A Flexible Learning Approach to Numerical Skills

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Introduction

A recent development at Coventry University has been the introduction of Numerical Know-How, a module open to any student in the University who wishes to improve his or her numerical skills. The module is taken by students as one of the free choice modules in the first year of their programme of study. To meet the requirement of being accessible to every student it was decided that the module should be resource-based rather than lecture-based. Indeed there are no timetabled classes for the module. This avoids clashes with other modules which would deny some students access to this module.

This paper describes the resources available for students studying this module, the mode of operation and the students' reaction to the module. A variety of resources are used including paper, video and electronic. The electronic resources were originally made available over a local area network but in 99/00 were transferred to the Internet. This option was made particularly attractive following Coventry University's decision to adopt *WebCT* as a standard. In 99/00 all the University's modules had a *WebCT* site which students could easily access through a locally developed front-end, called *Learn On-line*. Whilst many of the University's modules made little or no use of their *WebCT* site, the site for Numerical Know-How became integral to the running of the module.

Resources

The module consists of 12 units divided into three blocks of four. A simple video has been made to introduce each of these units. The videos, which were made in the University using a VESOL facility, are essentially a commentary to a set of *PowerPoint* lecture slides. The *PowerPoint* files can be viewed or downloaded (and printed) from the *WebCT* site. Paper copies of the slides are available in the University's Mathematics Support Centre.

Some of the slides on the video contain exercises for students to work through (answers and explanations are also given on the video). However, the nature of the material being covered is such that students need to practise repeatedly the skills being covered. To give students the opportunity to gain this practice and to receive feedback on their progress, a large question bank was created using the *WebCT* assessment engine. Using this question bank twelve on-line tutorial sheets (quizzes) were created (one for each unit). The questions which make up a specific tutorial sheet are randomly selected from a pre-defined set. This allows students to take the same tutorial sheet repeatedly with little likelihood of being asked the same question.

A tutorial sheet typically contains 20 questions and to provide a large enough question bank to ensure different questions on repeat attempts at least 10 (preferably more) alternatives for each question are required. The requirement to author at least 2400 questions might appear daunting.

However, by appropriate use of the *WebCT* question type 'Calculated Question' the amount of work required to generate these questions is significantly reduced. Figure 1 shows one of the questions. Within this question the two weights are chosen at random by *WebCT*. Figure 2 shows the authoring screen for a question like this. Parameters {a} and {b} are written into the question and the answer is specified as a formula in terms of {a} and {b}. Suitable ranges for the parameter values must be defined before the random values can be selected.

A bucket containing 10 litres of a certain liquid weighs 12.0 kg.
When the bucket contains 16 litres of this liquid the weight is 16.7 kg.
Plot a graph of weight against volume of liquid in the bucket and use this graph to determine the weight of the bucket when empty. Give your answer to 1 decimal place.

Answer:

Figure 1. Sample question from *WebCT* question bank

Title: Buckets

Question:

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A bucket containing 10 litres of a certain liquid weighs {a} kg.<br>
When the bucket contains 16 litres of this liquid the weight is {b}
kg.<br>
Plot a graph of weight against volume of liquid in the bucket and
use this graph to determine the weight of the bucket when empty.
```

Format: ⦿ HTML ○ Text

Image: [   ] [Browse...]

Formula: {a}-5*({b}-{a})/3 [Analyze Variables]

Variables:

| a | Min: 10.1 | Max: 13.9 | Decimals: 1 ▾ |
| b | Min: 14.1 | Max: 17.9 | Decimals: 1 ▾ |

Calculate Answer Sets to: 1 ▾ Decimal Place(s) ▾

Figure 2. Calculated Question authoring in *WebCT*

There is a minor drawback with these questions in that the feedback for wrong answers can only be an outline of the correct process - the parameter values cannot be carried forward into the feedback to enable students to check specific interim values in their calculations. However, there are those who would argue that it is preferable to give an outline rather than a detailed solution as

this encourages the students to think more fully through the information being presented and relate it to the specific values of their question rather than simply being spoon-fed the answer.

It was decided in the initial development of the module that the assessment should be an integral part of the learning process. To this end, students are encouraged to view all summative assessment as formative as well. To enable this to happen, students are allowed to take the three summative tests on-demand and also to have repeated attempts at the assessments. This allows students to use the tests formatively, as when they have completed a test they are immediately told not only their mark but also which questions were answered correctly and which incorrectly. This then indicates to them the areas that they most need to work on before they take the test again.

Whilst this may seem to be a generous assessment regime it appears to be particularly suitable to this kind of module which is essentially skills based. Furthermore, in order to pass, they have to achieve a mark of at least 75% on each of the three tests. At the start of the module the assessment is explained to the students by comparing it with the driving test. Just as in the driving test there is a known set of skills which the examiner is checking the potential driver has mastered, so in this module there is a clearly defined set of skills which a student must be able to demonstrate mastery of in order to pass the module. Also, just as in the driving test a minor error may not result in failure, so in this module the student is allowed the odd small slip.

Although there are no timetabled classes for this module there is still a human resource available to the students. The module leader can be contacted either by email or by using the bulletin board facility within the module's *WebCT* site. Those students wanting face to face contact are encouraged to use the University's Mathematics Support Centre, which is open as a drop-in help facility for 33 hours each week.

Mode of operation

At the start of the year there is an initial meeting between the module leader and the students enrolled in the module. At this meeting the mode of operation of the module is explained and students are given a paper copy of the module guide (which is also available on the *WebCT* site). Essentially the students are told that the module is delivered by supported self-paced study. At this point the various resources available are described. During this meeting the students are taken to the University's Mathematics Support Centre and the fact that they can use it as much as they need is emphasised.

By the time the students attend this initial meeting they have been introduced to *WebCT* and the Coventry University front end *Learn On-line*. All students are given introductory sessions during induction week. Although it would be an exaggeration to say that, by the time of the initial meeting of Numerical Know-How, they are all comfortable with using the system, it is at least not totally new to them. Furthermore, the fact that it is used in a large number of modules means that this is not the only time they will see the system, although for most of them this will be the only module where all their assessment takes place in *WebCT*.

A further purpose of the initial meeting is that it enables the students to meet the module leader. For many students the next meeting will be when they take the first test. There is no requirement for a student to contact the module leader again until he/she wishes to have their first attempt at the first test.

Student feedback

When students took the third and final test they were asked to complete a feedback questionnaire which explored their opinions of specific resources and of the overall operation of the module.

The first two questionnaires listed all the resources available for the module and asked students to state which they had used for more than two of the twelve units and also which they used the most. Figure 3 shows their response to the first of these questions. This shows that almost every student made use of the paper handouts, around two-thirds used the on-line quizzes (tutorial sheets) but the usage of the other resources was very low.
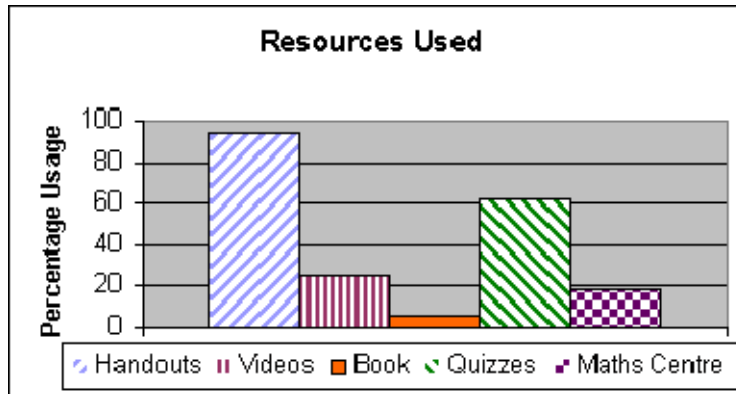

Figure 3. Percentage of students using the different resources

Not surprisingly given the answers to question 1, the paper handouts were identified as the best resource by 66% of students. The remaining 34% selected the on-line quizzes as the most useful.

When the module was in preparation the videos had been identified as a novel and, it was thought, appealing resource for the module. It became clear as the module progressed that the videos were not being used heavily. Further questions explored the amount of usage of the videos and reasons for the low usage. Figure 4 shows the breakdown of how many videos the students watched (the maximum possible was 12).

The three main reasons for the low usage are given in Table 1. There are important lessons to be learnt here. The first is that access to resources must be made as easy as possible. It was thought that the library was a good place to hold the videos as the students would, presumably, be regularly visiting the library for their other modules. There are facilities in the library for viewing the videos, they were not available for loan. The other two reasons for low usage are similar and could perhaps be summarised as the videos did not add significantly to what the students gained from the handouts. On the one hand this could be taken as evidence of the quality of the

handouts, but it is more likely a reflection on the videos. The videos are essentially commentaries for the *PowerPoint* slides which make up the handouts. There is significant extra spoken explanation and active demonstrations of the steps required in the solution of some problems which only appear statically on the handouts. However the fact that the visual appearance of the videos was so similar to the handouts produced the perception that there was little difference between the two.
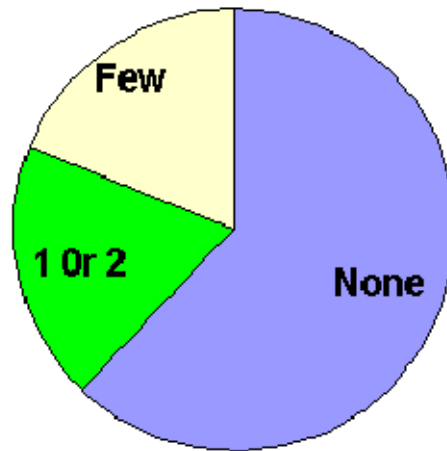

Figure 4. Number of videos watched

Reason	%
Making time/inconvenience of going to library	42
Handouts were enough	23
Videos too similar to handouts	19

Table 1. Reasons for not using videos

As can be seen in Figure 3, the on-line quizzes were used by almost two-thirds of the students. The only common explanation of infrequent use was that there were plenty of exercises on the handouts and so no others were needed.

The final question on the questionnaire asked students to write down the three best features and the three worst features about the module. A wide range of answers were given to this question although it is heartening that whilst almost all students listed three good things many listed less than three bad things. The most frequent best features were:

- multiple attempts at the tests;
- the self-paced nature of the module;

- the flexibility given by no lectures;
- the level of support;
- the availability of the resources on-line; and
- being able to take the assessments on demand.

Fewer bad features were listed and there was generally less agreement than with the good features. There were only two that were listed by more than one student. These were:

- the self-support nature of the module; and
- the lack of lectures.

Quite clearly it is impossible 'to please all of the people all of the time'. No lectures appears in both the best and worst features lists. The high level of support was praised by many but one student gave one of the worst features as 'Not having a lot of help'. One student said 'On-line assessment feels less formal' (this was a good thing) whilst another said that taking tests on paper was better than at a computer.

Reflections

The basic operation of this module will remain unchanged for the next academic year. However, some lessons have been learnt about the practicalities of running a module like this. Initially the plan was for the module to be completely self-paced with no dates given for anything (other than a final date to meet the examination board schedules). This complete open-endedness was too much for many students. Not long into the module a number of them asked if dates could be set for the tests as this would give them 'something to work towards'. This request was complied with, although students who wanted to take the tests at other times were still permitted to do so.

Communication is a vital part of running a module like this. The student who wrote that one of the worst features was 'Not having a lot of help' was presumably not aware that there was up to 33 hours per week of help available in the Mathematics Support Centre, despite the fact that this was stated on the module guide. Either this was not read, or it was read at the wrong time (i.e. the beginning of the module), when the student did not feel in need of help and forgotten by the time help was required.

Email and the *WebCT* bulletin board were used to communicate with students. This may not have been totally effective, particularly at the start of the year when these were new forms of communication for some students. At the initial meeting more emphasis will be placed on the need to maintain communication with the module leader.

Conclusion

Overall this method of delivering this module can be judged a success. Of the students who took all three tests only one did not pass the module. Some of the module resources, notably the videos, were not used as widely as anticipated but others were well-liked by the students. Although there were a few who did not appreciate this mode of delivery the overwhelming

majority were satisfied. When asked to give the module a mark out of 5 (with 5 being the best mark) the average mark given was 4.

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