Effective reporting for online assessment --- shedding light on student behaviour

by

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Introduction

Online assessments can offer students individual and independent learning experiences, which can greatly enhance the teaching and learning process. Feedback, as an important factor in the learning process, is a feature, in one way or another, of many learning theories; through conversation (Laurillard [1]) or through reflection (Kolb [2]). “Action without feedback is completely unproductive for a learner” Diana Laurillard [1].

In online assessment immediate, or synchronous, feedback to a submitted answer can take a number of forms – for a good classification see Mason & Bruning [3]. As valuable as synchronous feedback is, there is also a place for asynchronous feedback that supports student reflection and bolsters learning. In a traditional classroom setting most feedback is of an asynchronous nature and one way of supporting the provision of asynchronous feedback in an online context is through the use of post-assessment reporting. Whilst many assessment systems have reporting facilities, they often do not provide the level of detail required to support the learning process in depth. This article seeks to describe some of the work from a project known as PASS-IT [4] and how effective reporting can enhance formative online assessment.

Since 1984 the CALM group at Heriot-Watt University has been developing computer-based assessments [5-9] for delivery to engineering and science students at Heriot-Watt University [10], and to secondary schools through the SCHOLAR Programme [11].

For the last two years development work has been under the remit of a Scottish collaborative project called PASS-IT [4], which has been investigating the delivery of on-line assessments to secondary school children across Scotland.

Teaching and learning dialogue

In a traditional classroom based assessment the teacher and students enter into a dialogue with students exchanging work for feedback from the teacher (Fig 1). Students learn by undertaking the assessment, and also by reviewing feedback. At the same time the teacher gains an understanding of how well an individual student is performing and how well the class as a whole is progressing.
However, because online assessments allow students to undertake exercises when and where they feel best suits their learning needs, there is a danger that the teacher is removed from the process (Fig 2).

Whilst the computer can provide some instant feedback through automatic marking, for example, it is less complete than that which a teacher would provide.

What is key to the success of online assessment is that teachers are retained at the heart of the learning process. During PASS-IT a reporting system has been developed that gives teachers similar information to that which they would receive with paper-based assessment. The strength of the reporting system is that teachers can see all the answers submitted by students as well as their marks, and because it is computerised teachers have the ability to group and view information by student or by class making it much easier to comprehend performance.

**Summary of PASS-IT Assessment System**

A description of the PASS-IT assessment system’s forerunner (CUE) can be found in the article by Paterson [12], and whilst developments have been made to extend the assessment engine’s capabilities, functionality and question types there are a number of key features of which to be aware.

**Delivery modes**

Assessments can be run in a variety of modes e.g. help, practice and exam with the level of immediate feedback being different in each.

For example:

- Help mode
students are told whether their answer is correct, partially correct or wrong; students see how many marks have been awarded for an answer; and students can reveal the correct answer.

- **Exam mode**

no feedback is given during the assessment, and the only feedback given is a final mark on leaving the assessment.

**Assessment Structure**

The PASS-IT assessment system is different to many in that it presents questions to a student on an individual question by question basis. An assessment may have a number of questions, each question may have a number of parts and each part may have a number of sub-parts or steps (Fig 3).

The PASS-IT system allows an author to specify whether navigation is allowed sequentially forward; sequentially backwards; or freely. In the majority of cases navigation is freely allowed to enable students to answer, and re-answer, any question in any order.

A student submits answers to each question part independently of any other question part and can submit answers in any order. A student can submit as many answers as they wish to a specific question part with only the last submitted answer for each question part counting towards the final mark.

![Fig 3 - Assessment structure](image)
Question Types
The PASS-IT assessment system has a number of question types including:

- Multiple choice;
- Multiple response;
- Hotspot;
- Wordmatch;
- Essay;
- Judged mathematical expression; and,
- Integrated multimedia [13,14]

Of the question types above only responses to essay questions cannot be marked automatically. As with all question types, answers to essay questions are stored and can be marked by a teacher at a later time.

Beyond multiple choice/response type questions it is important to be able to view the student constructed answer. It is no longer a case of reporting which of the presented options a student chose, but how did the student choose to present his/her answer. With the more advanced question types, the student answer is not constrained, but a wide range of answers are accepted that comply with the marking scheme.

The PASS-IT assessment system records every student initiated action, including:

- Starting a test;
- Navigating between questions;
- Submitting answers to individual question parts;
- Multiple submissions to the same question part; and,
- Ending a test.

As a result it is possible to reconstruct how a student undertook an assessment.

Reporting in the PASS-IT System
Most assessment systems provide teachers with reports on marks; for example average marks, distribution of marks, and other statistical analyses. These reports are useful in summative assessments that are generally administered at a stated date and time, and very often invigilated in a fashion similar to traditional paper-based assessments.

However, in formative usage there is far less control over when and where assessments are undertaken and how students choose to use them. In a formative setting it is much harder to interpret marks.

As an example, the following diagram (Fig 4) shows the total marks for a single student, for multiple attempts at a single assessment in reverse chronological order. The assessment was run in 'Exam Mode’ so that the student knew how many marks an individual question part was worth but did not receive any immediate feedback to the answers submitted. The only indication of performance was when the student exited the assessment, at which point a total mark was displayed. It should be emphasised that the mode of the test chosen by this student was completely in his/her control.
Note the spread of marks. This assessment has a possible 43 marks and all the attempts on 10/12/2003 scored 5 marks or below. In contrast, the single attempt on the following day scored 34.1 marks.

From a teachers perspective there are a number of questions raised by this data.

1. Is this a record of poor performance? Has this student failed to understand the subject being assessed altogether?
2. Is this a record of computer crashes? Has the student tried to sit the assessment on the 10th but the system has consistently crashed at the first question, whereas on the 11th the system worked?
3. As this was a formative test was the student unable to learn from their mistakes?
4. Were the questions in this assessment just too hard for the student to understand and answer?
5. Is this an example of cheating? Is the honesty of this student in question as they did very poorly on the 10th but gained near maximum marks on the 11th? Is such a change in performance expected?

To assist in answering these questions the PASS-IT reporting system was developed to include reports that visualise the data to aid interpretation. The next diagram (Fig 5) shows the same
test attempts but this time the mark for each question is presented. As the PASS-IT assessment engine allows free navigation through a test students can jump to a question and so this report only displays a mark if a student has accessed a question.

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**Fig 5 - Visualising data**

From this report it is immediately evident that this student has been using this formative test in a very specific manner to satisfy his/her own purposes. The student has decided to address each question in turn. At the start of each question the student can see how many marks the question is worth. The student attempted the question and then exited the test. As the student completed their test attempt a final mark was shown. At this stage the student compared the mark awarded to the mark available for the question attempted and made a decision whether to start a new assessment and attempt the question again, or move onto the next question.

If focus is made on one particular question, question 8 (this is taken from a Higher Mathematics paper delivered by the Scottish Qualifications Authority, see Fig 6), it can also be seen what answers the student submitted for each question part, in each attempt. Fig 7 shows the answers submitted on the first attempt at the question. Fig 8, Fig 9, and Fig 10 show the next three attempts at the question where the student has deliberately attempted only one part of the question at a time to ascertain which part of the question he/she got wrong at the first attempt. It should be noted that this question contained random parameters, and so the expected answer in each assessment attempt is different.
Fig 6 - Question 8

8.1) In the form \( \sin(A + B) \), \( \sin(x) \cos(15^\circ) + \cos(x) \sin(15^\circ) = \) \[ \text{Your currently accepted answer: } \frac{2}{3} \]

8.2) Find the solutions to the equation.

The smaller value of \( x \) is: \[ \text{Your currently accepted answer: } \]

8.3) The larger value of \( x \) is: \[ \text{Your currently accepted answer: } \]

Fig 7 - First attempt at question 8

Fig 8 - Question 8 part 1 (second attempt)
By systematically working through each question this student has identified where his/her weaknesses lie and attempted to learn from his/her mistakes. On the final attempt at this question the student scored full marks, and again the following day achieved full marks for this question.

This pattern of behaviour was unexpected and would not have been visible without the ability to visualise the question data; as shown in Fig 5. Had the teacher only been able to see an average mark for all attempts, or even the individual attempt marks, then it would have been very easy to jump to an incorrect conclusion. The teacher would have needed to speak to the individual student to ascertain what was behind the scores. However, without the level of information shown above any discussion may be influenced by incorrect assumptions.

Other uses for effective reporting
The ability to visualise and follow student behaviour, and review submitted answers also allows the reporting system to be utilised for other tasks. For example, another feature of the reporting system is to enable a teacher to view the entire class’ answers to a particular question. Professional judgement can then be applied to spot common errors and misconceptions; identify students requiring focussed support; and inform teaching practice.

Reporting systems can also be useful in moderating the effectiveness of an assessment system, questions and marking schemes against the learning objectives being measured [15].

The vast amounts of data collected can also be used in a deeper statistical analysis and so any effective reporting system should allow for the downloading of data into advanced statistical packages.

Conclusion
As assessment systems become more commonplace within the learning environment so will the need for more effective reporting systems increase. Without the ability to see what a student is
entering as an answer teachers will find it increasingly difficult to provide focussed and effective feedback to students to aid their learning.

Fig 11 - Online assessment with reporting

As the above diagram shows (Fig 11) by the inclusion of an effective reporting system the teacher is once again part of the learning dialogue. Through the use of reporting systems students have access to their submitted work after an assessment has been completed, enabling reflection, and teachers are now able to review student and class performance. Teachers can then provide directed feedback to individual students or the class as a whole and amend their teaching practice in light of performance.

References
