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1. Name/s of the main author/s and affiliation*:P G Butcher, The Open University, Milton Keynes, UK
2. Name/s of co-author/s and affiliation: S J Swithenby and S E Jordan, The Open University, Milton Keynes, UK
3. Name/s of the presenter/s at the M-2009 conference*:P G Butcher
4. Current position of the main author/s*:Teaching Fellow, Centre for Open Learning of Mathematics, Science, Computing and Technology
5. Latest publications of the main author/s *(Limit: 3 per author)*:
   Ross, S.M., Jordan, S.E and Butcher, P.G. (2006) Online instantaneous and targeted feedback for remote learners. In C. Bryan and K.V.Clegg (eds) *Innovative Assessment in Higher Education*. London: Routledge, 123-131.
   Butcher P.G. (2008) Online assessment at the Open University using open source software: Moodle, OpenMark and more. 12th International CAA Conference, Loughborough, UK, July 2008.(with supporting website at http://labspace.open.ac.uk/course/view.php?id=3484)
   Butcher P.G. (2006) OpenMark examples (at http://ww.open.ac.uk/openmarkexamples)
6. Field of research of the main author/s *(3-6 keywords per author)* *:eAssessment for learning

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Please insert your full paper *(Limit: 2500 words excluding references):*

# eAssessment and the independent learner

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## Introduction

This study informs the development of eAssessment aimed at independent learners, particularly those studying through open and distance learning. It was motivated by the perception that recent developments in computing and communications technologies could lead to eAssessments fulfilling a much wider role than had hitherto been possible, combining motivating interactions with rich, and instant, feedback to create engaging eAssessments across a broad range of learning outcomes.

The technology platform to support the study was provided by the university's OpenMark eAssessment system (Butcher, 2006) which differs from traditional Computer Assisted Assessment (CAA) systems in:

- *The emphasis placed on feedback.* All Open University students are distance learners and within the university we emphasize the importance of giving feedback on written assessments. The design of OpenMark assumes that feedback, perhaps at multiple levels, will be included.
- *Allowing multiple attempts.* OpenMark is an interactive system, and consequently we can ask students to act on feedback that we give 'there and then', while the problem is still in their mind. If their first answer is incorrect, they can have an immediate second, or third, attempt.
- *The breadth of interactions supported.* We aim to use the full capabilities of modern multimedia computers to create engaging assessments.
- *The design for anywhere, anytime use.* OpenMark assessments are designed to enable students to complete them in their own time in a manner that fits with normal life. They can be interrupted at any point and resumed later from the same location or from elsewhere on the internet.

**The interactive Computer Marked Assignment (iCMA) initiative**

The Open University Centres for Excellence appointed their first fellows in 2005. Within the Centre for Open Learning of Mathematics, Science, Computing and Technology (COLMSCT) an initial focus was assessment, which encompassed eAssessment, where fellows were able to ask questions that went beyond the bounds that constrain normal course production cycles. Foremost among these discussions was the general question of whether or not eAssessment was capable of assessing higher order learning in any meaningful way. To help think this through, a workshop was convened in late 2005 with invited experts at the forefront of eAssessment from other universities. One conclusion, arising from the combined educational and computing expertise of the discussants and the 'what if' enabling approach of the COLMSCT leadership, was that developing models of eAssessment had the potential to be used in a much wider role than had hitherto been possible. The challenge to COLMSCT was to establish projects, with appropriate support from within the CETL, to test the conclusion of the experts.

Autumn 2005 also saw the unveiling of the latest version of the university's OpenMark eAssessment system and the new capabilities available within OpenMark persuaded the COLMSCT leadership that the university might have a computational vehicle capable of the delivering some of the novel forms of eAssessment suggested at the workshop.

In March of 2006 COLMSCT issued a call for proposals from academic staff to "develop and evaluate innovative e-assessment projects within their own teaching context". While the remit of COLMSCT was the Mathematics, Science and Technology areas the call was widened to the whole university with appropriate support from the university's Learning and Teaching Office. The initiative specifically acknowledged the current gap between academic aspirations and the types of interactions commonly found within standard Computer Assisted Assessment systems and encouraged proposals that went beyond those current boundaries. The iCMA project offered collaboration and resources to help specify and implement the assessment and to evaluate both the process of creating the assessment and the outcomes.

In the intervening years the iCMA initiative has grown to include projects that have delivered iCMAs for use in Biology, Chemistry, Computing, Earth Science, General Science,

Languages, Mathematics, and Nursing. The projects are required to undertake the full project cycle from proposal, through specification and implementation, to evaluation with students and propagation of the outcomes within and outside the university.

**Common characteristics of the iCMA projects**

The major similarity between projects in the iCMA initiative is reflected in the name; all projects are attempting to engage students in an 'interactive' exchange around one or more learning outcomes, with the computer providing instant feedback and multiple attempts for students who answer incorrectly. The overall project is titled *eAssessment for Learning* and all projects include teaching feedback, often with course references, to persuade students to revisit topics where their answers are incorrect, before attempting the question again. For example

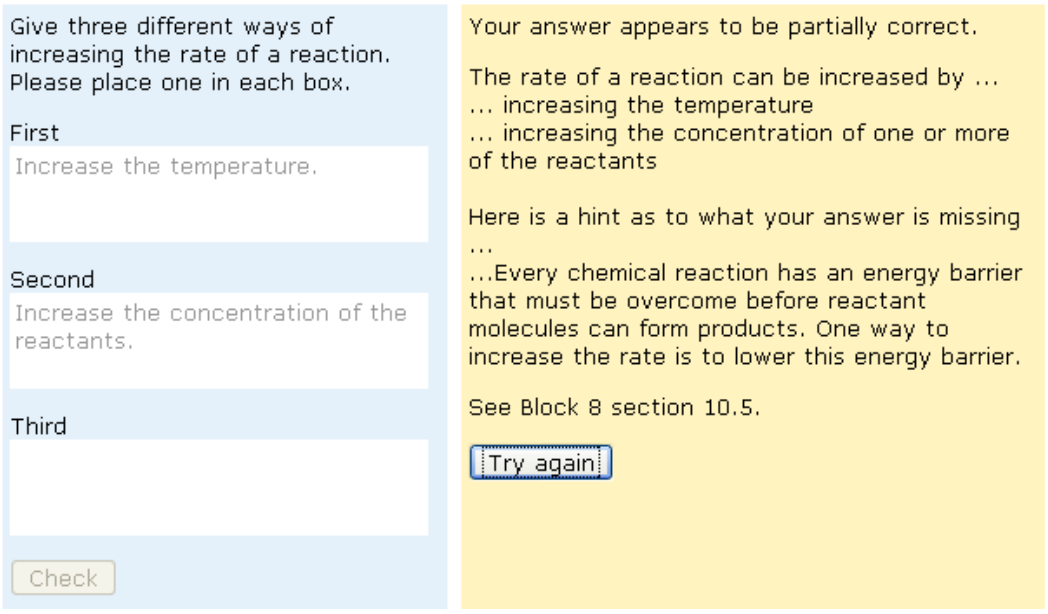


Figure 1 An illustration of immediate targeted feedback

The importance of feedback for learning has been highlighted by a number of authors, emphasising its role in fostering meaningful interaction between student and instructional materials (Buchanan, 2000), its contribution to student development and retention (Yorke, 2001), but also its time-consuming nature for many academic staff (Gibbs, 2006). In distance education, where students work remotely from both peers and tutors, the practicalities of providing rapid, detailed and regular feedback on performance are vital issues.

Gibbs and Simpson suggest eleven conditions in which assessment supports student learning (Gibbs and Simpson 2004), of which four are particularly apposite with regard to the use of eAssessment within distance education.

1. Sufficient feedback is provided, both often enough and in enough detail.
2. The feedback is provided quickly enough to be useful to students.
3. Feedback is received by students and attended to.
4. Feedback is acted upon by students to improve their work or learning.

They are reflected in the design of OpenMark and are amplified in the rationale behind the development of the S151, *Maths for Science*, online assessments (Ross, Jordan and Butcher, 2006) where

- the assessment questions provide individualized, targeted feedback, with the aim of helping students to get to the correct answer even if their first attempt is wrong
- the feedback appears immediately in response to a submitted answer, such that the

question and the student's original answer are still visible
- students are allowed up to three attempts at each question, with an increasing amount of feedback being given after each attempt

The approach of the iCMA initiative was to build on this model.

The OU is well known for the care with which tutors are asked to provide feedback to students on written assignments; these projects are reflecting the same care when the computer is providing the marking.

Wherever possible questions include in-built variability, such that a student may revisit the iCMAs for further practice and receive variations on their original questions; in this respect the iCMAs resemble a patient tutor, correcting initial misunderstandings and providing further examples to reinforce the learning. Where iCMAs are being used for summative purposes the in-built variability also counteracts plagiarism. Here are two such variations.

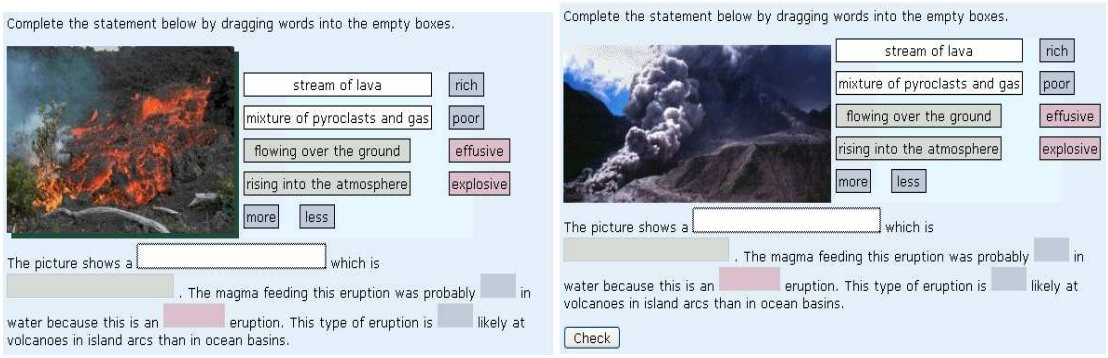



Figure 2 There are a variety of eruptions available to this question; of course the response matching behind the scenes has to cope with the variety of eruptions too

Several iCMAs provide resources within the question that must be explored and understood before an answer is provided. For example within Science there are several examples of 'virtual microscopes' having been put to imaginative use as teaching tools. It is possible to reuse the same idea within an iCMA with each of the views below corresponding to different levels of magnification.

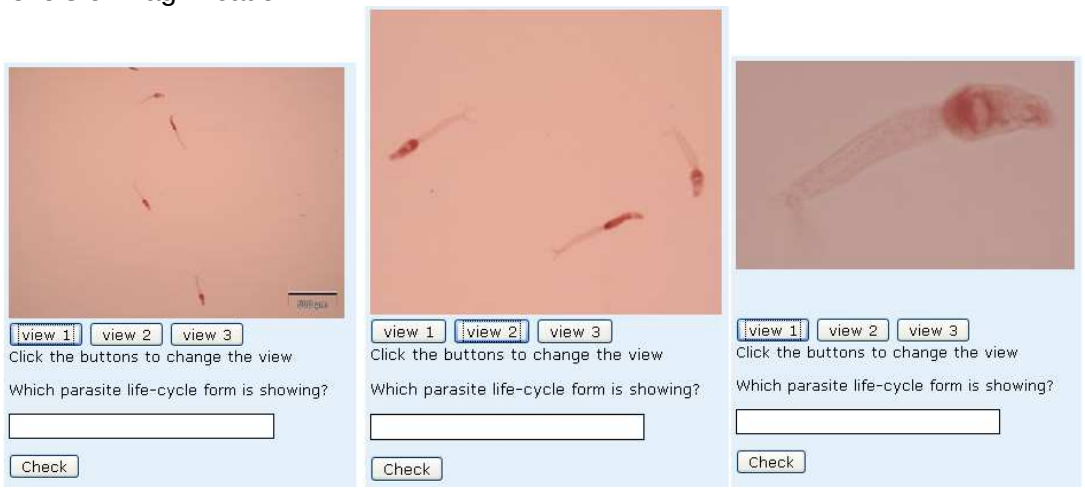
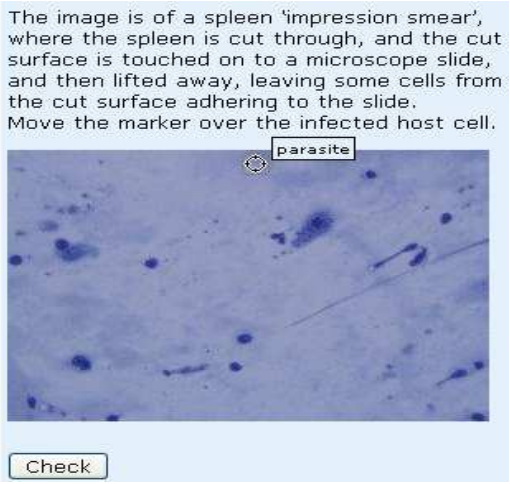



Figure 3 Three views of a parasite




And as Figure 4 shows not only can the resources be varied but students can be asked to interact with them directly to show that they have understood what they are looking at.

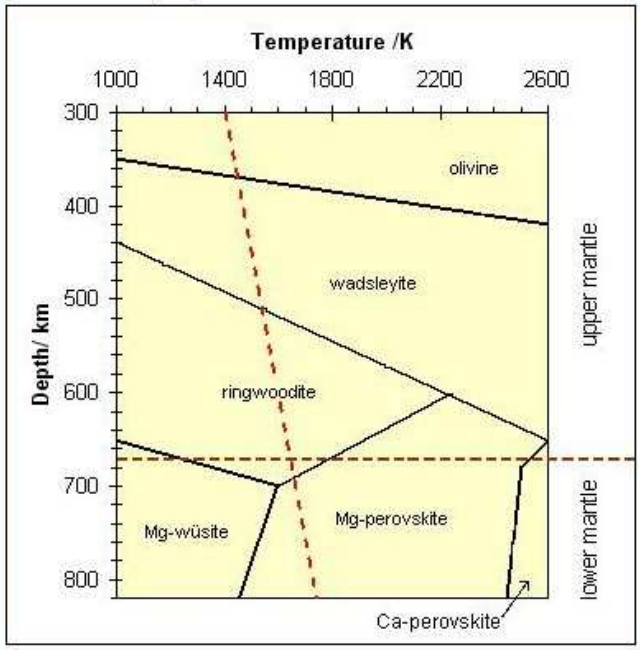
Figure 4 Identifying a parasite on a microscope slide

One project is exploiting this facility to build a substantial decision making task within the iCMA. Student nurses are presented with a patient, various resources such as video and audio interviews with the patient, plus patient records and typical internet resources for potential treatments. The iCMA allows the student to treat and track the patient over a number of visits before arriving at a conclusion which the student is asked to reflect on. As the whole process is within the iCMA system it is possible to keep detailed records of the students' actions and reasons such that an assessment of their actions can be made.

Most projects appear to become more sophisticated as the authors gain confidence in the technology behind the iCMAs and compound questions are not unusual (e.g. Figure 5). While these are more difficult for the author to analyze and comment on they do provide students with more substantial tasks.

Mantle convection models must account for a variety of influencing factors, including the transition between different mantle phases with changing pressure (depth) and temperature, while the direction of slope of a phase boundary determines the extent to which material can move through the mantle.

a) A **mantle plume** starts to rise along the adiabatic gradient (red dashed line) shown on the pressure-temperature diagram below. With reference to the Clapeyron Law, label each of the phase boundaries it crosses as either exothermic or endothermic. *Place the marker where the gradiant crosses and use only the exact number of labels required on the graph.*




endothermic

exothermic

b) To what minimum depth on the P/T diagram will this plume rise?:

km

Check

Figure 5 A compound question

The photograph shows a selection of igneous rocks. How are igneous rocks formed?

Check

Several authors are exploring how advances in computing technologies can be utilized in iCMAs. For example while the questions in Figure 1 and Figure 6 would create few difficulties for a human marker, how accurately can a computer mark such answers? One iCMA project is attempting to find out using computational linguistics software from Intelligent Assessment Technologies.

Figure 6 Analyzing free-text responses

Finally most projects do mark students in the background with reports of varying detail being provided at the end of the projects. One project is explicitly marking questions against course learning outcomes thereby providing students with an independent measure of their progress

on the course. Where a student has done poorly suggested further reading and exercises can be provided as links.

**Reactions from colleagues and students**

The breadth of innovative proposals that resulted from the March 2006 call for projects indicated a healthy engagement by academic staff with the developing role of eAssessment. But taking those initial ideas and turning them into working eAssessments has in itself been a challenge. By grouping the projects into the iCMA initiative the COLMSCT has enabled a significant investment to be made in refining and developing the ideas into specifications that can be implemented on a computer.

As these projects were chosen for their novel ideas the authors, the iCMA coordinator and our consultants have needed to be flexible and innovative in our use of the computational systems at our disposal. Nevertheless I can report that in all cases we have been able to support the novel question interactions for each project within the flexible framework provided by the university's OpenMark eAssessment system, extended in one project by incorporating a real-time interface to Intelligent Assessment Systems Free Text marking software. However we have been less successful in linking those question interactions into adaptive assessments where subsequent questions are chosen based on user performance. Several fellows wanted to choose the 'next' question based on 'student's route so far' but the variety of models proposed proved to be beyond the scope of the iCMA initiative. Extending our framework to allow some forms of adaptive testing will have to form part of a future project.

The iCMAs developed so far offer stimulating and interesting challenges to students, which is reflected in the positive feedback that we have received across all projects. While each project has its own theme and topic and each has a different author, what they have in common is the constant interchange of information between student and computer. There is almost a rhythm to it, a rise and fall, or give and take, as the computer builds a profile of the student's abilities.

And the iCMA initiative has also had an impact on the design of eAssessment within the University's VLE which is based on Moodle. With all iCMA initiative projects from five faculties specifying eAssessments where the student obtains instant feedback after responding to a question it became clear to us that the eAssessment tools within the VLE should be able to replicate this same functionality. OU Moodle now has this feature and there are proposals to include it in core Moodle. (Butcher 2008)

Figure 7 shows how the use of iCMAs has grown since the start of the COLMSCT initiative. We would not wish to claim that COLMSCT projects alone are responsible for the increase over the period but we can be quite clear that COLMSCT fellows have been the leaders in driving the upwards trend shown both through their role in COLMSCT and in their faculty's Course Teams.

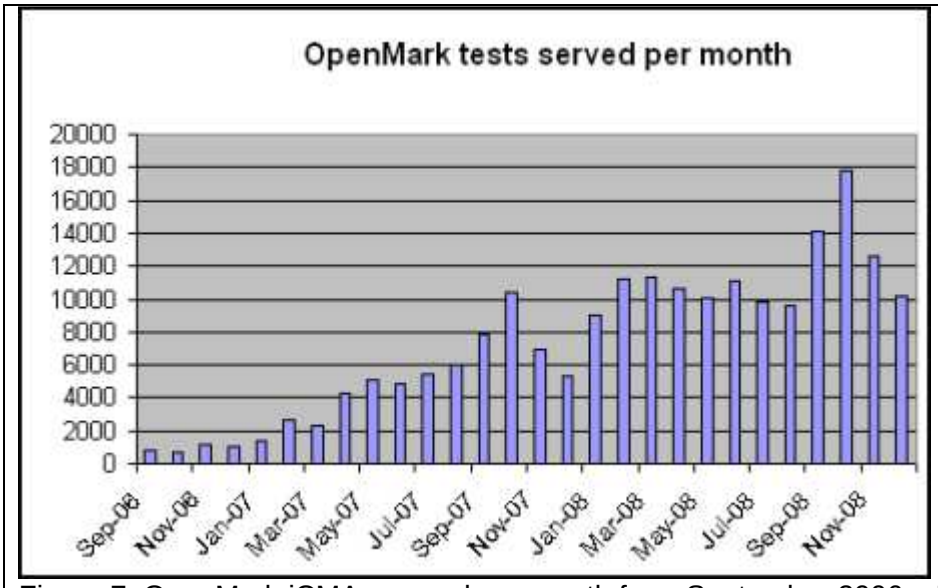


Figure 7: OpenMark iCMAs served per month from September 2006 – December 2008

The majority of students like the iCMAs and find them helpful. We have known students describe them as 'fun' and individual students are repeating the iCMAs as we had hoped and demonstrating greater learning awareness. Clearly iCMAs which are available 24/7 dovetail in with open learning. Student perceptions rate test of understanding, measure of progress and revision higher than awareness of learning outcomes. However where we have a sequence of formative iCMAs during a course student usage drops off as the course progresses. In some areas students are finding the questions harder than expected.

Our approach has been used successfully in multiple disciplines; so far in Mathematics, Science, Computing, Health Science and Languages.

Student quotes reflecting on the usefulness of the iCMAs

1 *This was my first iCMA and I really enjoyed it. Great study and revision tool, very convenient to work through, and quite fun to boot!*
2 *Excellent, excellent tool which can be used in lunch hour!*
3 *Interactive assessment (is) a particularly good learning tool, if you are getting the answer wrong it doesn't give you the answer right away but gently coaches you till you get it right yourself.*
4 *I found this very useful in the fact that it tested me right when I needed it*
5 *It is a very useful tool to point out where I was lacking. Have made several notes to myself on what to revise (mainly the maths)… in the run-up to the exam.*
6 *The assessment has made me appreciate just how difficult this course is so far…*
7 *This is a great way to test what has been learnt and is a great revision tool!! I now know where I have gaps in my knowledge and also learnt some things which I didn't pick up when reading the book. You don't always appreciate what you're reading and its significance, until you try and apply it.*

**Conclusion**

A flexible eAssessment framework and appropriate support has enabled colleagues in different disciplines to develop novel question types targeted at their particular learning outcomes. The activities have succeeded in engaging students by focusing on an interactive exchange around defined learning outcomes. Multiple attempts and instant iterative feedback

are standard.

The generation of the assessments is academically demanding and may be technically complex but the resource demands are mitigated by large scale re-use. Colleagues who engaged in this initiative have stimulated wider use of eAssessment with an increasing number of courses choosing to include summative iCMAs that operate in the manner described above so that they serve a formative role too.

The iCMA initiative has demonstrated that the scope of eAssessment can be extended considerably and is pedagogically valuable. Wider implementation requires investment in two areas; the underlying computational systems and staff development.

Readers may interact with the iCMAs described here by visiting the *eAssessment for Learning* section of http://www.open.ac.uk/colmsct/activities.

All of the systems used in this project are open source.

**References**

Butcher, P G (2006) OpenMark Examples http://www.open.ac.uk/openmarkexamples

Butcher, P G (2008) Online assessment at the Open University using open source software: Moodle, OpenMark and more. 12th International CAA Conference, Loughborough, UK, July 2008 (with supporting website at http://labspace.open.ac.uk/course/view.php?id=3484).

Buchanan, T. (2000) The efficacy of a World-Wide Web mediated formative assessment, *Journal of Computer Assisted Learning*, 16, 193-200

Gibbs, G. and Simpson, C. (2004), Conditions under which assessment supports students' learning. *Learning and Teaching in Higher Education,* 1, pp 3-31

Gibbs, G, (2006) Why assessment is changing, in C. Bryan and K. Clegg (eds), *Innovative assessment in Higher Education*, Routledge

Ross, S, Jordan, S and Butcher, P (2006), Online instantaneous and targeted feedback for remote learners, in C. Bryan and K. Clegg (eds), *Innovative assessment in Higher Education*, Routledge

Yorke, M. (2001) Formative assessment and its relevance to retention, *Higher Education Research and Development*, 20(2), 115-126

**C. Summary of the full paper***

Please insert your summary *(Limit: 200 words):*

This study informs the development of eAssessment aimed at independent learners, particularly those studying through open and distance learning. It was motivated by the perception that recent developments in computing and communications technologies could lead to eAssessments fulfilling a much wider role than had hitherto been possible, combining motivating interactions with rich, and instant, feedback to create engaging eAssessments across a broad range of learning outcomes.

By using a flexible eAssessment framework and providing pedagogic and technical support we have enabled colleagues in different disciplines to develop novel question types targeted at their particular learning outcomes. The activities have succeeded in engaging students by focusing on an interactive exchange around defined learning outcomes. Multiple attempts and instant iterative feedback are standard.

The generation of the assessments was academically demanding and at times technically complex but the resource demands are mitigated by large scale re-use. Colleagues who engaged in this initiative have stimulated wider use of eAssessment within the university.

The iCMA initiative has demonstrated that the scope of eAssessment can be extended considerably and is pedagogically valuable. Wider implementation requires investment in two areas; the underlying computational systems and staff development.

**D. Short description of the full paper for the programme booklet***

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This study informs the development of eAssessment aimed at independent learners. It was motivated by the perception that recent developments in computing and communications technologies could lead to eAssessments fulfilling a much wider role than had hitherto been possible, combining motivating interactions with rich, and instant, feedback to create engaging eAssessments across a broad range of learning outcomes.

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- ☐ Virtual Mobility
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- ☐✓ Technology Enhanced Learning
- ☐ Learner Support Services
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- ☐ Cultural Diversity
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- ☐ International Co-operation and Development

**3. My paper is adopting one or more of the following *approaches**
*Please restrict yourself in marking the relevant approaches*:

- ☐ Vision
- ☐ Policy
- ☐ Strategy
- ☐✓ Research & Development
- ☐ Good Practice
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