Redesigning computer-based assessment tests for use as a learning tool: profiling tacit learning processes instead of measuring learning outcomes.

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Relevant professional project websites
LSN: http://www.lsneducation.org.uk/research/centres/rcfteachlearncurricqual/programmes.aspx
IFA: http://www.brookes.ac.uk/schools/education/staffinfo/eccleston-FAproject.html
TLTP3: http://www.caacentre.ac.uk/

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OVERVIEW

In this paper we have redesigned Computer Based Assessment (CBA) test items and test construction to enable the profiling of tacit learning processes, instead of solely measuring learning outcomes. The idea, developed as part of a research degree programme is to use CBA as a developmental tool to guide learning processes through the strategic use of feedback. The background and underpinning knowledge evolved as a result of personal professional activity on two research projects: Improving Formative Assessment (IFA, 2005-07) and the Computer Assisted Assessment Centre (CAA, 2000-03). Coupled with this is practical, hands-on experience of implementing Computer Based Assessment (CBA) at the University of Bedfordshire. In this paper we present a theoretical model of a CBA design that is an iterative and non linear process. The model has been designed with its embedded subject content to provide an illustrative model and example of how feedback in CBA can enhance learning. This is important as a means of challenging widely held assumptions about CBA and extending its use as an effective learning tool. The paper is relevant to the conference theme 2, G*reat designs for assessment*.

DESCRIPTION OF THE CASE

Computer-based Assessment (CBA) is founded on objective test methods and is primarily used for measuring learning outcomes. Objective test methods require that an answer(s) or solution(s) be stipulated in advance. In contrast, in a more subjective type of assessment, answer(s) are not stipulated in advance and are considered impressionistic (whereby the whole is greater than the sum of the parts). Assessments of this kind will typically include critical analysis of literary works. (Bull and Collins, 2001). A discursive assessment of this kind is often evaluated by e-peer or e-tutor, using a scoring rubric or criteria and personal judgment and intuition. The model presented in this case is one that places learners at the centre to (a) capture and profile the learners' tacit learning processes, (b) capture mode of expression used and (c) provide a printout for use as critical reflection or peer review in a personal development plan or portfolio. While the conceptual model is based on Question Mark Designer and Perception software, any product or combination of products that has the functionality to perform the operations required can be used. These include: a range of basic question types, branching facility, feedback options, scoring mechanisms, meta-tags, item analysis statistics and print-out of results. The case is contextualised by populating with intellectual content in the science domain of volcanoes. The activity

requires learners to seek answers by asking questions and to critically reflect on their actions based on the feedback information supplied. It is designed not as a delivery tool to learn about volcanoes but as an analytic tool to evidence the students' reasoning strategies and judgements taken to solve a specified problem. It captures the reasons why particular actions were important to the students at that point in time.

RATIONALE IN TERMS OF EDUCATIONAL IDEAS

The area of automating subjective or free type assessments (ones not linked to the principles and practices of objective tests) within a CBA type environment is an area much sought after by awarding bodies and testing agencies. However, since free expression requires complex linguistic parsing of free text responses, this is an area still in its infancy and remains a challenge for the future. However, the potential is there to extend CBA type activities through the strategic use of feedback in the design features. Skills and competencies (and through identification of sub-skills) that signal or indicate performance in relation to learning outcomes can be profiled. If test items are meta-tagged at the test construction stage, CBA can produce a profile of individual and cohort performance based on these tagged test items. For instance, performance on certain question *types* (that hold embedded features such as visual, mathematical or linguistic expression) and specific education *objectives* (that embed a specific skill level) can be generated by the computer and fed back to the test designer and the learner for refinement or reflection. Test items can be calibrated or information can be given to the test taker for analysis and reflection upon their particular strengths and weaknesses. For further details see Collins (2003).

In the example below, the common types of meta tag conventionally used in CBA test design is given based on Bloom's taxonomy of cognitive skills (1956). Scores for test items can be allocated individually or a combinatorial system as in a matrix can be designed to add sophistication and complexity to the outcome.

Table 1. Meta-tagging for profile building (with illustrative sub-skills)

Question Type	Educational objective	illustrative Sub-skills
Multiple Choice	Knowledge	
Multiple Response	Comprehension	
Graphical hot spot	Application	
Assertion/reason	Analysis	Identification of patterns Recognition of components and their relationships
Drop down list	Synthesis	Generalise, relate knowledge, integrate, predict
Drag and drop Text/numeric match	Evaluation	Make judgements, evaluate, defend, discriminate,

However, indicated above is only an example of the most typical or common variables used in CBA and these could be substituted for other less common typologies or traits. For instance, the attribute of creativity might include items designed to demonstrate the process that embeds features that are said to describe the creative process (preparation, incubation, illumination and verification) or to demonstrate other traits identified by typologies as *types*.

Instead of meta-tagging items by outcomes, they can be meta tagged and scored by process. An analytic indicator of specific tacit learning processes can be formulated and with further technological refinement implemented as an analyser. The scoring mechanism will initially be set as a default measure (based on the expert judgement of an optimum answer) but with the item response analysis functionality can capture the view of the individual and the cohort.

EVALUATION

This is a theoretical model. Objective test principles and practices can form the basis of the design if all the variables (potential predictable answers) for a solution to a given problem are identified in advance (as in the case of item 2 above) or a catch all used. The student can work through the process of finding an optimum answer, by activating the supply of feedback. Through the strategic use of free text expression the student can critically reflect and compare with peers or expert judgement about the optimum solution and discuss the differing modes of expression.

A working model would produce an output that is useful at all stages of its development to assess threshold learning skills and tacit traits as part of a Personal Development Planning(PDP).

MODEL OF PROCESS

Test Construction: CBA adaptive test design: <iterative process>

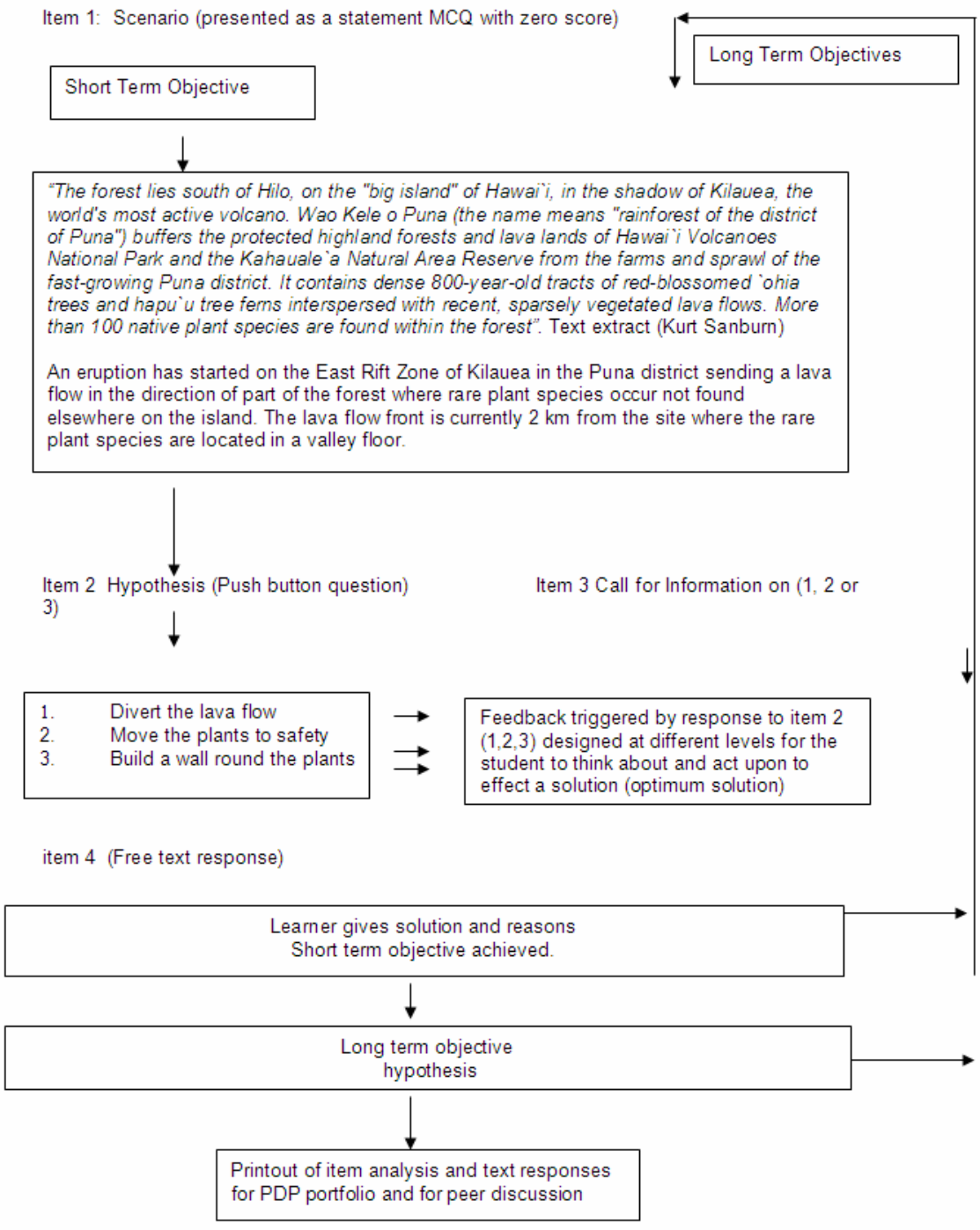

Figure 1. Model of Iterative Process

EXAMPLE OF FEEDBACK TO BE SUPPLIED ON LEARNER ACTIVATION

SHORT TERM PROBLEM

INFORMATION 1a
It is not possible to divert this lava flow

INFORMATION 1b
It is almost impossible to stop the advance of a lava flow with a barrier. Attempts have been made on Etna and Hawaii to breach the lateral walls of lava flows near source thereby starving the flow front – it is arguable whether this has been successful.

INFORMATION 2a
There is good access by road to close to the Plant site.

INFORMATION 2b
There is a track accessible by 4xWD jeeps to within 50 m of the plant site.

INFORMATION 3a
If a lava is in full flow it will overtop most walls

INFORMATION 3b
Lava flows typically obstacles

Option 2 activated: You are given above the fact that the lava is 2 km from the plant site. The lava flow is advancing at 200 metres an hour how long have you got to move the plants
REQUEST INFORMATION (4)

INFORMATION 4a
You can calculate how long it will take. You know the distance is 2 km and the lava is traveling at 200 metres per hour. Convert the distance 2 km into metres which is 2000 metres and use the following expression to calculate how long it will take the lava to reach the site.
Time (in hours) = distance (in metres)/ velocity (metres per hour)

INFORMATION 4b
Time = distance/velocity

LONG TERM PROBLEM

This is a predictable problem. Eruptions from the East Rift Zone of Kilauea are frequent – in the last sixty years there have been eruptions of lava in 1955, 1960, 1965, 1969-74, 1977, and 1983 – ongoing 2007.

Q: What needs to be done in the long term to make the rare plants less vulnerable?

REQUEST INFORMATION 5

INFORMATION 5a
Vulnerable means they are likely to be destroyed by eruption of lava from the East Rift Zone of Kilauea. You need to think of ways of making the rare plants vulnerable to single eruption. You have six months to undertake your plan of action.. Think carefully about ways of reducing vulnerability. The following example may help you. A single engine aircraft is very vulnerable to crashing if it suffers engine failure, a jumbo jet with four engines is much less vulnerable if it suffers failure to an engine.

INFORMATION 5b
Vulnerability is a measure of the degree of damage or loss which will be suffered when subjected to a hazard event (e.g. eruption of a lava flow). You have six months to put in place your plan of action. Think carefully about ways to reduce vulnerability.

SUGGESTED SOLUTION OF EXPERT
To reduce vulnerability from an eruption of lava it is proposed to disperse the rare plants to several different sites scattered along the East Rift Zone. This will greatly reduce their vulnerability to damage from an eruption. Careful selection will need to be made to identify sites with the right ecology. Remember lava flow tend to travel down valleys so selecting sites on ridges will further reduce the vulnerability of the rare plants to be destroyed by lava.

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