LEARNING SUPPORT FOR MATURE, PART-TIME, EVENING STUDENTS: PROVIDING FEEDBACK VIA FREQUENT, COMPUTER-BASED ASSESSMENTS

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Abstract

A new module in our first year Biology curriculum was used as a vehicle to test strategies for improving learning support. To this end, we have administered frequent CBA, incorporating extensive feedback, both to pace the students' study efforts and to pinpoint areas in which additional help from lecturers may be required. Three of the 7 CBA provided through the 15-week course were initially given as open-book summative tests, thus contributing to the overall mark for the module. Other CBA were formative: these included repeats of the summative CBA made available for revision purposes, as well as other CBA which focused mainly on aspects of the course that were summatively assessed by other means. A closed-book final exam, also computer-based, was given in the final week as a comprehensive assessment. We have evaluated the utility and effectiveness of our approach by surveying student opinion via questionnaires, examining patterns and extent of student use of formative assessments, and by analysing grades for the summative CBA. We have found the students' perceptions of the approach to be largely positive and that the formative CBA were well-used, especially as revision aids for the final exam. Our analysis further indicates that the style of the assessments may have been especially helpful to students whose first language is not English.

Keywords

Assessment, feedback, mature students, part-time students, TRIADS, WebCT

Introduction

Our institution's primary teaching mission is to provide degree programmes for a very specific audience: adult learners, in full-time employment during the day, who wish to pursue a degree by part-time study in the evening. Unlike some other

institutions that cater to this group, our provision is largely face-to-face, with classes meeting weekly within a traditional academic calendar (i.e. 3 terms, 11 weeks each). Students attend 2 or 3 classes per week, each of up to 3 hours duration. It normally takes not less than 4 years of such a regime to complete an undergraduate degree.

Given the severe time pressures faced by students pursuing their degrees in this way, it is not possible for us to provide timetabled, formal academic tutorials, a practice which in other contexts would be the method of choice for providing feedback and targeted learning support. Because of this limitation, we continually seek strategies to support and enhance our face-to-face teaching without placing undue time demands on our students or our academic staff. The potential benefits of communications technology / computer-based methods (email, discussion boards, online questionnaires, etc.) in this regard are well known (see Collis, 1999).

We see computer-based methods as a supplement to — not a substitute for — our face-to-face mode of teaching. For several years, we have been steadily increasing our use of computer-based methods to support student learning, employing mainly email and WWW technologies (on their own and/or within a VLE). More recently, we have begun to develop CAA-based approaches, primarily as tools to enhance learning through provision of feedback.

Here we describe an ongoing project within an undergraduate module in biology that has used a variety of computer-based tutorial materials and frequent CBA to provide learning support. The CBA approach enabled us to provide feedback to learners that was both timely (in some cases immediate) and targeted directly to particular learning deficits. A mix of summative CBA and formative CBA was employed, with open-book summative tests at logical points through the term to pace the students' work rate, ensure participation, and provide encouragement. A closed-book CBA "final exam" served to motivate students to make use of formative CBA for revision. As a side-benefit, the frequent use of computer-based materials promoted development of generic computer fluency essential for further progression in the degree programme.

Student Profile

Sixty-one students participated in the module, although there was some attrition during the term so that by ca. week 8, there were about 56 students in the class. Forty-nine students completed all the coursework and sat the final exam.

All students were in their first year of study at Birkbeck. Approximately half the class was female (53%), and roughly 2/3 were in the age range 20-35, the remainder being aged 36+. For approximately 39% of students, English is not their first language. At the time of the first CBA, 62% indicated some previous experience with CBA.

Plan of the Course

Our study was undertaken in a newly-designed, 15-week module (*Molecular Cell Biology*) from January to May, 2001. This module is an obligatory element of the first year curriculum for students undertaking a BSc programme in which biological subjects form important components.

Table 1 outlines the plan of the module. WebCT was used as a hub for dissemination of learning materials and for communication with the class. Three main types of learning sessions were provided: lectures, a laboratory practical, and a problem solving session. In the lab practical, Excel spreadsheets were employed to build data-handling skills. The problem-solving session was designed to develop students' reasoning skills through evaluation of data generated by computer-simulated, diagnostic laboratory procedures. Here we employed the CaseIT! DNA Electrophoresis software module (Bergland and Klyczek, 1999) to simulate laboratory tests for the diagnosis of genetic diseases. Students presented the results of their case studies in "web posters" using an automated web page authoring system and their presentations were peer-evaluated through a web-based discussion forum (Bergland, 2000).

Summative assessments were primarily based on learning resources including lectures (and accompanying notes), web-based documentation, and reading assignments from a single core text (*Biology*, 5th ed. by Campbell, Reece and Mitchell). The first summative CBA (CBA A in Table 1) was given on Week 2 or 3 (the class was split into two groups of approximately equal size), followed by further summative CBA on Weeks 5, 11, and 15 (i.e. C, G, and H; Table 1). Because of the size of the class it was necessary to run CBA in shifts to match the number of available workstations which ranged from 25 to 40. CBA for purely formative purposes (i.e. B, D, E, and F) which related to particular class sessions were made available at intervals throughout the course.

Delivery of the Tests

The first assessment (CBA A; Table 1) was produced and delivered in WebCT. All subsequent CBA (B–H; Table 1) were developed in Macromedia Authorware and delivered via the Tripartite Assessment Delivery System (TRIADS) (see Mackenzie, 1999). Importantly, both of these delivery systems are web-based, which allowed students to access tests either from the Birkbeck LAN or from off-site via the Internet.

CBA classified as summative (i.e. A, C, G, H in Table 2) were initially delivered during timetabled class sessions with instructors present. Students were not permitted to complete these tests for a grade unless they attended the specified class session. Feedback on question-by-question performance for each student (answers given, correct answers, score, final grade) was delivered to students via WebCT email except in the case of the CBA H (the final exam). Following formal administration of each summative CBA (again, with the exception of CBA H), the *same* test was made available to the class for later, formative use.

CBA classified as formative (i.e. B, D, E, F) were made available for use at logical points within the timetable and were specifically intended for use *outside* of class time. As implied by this classification, scores on these CBA did not count toward the students' grades for the module.

TRIADS formative CBA were provided in two versions. One version of each test was designed so that full feedback (student's answers, correct answers, score) on each question was provided as soon as the student submitted an answer. A second version of each formative CBA worked in the same way as a summative test: the student had to complete the entire test within a specified time period before any feedback was supplied. This second mode of delivery therefore permitted students to test their knowledge under "real" exam conditions.

Design of the Tests

Details of each CBA are shown in Table 2. CBA A and B were constructed using question styles requiring little more than recall of factual information. For CBA C through H, tests included a substantial proportion of question styles designed to assess understanding of key concepts. Such styles included questions requiring assignment of text labels to logical groups (*classification* style) and those ordering text labels into sequences (*sequence* style). The latter sometimes required the exact sequence for the student to score any marks; in other cases, some credit would be awarded for a partial sequence. A limited number of questions required the student to enter text via the keyboard (*text entry* style). This progressive evolution in the test composition was intentional, inducting the student reasonably gently into the CBA regime, with tests ramping upward in difficulty as the unit progressed. To further assist in the "induction" process and to compensate for the rapid pace of the course, CBA A, C, and G (all summative) were open-book (see Table 2) and focused on limited blocks of the course material. CBA H – a "closed book" test administered in the final class session – consisted of novel questions comprehensively covering the entire module. In order to emphasise its importance, CBA H was advertised as a "final exam".

An exception to this progressive approach in test design was TRIADS assessment D, a formative tutorial on laboratory report writing. Here, an unusually large proportion of question styles were of the classification/sequence type (75%). This structure reflects the nature of the ultimate task, scientific report writing, a practice that follows a highly stereotyped, sequential process.

Student Perceptions of TRIADS CBA

Surveys were conducted prior to summative CBA on Week 11 (CBA G) and Week 15 (CBA H) to solicit student opinion on aspects of the TRIADS assessments. Seventy-four percent of the students found the package easy to use; 90% found the instructions to be clear. Ninety-two percent found the assessment unbiased (or only moderately so), while 75% felt that the assessments were fair.

Prior to the CBA G (on Week 11), approximately 25% of the students reported that the level of stress experienced during the test was “much worse” than their initial expectation. However, by CBA H (on Week 15), the proportion in this category had decreased to 9%. A majority of students felt that CBA gave “a better estimate of knowledge than essay-based exams” and that the tests were “more enjoyable to complete than traditional exams”.

Approximately 62% reported being “anxious” or “pretty anxious” about their score having just completed CBA G. Immediately following CBA H, the corresponding figure had dropped to 46%, suggesting a growth in students’ confidence regarding this mode of testing.

Surveys also revealed the levels of students’ confidence in their own achievement on the CBA. For CBA G and CBA H, students were asked to predict their scores. For CBA G, the students’ predictions were reasonably accurate although an overestimate of the actual score, the median predicted score being 57% and the actual median score 47%. Interestingly, for CBA H, students predicted a score identical to the actual median score on the earlier test, i.e. 47%. This severely underestimated the actual median score of 64% on CBA H. This effect likely reflected student uncertainty owing to the nature of CBA H, which was “closed-book” while all previous CBA had been open-book.

Student Use of Formative TRIADS Tests

Our log files recorded a total of 485 TRIADS test completions and revealed that 38 different students accounted for these completions. Thus more than 3/4 of students who sat the exam (n=49) had made some use of the formative tests. Thirty-two of the 38 individuals who completed formative tests completed more than 1 of the 6 available tests. Although a majority (65%) of test completions were from workstations on the LAN, it was encouraging that 35% of completions were made from remote locations. Perhaps not surprisingly, approximately 80% of completions took place in the 2 weeks prior to the final exam!

It is important to emphasise that the figures quoted above reflect *only* test *completions*; if a student logged in and performed only part of a test, quitting prematurely, this would not appear in the record. The figures also do not take into account the possibility of groups of students working together on the formative tests. In such cases, of course, only one user will have been recorded as completing the test. The figures therefore may underestimate use of the formative tests.

Quality and Effectiveness of the CBA

It is important to evaluate whether the summative TRIADS tests were well designed (i.e. appropriately difficult and discriminatory) and whether our testing approach (i.e. frequent CBA) actually helped students to learn the course material.

At present we have performed only one measure of “design quality”, a calculation of the median score for each test. Median scores for the summative TRIADS CBA were 60% (CBA C), 48% (CBA G) and 64% (CBA H). These scores range approximately from D+ to B on our marking scale (D, or 3rd class is 40-49; C, or 2.2, is 50-59; B, or 2.1, is 60-69). We therefore believe the tests were of appropriate difficulty, each median falling to just one side or the other of the middle of the marks range. The approximate mid-range value of the median score in these tests also is important as an indicator of appropriate “dynamic range”: there was useful scope for improvement in the score. We intend to further analyse the tests on a question-by-question basis, but at the time of this writing (2 days after CBA H!), the analysis is incomplete.

Toward validating the effectiveness of the approach, we have analysed the performance on CBA H (the final exam) of those students who had made use of the formative tests (see previous section, **Student Use of Formative TRIADS Tests**). For the 38 students who accessed formative tests, the mean exam score was 63%; those who did not avail themselves of these revision aids managed to compile a mean score of only 50%. This represents more than an full; grade’s difference: C- to B. Furthermore, 23 of 38 students who used formative CBA showed improvements in their scores from CBA C to CBA H. The mean increase in score for this group was 16.1 (±2.63 SEM), in contrast to a mean *decrease* in score of 4.98 (±5.75 SEM) for those who did not access the formative tests.

Our discussions with some of the non-native English speakers in the class and our observations of the performance of these students indicated that this group might have especially benefited from the CBA regime employed in this module. Informal survey of these students indicated that most found it easier to express their knowledge within the CBA than by writing essay responses to exam questions, the norm in many of our courses. In addition, we noticed that a number of these students showed substantial improvements in CBA scores through the module.

These observations prompted us to perform another analysis of the results of summative CBA, this time to compare the extent of improvement between native English speakers and non-native English speakers. Here, we compared scores on CBA C and CBA H, calculating the difference in scores (both based on 100 marks, maximum score). From this, we identified the respective native English speakers and non-native English speakers who showed improvement in their score from CBA C to CBA H and calculated the mean improvements for each group. We then compared the mean improvements to determine if there was a significant difference between the groups.

The class *as a whole* (29 native English speakers and 20 non-native English speakers) showed a modest improvement from CBA C to CBA H, with a mean difference of +2.99 (± 2.56 SEM; range –34 to + 51; n=49). The native English speaking “improvers” showed a mean increase of +9.03 marks (± 1.94 SEM; range +0.5 to +24.8; n=13), while the non-native English speaking “improvers” increased their scores on average by +23.0 marks (± 4.24 SEM; range +6 to +51.2; n=11). Clearly, the non-native English speaking “improvers” raised their scores to a greater degree than the native English speaking “improvers”, and the difference between the

means was significant at $p < 0.01$. It was notable that for both groups of “improvers”, *all* had made use of the formative tests in revising for the final exam. The difference in improvement between the 2 groups was not a consequence of differential use of the formative CBA: the mean number of formative CBA completions per student was nearly equivalent, at approximately 15 for each group.

Conclusions

The CBA provided support as evidenced by the fact that the majority of students made use of, and benefited from, the formative tests. Students made use of both versions of formative materials: those providing instant feedback, and those that mimicked exam conditions, providing feedback only once the test was completed. This capability of CBA contrasts with traditional assessment methods, which rarely provide a convincing simulation of exam conditions. Furthermore, students found the TRIADS supportive of their learning and quickly gained confidence in their use of it.

The CBA support promoted learning as evidenced by the fact that the median score was maintained between the open-book summative and closed-book summative assessments. The latter assessment presented the students with novel questions (i.e. not repeated from previous CBA) over the entire range of topics covered in the module and so did not simply test students’ familiarity with the CBA delivery system per se. Furthermore, those who used the formative CBA performed better on the closed-book exam. It is likely that the extensive feedback provided was an important contributor to the success of these students.

The nature of the CBA design was especially helpful to students whose first language was not English. For those students who exhibited an improvement in their test score between CBA C and CBA H, the increase for non-native English speakers was more than double that achieved by those students whose native language is English. We attribute this to the nature of the TRIADS assessments. The question styles require the user to read, interpret and manipulate (as graphical text labels) English text, rather than to compose essays. Anecdotal reports from students in this category indicated that this style of test allowed them to communicate their knowledge more effectively than would have been possible through traditional assessments.

Closing Comments

CBA provides a number of advantages to both learners and teachers (see Brown et al., 1999). The advantages most relevant to our particular goal — to provide learning support for part-time, mature students who are full-time employed through the day — are the timeliness of feedback and the possibility of remote use. In addition, we feel that specific and emphatic milestones created by the summative CBA enforced a steady pace on the students which was valuable for their learning. It also provided them with frequent feedback on the progress of their learning, helping to build their

confidence with respect both to subject-specific knowledge and generic computer fluency.

Although our study has focused on a very specific student experience (mature students, employed full-time, studying part-time in the evening), we feel that our approaches are widely applicable. Today's "full-time" student is hardly "full-time"! It is likely that constraints on student and staff time will continue to erode student-staff contact time. Computer-based methods will be valuable in addressing these problems.

References

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Table 1: Summary of Learning Sessions and Resources Utilised Within the *Molecular Cell Biology* Module

Week(s)	Session Type	Summative CBA[1]	Formative CBA/CAL	Notes/Other Learning Resources[2]
1	Lecture	–	–	–
2, 3	Lecture Computing	– WebCT (A)	– TRIADS Demo (B)	– Handouts describing use of TRIADS and Question Styles
4	Lecture	–	Chime-based web pages for molecular visualisation	
5	Test	TRIADS (C)		Feedback delivered to students via WebCT mail
6	Lab Report	–	TRIADS (D)	An Excel file containing lab data was made available for downloading; training in use of Excel was provided.
7	Lecture	–	TRIADS (E); Pharma-CAL-ogy[3]	Selected elements of Pharma-CAL-ogy tutorial packages[3]
8	Lecture	–	TRIADS (F)	
9, 10	Problem Solving (computer simulation) Library Visit	–	CaseIT! Investigator and Web page builder[4] Online bibliographic databases	WebCT Discussion and Mail for student collaboration; Chime-based web pages for molecular visualisation Use of search engines and ISI Web of Science
11	Test	TRIADS (G)		Feedback delivered to students via WebCT mail
12	Web Page (Poster) Presentations			Using automated web page authoring system[4]
13, 14	Web-based Conferencing[4]			Forum for discussion of web pages (posters); feedback from peers on design and content
15	Test	TRIADS (H)		Grades delivered to students via WebCT mail

[1] Letters in parentheses are provided to identify each CBA; details for each are given in Table 2.

[2] Extensive notes covering each session were given each week as handouts to the class. All such materials were made available for downloading from WebCT.

[3] Pharma-CAL-ogy materials were designed and produced by a group from Leeds University through an award from UK Higher Education Funding Council (see http://www.ncteam.ac.uk/tltp/). Here we used selected tutorials covering aspects of cell signalling.

[4] The CaseIT! DNA Electrophoresis software module (developed at University of Wisconsin-River Falls; project led by Dr Mark Bergland; http://www.uwrf.edu/caseit/caseit.html) permits computer simulation of various molecular biology techniques. The authors have developed its use in conjunction with a variety of case studies to illustrate methods for and issues in genetic testing. An automated web page publishing system enabled students to produce “web posters” documenting their assigned investigation. A web-based forum was used in peer feedback/assessment of the web posters.

Table 2: Details of Formative and Summative CBA

						Question Style				
CBA[1]	**Assessment system**	**Assessment mode**	**Sequence of questions determined by:**	**Time (mins)**	**Number of questions**	**(1) Multiple choice (%)**	**(2) Label diagram (%)**	**(3) Classification/ Sequence (%)**	**(4) Text entry (%)**	**(3)+(4) (%)**
A	WebCT	Open book/summative	tutor	45	17	100	0	0	0	0
B	TRIADS	Formative	tutor	N/A	4	50	50	0	0	0
C	TRIADS	Open book/summative	tutor	60	20	25	30	45	0	45
D	TRIADS	Formative	student	N/A	8	12.5	0	75	12.5	87.5
E	TRIADS	Formative	student	N/A	10	60	20	20	0	20
F	TRIADS	Formative	student	N/A	8	50	0	25	25	50
G	TRIADS	Open book/summative	tutor	35	8	44	22	22	12	34
H	TRIADS	Unseen/summative	student	45	19	37	11	41	11	52

[1] The letter designations refer to entries in Table 1 under “Summative CBA” and “Formative CBA/CAL”, respectively.