential that any form of formative assessment provides a positive learning experience for the student. Research has shown that external feedback can have a positive or negative effect on motivational behaviour and self-esteem. Harlen and Crick (2003) have recorded that assessments where marks or grades are given can lower motivation to learn. Also this type of feedback has been shown to have especially negative effects on the self esteem of low ability students (Craven *et al.*, 1991). As outlined previously in point three, the majority of the students are oversees and may find mathematical descriptions of there level of achievement easier to grasp than more descriptive terms.

7. Provides information to teachers that can be used to help shape the teaching.

As outlined in principle two, the system must encourage teacher student dialogue to enable the student, but good feedback practice must also provide good information to lecturers. To enable good reflection on the performance of any formative assessment it is essential that good data is obtained about how the students are progressing. Also the correlation of student activity to final performance is required to determine the success of an activity.

A formative assessment that is required to fulfil the points outlined above, yet not be overly burdensome for staff should ideally be information communication technology based (ICT). Perhaps surprisingly this sort of assessment is still a minority (Gipps, 2003). Bull (1999) found that computer assisted assessment (CAA) was mostly used for large first year classes. This is still the case, with very little information being found on the use of CAA at postgraduate level. Gipps (2003) asked the question why would we want to introduce ICT based assessment. She developed three reasons:

1. To avoid disjunction between teaching and assessment modes where e-based learning is employed
2. To save staff time
3. To enable formative assessment

As has already been detailed some of the main reason for envisaging this concept was to enable points two and three. But the first point that Gipps makes has especial relevance to this MSc. A number of the modules especially where the students are studying Bioinformatics are predominately based on e-learning systems.

Wolverhampton Online Learning Framework (WOLF), the Universities VLE, provides a platform for e-based learning to prosper and through which Bioinformatics modules produce interactive course content. The courses make use of the different inbuilt tools that WOLF provides, including the collaborative and formative assessment tools, to facilitate the learning of the module material. The University has a site licence for the use of QuestionMark Perception for summative assessment purposes. The program allows for the flexible production of a large range of assessment tasks and is used in 5-10% of University modules. The University also promotes innovative practice in the development of e-learning systems and, as such, benefits from a range of unique and varied solutions to the issues faced in online learning.

Actions/Results

A review of the students currently on the module AB4010 Genes and Genomes was undertaken. 32 students were registered on e vision for the module. This is a Semester 1 module. The students were asked the country where they studied their undergraduate degree and what was the title of their degree.
The place of study of the students is as follows:
22 responded to questions
3 University of Wolverhampton
16 India
2 Nigeria
1 Ghana

The types of degree studied can be broadly classified as follows

Genetics/Biochemistry	3
Biotechnology	8
Biology/Botany/Zoology	7
Microbiology	2
Others	2

A formative assessment to determine the genetic knowledge of students was developed (see appendix 1). To determine the discriminatory nature of the test it was initially trialled on a number of students of known ability.

Student Descriptor	Result
First Class in Genetics and Molecular Biology. Presently studying MSc	88%
Lower Second in Genetics and Molecular Biology	64%
Lower Second in Genetics and Molecular Biology	64%
Lower Second in Biological Science	52%
Third Year Forensic student (B average)	51%
Second year forensic student (A/B average)	43%
Second year forensic student (A/B average)	47%

From this the following guidance was constructed as to what action the students should take.

>80%- An Excellent Score, well done. We look forward to some excellent marks from you

60-80%- Well done you have passed well and your background knowledge will stand you in good stead for this module.

40-60% Well done you have passed this test. You may want to refresh some of your genetic knowledge from a general text book. If you are unsure where you went wrong e-mail me for an appointment and I will try to help you out.

< 40% You did not do well in this test. Your basic genetic knowledge is not sufficient for this module. You must e-mail me immediately so I can point you to the Chapters of books you need to read. If you do not contact me you may fail this module

Conclusions and future developments

The results of the survey of students on AB4010 Genes and Genomes (which is representative of other modules on the MScs) confirms that we are now teaching to a highly diverse group of students. This means their previous experience in terms of teaching styles and subject specific knowledge is varied. This therefore confirms the need for the sort of formative assessment we have outlined. This will form the basis of a phase two application for CELT funding. We have been able to develop an initial formative assessment. This obviously needs some refinement and again would form part of a phase two application for CELT funding.

The information obtained from the literature review will prove extremely useful in developing an introductory statement, formative questions and subject specific feedback. It has also highlighted the problems that this mode of delivery can bring. One particular problem was that there was no university wide method of producing formative assessment exercises that recorded student marks. In order to overcome this issue, the team created an assessment exercise that was able to record student interactions using Macromedia Flash™, Macromedia Dreamweaver™ and Microsoft Access™. Further developments using this system are not possible as an original member of the team, Matt Hammerton, has left the University. It is now planned to base the assessments on the new version of WOLF.

During this investigation it became apparent that generic and intangible skills need to be assessed. This has particularly been highlighted as a problem for Bioinformatics students (Hack and Kendall, 2005). Further reading addressing this problem is currently being undertaken and will be ready for implementation in phase two of the bid.

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Appendix 1

Formative assessment to determine current level of DNA and molecular biology knowledge.

Answer the questions below

1/ If 16% of the bases found in an organism's DNA are made up of adenine , what percentage of cytosine will be found in that DNA?
1. 16
2. 24
3. 30
4. 34
5. 40.

2/ Which base is usually only found in **RNA** molecules?
1. adenine
2. uracil
3. thymine
4. guanine
5. cytosine.

3/ What is the most common helical form of DNA?
1. A form
2. B form
3. C form
4. Y form
5. Z form.

4/ Which is the main enzyme used for the **replication** of DNA in *E.coli* ?
1. DNA ligase
2. RNA polymerase
3. DNA polymerase I
4. DNA polymerase II
5. DNA polymerase III.

5/ Between what size ranges should plasmids be, when used as vectors?

1. 1-1,000 base pairs
2. 100-1,000 base pairs
3. 100-10,000 base pairs
4. 1,000-10,000 base pairs
5. 1,000-100,000 base pairs
6. 10,000-100,000 base pairs

6/ Which of the following features makes a good plasmid vector for transformation?

A. Contains an origin of replication. B. High copy number
C. Contains antibiotic resistance genes D. Contains restriction enzyme sites.

1. A and D
2. A, B and D
3. B and C
4. B, C and D
5. C and D
6. All of them

7/Which of the following restriction digests (RE = restriction enzyme) would produce compatible ends with each other?

R.E. 1	G⇩GATC C C CTAG⇧G	R.E. 2	A⇩GATC T T CTAG⇧A
R.E 3	G⇩AATT C C TTAA⇧G	R.E. 4	A⇩CGCG T T GCGC⇧A

1. RE 1 and RE 2
2. RE 1 and RE 3
3. RE 1 and RE 4
4. RE 2 and RE 4
5. RE 3 and RE 4
6. All of them

8/ Which enzyme is used to join up fragments of DNA when performing cloning experiments?

1. DNA joinase
2. Primase
3. *Eco*RI
4. DNA sealase
5. DNA polymerase
6. DNA ligase

9/ A woman with normal health carrying a recessive allele for haemophilia wishes to have children with her partner who also has normal health .If the gene for haemophilia is carried on the X chromosome what is the probability that any one **male** child will suffer from this condition ?

1. 100% 2. 75% 3. 50% 4. 25% 5. 10% 6. 0%.

10/ In the same case discussed in question 3/ what is the probability that any **female** child will be a **carrier** of haemophilia?

1. 100% 2. 75% 3. 50% 4. 25% 5. 10% 6. 0%.

11/ In *Drosophila,* sepia coloured eyes are due to an autosomal recessive allele. If sepia eyed females are crossed to homozygous wild type males, what phenotypic proportion of sepia eyed flies would be expected in a backcross of F_1 males to sepia eyed parental females?

1. 100% 2. 75% 3. 50% 4. 25% 5. 10% 6. 0%.

12/ The classic dihybrid ratio (no epistasis or linkage between the two genes), shown for example by Mendel when he allowed pea plants heterozygous for both round and yellow seed characters to self pollinate, is :

1. 3:1 2. 1:2:1 3. 9:3:4 4. 9:3:3:1 5. 15:1

13/ In such a classic dihybrid cross as in Q12/ what proportion of progeny will show the double dominant **phenotype** (round , yellow) if plants of **genotype RrYy** are allowed to self – pollinate ?

1. 1/16 2. 3/16 3. 9/16 4. 1/8 5. 4/16

Choose the most appropriate answer from the list below (1-8) of types of DNA molecule and match each to the description.

1. A
2. B
3. Z
4. Open circular
5. Covalently closed circular
6. Supercoiled
7. Oligonucleotide
8. Concatamer

Q14/ Rotates left handed with 12 base pairs per turn. 3

Q15/ Produced by nicking <u>one</u> strand of a double stranded plasmid. 4

Q16/ Continuous lengths of lambda genomes formed by rolling circle replication . 8

.Choose the most appropriate answer for the descriptions of enzyme activity from the list below.

1. SSB protein
2. Primase
3. RNA polymerase
4. DNA ligase
5. DNA polymerase I
6. rep protein
7. DNA helicase
8. DNA polymerase III
9. telomerase

Q17/ Produces Okazaki fragments. 8

Q18/ Transcribes DNA into mRNA. 3

Q19/ Fills gaps between Okazaki fragment precursors. 5

Q/ Consider the following cloning vectors and assign the most appropriate response to the following questions.

1. Plasmid pBR322
2. Lambda bacteriophage
3. Plasmid pUC18
4. Yeast artificial chromosome pYAC1
5. Cosmid pCAP2
6. Bluescript M13

Q20/ The vector with the greatest cloning capacity. 4

Q21/ A vector with a single stranded form ideal for DNA sequencing. 6

Use this table to answer the following questions

Second position

First position 5' end	U	C	A	G	Third position - 3' end
U	UUU=Phe UUC=Phe UUA=Leu UUG=Leu	UCU=Ser UCC=Ser UCA=Ser UCG=Ser	UAU=Tyr UAC=Tyr **UAA**=Stop **UAG**=Stop	UGU=Cys UGC=Cys **UGA**=Stop UGG=Trp	U C A G
C	CUU=Leu CUC=Leu CUA=Leu CUG=Leu	CCU=Pro CCC=Pro CCA=Pro CCG=Pro	CAU=His CAC=His CAA=Gin CAG=Gin	CGU=Arg CGC=Arg CGA=Arg CGG=Arg	U C A G
A	AUU=lle AUC=lle AUA=lle **AUG**=Met	ACU=Thr ACC=Thr ACA=Thr ACG=Thr	AAU=Asn AAC=Asn AAA=Lys AAG=Lys	AGU=Ser AGC=Ser AGA=Arg AGG=Arg	U C A G
G	GUU=Val GUC=Val GUA=Val GUG=Val	GCU=Ala GCC=Ala GCA=Ala GCG=Ala	GAU=Asp GAC=Asp GAA=Glu GAG=Glu	GGU=Gly GGC=Gly GGA=Gly GGG=Gly	U C A G

Ala = Alanine	Arg = Arginine	Asn = Asparagine	Asp = Aspartic acid
Cys = Cysteine	Glu = Glutamic acid	Gln = Glutamine	Gly = Glycine
His = Histidine	Ile = Isoleucine	Leu = Leucine	Lys = Lysine
Met = Methionine	Phe = Phenylalanine	Pro = Proline	Ser = Serine
Thr = Threonine	Trp = Tryptophan	Tyr = Tyrosine	Val = Valine

Q22 If the coding strand of a piece of DNA is
5’ ATGCCGAATGGAGTAACA 3’
What is the sequence of amino acids it codes for

1. arg leu his cys gly pro
2. met his arg asn gly ile
3. met pro asn gly val thr
4 asn met phe tyr ser val

Q23. Using the Genetic Code provided, deduce the amino acid sequences of the polypeptides produced in an *in vitro* protein-synthesising system under the direction of the artificial mRNAs whose sequences are defined below. Assume the first base shown in each sequence is the first base of the first codon.

a) A U A U A U A U A U A U ....

b) G A U G A U G A U G A U ....

c) U A A U A A U A A U A A ....

1. a) poly(thr-ile) b) poly(leu) c) poly(ile)
2. a) poly(ile-tyr) b) poly(asp) c) none
3. a) poly(ile-thr) b) poly(leu) c) poly(ile)
4. a) poly(ile-thr) b) poly(asp) c) poly(ile)
5. a) poly(thr-ile) b) poly(asp) c) none

Q 24 Which of the following is the most accurate description of an intron

1. A region of RNA which acts like a transposon
2. A region of DNA which is found in a gene which codes for protein
3. A region of DNA which controls whether a gene is switched on or off (expressed or not expressed)
4. A region of DNA which is found in a gene which codes for "junk" and is removed during mRNA processing
5. A region of RNA which interferes with the process of transcription and translation

Q 25 Which of the following is the most accurate description of a promoter

1. A region of RNA which acts like a transposon
2. A region of DNA which is found in a gene which codes for protein
3. A region of DNA which controls whether a gene is switched on or off (expressed or not expressed)
4. A region of DNA which is found in a gene which codes for "junk" and is removed during mRNA processing
5. A region of RNA which interferes with the process of transcription and translation