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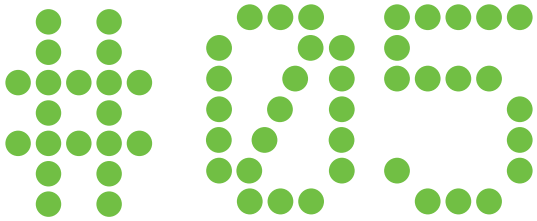

TEMPORAL ASPECTS OF MATHEMATICAL E-ASSESSMENT SYSTEMS

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Temporal Aspects of Mathematical E-Assessment Systems

ABSTRACT

e-Assessment has become a very integral part of study programmes which are mainly conducted in an online environment. Carrying out e-assessments for subjects that require a high level of skill in an online environment is a very demanding task. In this case, the temporal component of e-assessment plays a major role. Mathematical education in online higher education can be taken as one such example where e-assessment will be conducted as a combination of formative and summative assessment to access both skills and knowledge with rich feedback in a timely manner. In this paper we will be discussing some temporal aspects in e-assessments systems for mathematics, where the need for rich feedback goes beyond typical multiple-choice online questionnaires.

KEYWORDS

E-assessment, Formative e-assessment, Temporal aspects, mathematics, e-learning.

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INTRODUCTION

E-assessment (Crisp, 2007) is an end-to-end electronic assessment process where ICT is used for the presentation of assessment activity, and the recording of responses. This includes an end-to-end assessment process from the perspective of learners, tutors, learning establishments, awarding bodies, regulators, and the general public (JISC, 2007). There are important questions related to assessment, such as what and why to be assessed. When it comes to e-assessments or computer-based assessment, a third important question is how to carry out assessments.

Assessment for learning, commonly known as formative assessment, is designed to promote students learning. It differs from the assessment of learning, also known as summative assessment, which has been deigned to account, rank or certify competences. The first one provides information or feedback to assess both student and teacher activities. Feedback in formative assessment has to be used to adapt the learning and teaching work (William, 2011).

Formative e-assessment can be defined as the use of ICT to support the iterative process of gathering and analysing information about student learning by teachers as well as learners and of evaluating it in relation to prior achievement and attainment of intended, as well as unintended, learning outcomes. Within this definition, technologies of e-assessment are not seen, in themselves, as being inherently either summative or formative. What is of interest is whether e-assessment is being used summatively or formatively (Pachler et al., 2010)

These assessments can be carried out as Computer-Based Assessments (CBA), where assessment is delivered and marked by computer, or Computer-Assisted Assessments (CAA), where practice that relies, in part, on computers such as online discussion forums for peer-assessment and audience response systems in group work, completion and submission of work electronically, or storage of work in an e-portfolio for different contexts (JISC, 2007).

With respect the question of how to e-assess, Bennett (1998) describes three generations of e-assessment tests and the corresponding kind of tools:

- First Generation tests based on existing paper-based tests.
- Next-Generation tests using new formats including multimedia, constructed response, automatic item generation and automatic scoring.
- Generation "R" (Reinvention) tests using complex simulations and intelligent tutoring systems (see for example, http://www.carnegielearning.com/).

In the Roadmap for e-assessment developed for JISC by Whitelock and Brasher (2006), the authors concluded that the next roles of e-assessment are dealing with on-demand testing, e-portfolios, formative assessment supporting learner autonomy, and diagnostic assessment.

E-assessment system have limitations as well (JISC infoNet, 2012): staff are likely to require time and skills to create e-assessment resources, there are security problems and a higher risk of plagiarism than in paper face-to-face assessments, and new technologies and author tools for e-assessment are needed.

Time and e-assessment are inter-related, whether it is through development, planning or conducting assessments. One of the main advantages when it comes to e-assessment is that it saves time for both teachers as well as students. For teachers, it reduces their workload because of less correction time.

Therefore, they can focus on other productive tasks such as improving the curriculum or improving the teaching process based on students' progress (Boyle, A. & Hutchison, D. (2009). For students, feedback delays are avoided and this helps them to focus more on their personal learning process.

The different context where e-assessments will be used depends on the advantages of adapting the system. The usual main problem to use e-assessment is that the assessment process has to be converted from paper-based to an online environment and to facilitate immediate feedback. In subjects that require a high-level of skill as well as knowledge, that conversion is not always fulfilled (Bell, I. & Gibson, K. (2009).

In this paper, we will be mainly discussing e-assessment tasks, systems and temporal components when it comes to subjects like mathematics, which require not only acquired knowledge, but also a high level of skills, in an online environment.

E-ASSESSMENT FOR MATHEMATICAL E-LEARNING

Mathematical e-learning is where an organization uses both LMS and mathematical software in the field of mathematics and statistics for online education. In particular, interaction with mathematical software can provide additional benefits to students - for example, a better visualization of mathematical concepts by sketching graphs, surfaces, etc., and a constructivist approach to mathematical knowledge by experimenting with different scenarios. In this sense, computers make it possible to save time that used to be needed to solve operations manually. This time, in turn, can be employed in more constructive processes. In particular, it provides a reduction in the gap between theory and practice because the use of mathematical software allows the modelling and solving of real problems, when real conditions and data can be used without having to add simplifying restrictions (Juan et al., 2008).

The more general e-assessment systems in higher education offer a range of question types performed in a multiple choice question (MCQ) paradigm, but they are not designed to offer a specific assessment experience for mathematics, where the higher-level skills of comprehension and interpretation ('deep approach') are needed, Norton et al. (2001).

Distribution of both practice and feedback are key elements in learning skills. What is always essential for mathematical e-assessment is an automatic checking procedure beyond the MCQ tests, because the resulting grades have to reflect not only whether the answer is correct or not, but also the whole procedure of solving the problem (Juan et al., 2010). In particular, the need for introducing mathematical language and for recognizing symbolic representations in mathematics are very important criteria for automatic and immediate feedback in mathematical e-assessment. Thus, more advanced techniques belonging to Bennett's Generation "R" are needed, such as the use of simulations and intelligent tutoring systems (see for example, the Review of Advanced e-Assessment Techniques project (Ripley, Harding, Redif, Ridgway,& Tafler, 2009).

TIME FACTORS FOR MATHEMATICAL E-ASSESSMENTS

Time and e-assessments are two components, which are inter-related, throughout the process of assessments. Automatic correction is related to immediate feedback, which is especially needed when learning skills-based subjects like mathematics (Iahad et al., 2004; Espasa,

2010). Also, one of the criteria that should be supported by any mathematical assessment system is practicability, i.e. that the resources required for providing teachers' time, expertise and cost, and users' learning time should be coherent with the value informed for all its participants (Beevers et al, 2010).

The main regulatory agents that have a direct relationship on e-assessments are time regulated by students, time regulated by teachers, time regulated by organizations/ groups, and time regulated by society. Time spent on e-assessments, in different aspects, have a greater impact for the agents mentioned above. The main regulatory agents are affected by the time dependency of e-assessments.

When looking into 'time as a resource', temporal flexibility (Carreras & Valax, 2010) is important to both students and teachers. In most cases, and this is especially important with respect to mathematics, the e-assessment system itself provides immediate feedback (Espasa, 2010), which, in turn, reduces the marking time of teachers and, as a result, organizations are able to carry out large-scale assessments and allocate that time to more important tasks.

Tasks in maths e-assessment have to display information dynamically, and to model changes in situations over time, so that learners can interact realistically with "real" data of considerable complexity (Ridgway and McCusker (2003).

Technological time plays a major role in e-assessments. Both teachers and organizations have to spend time on learning new technologies to create interactive and effective e-assessments. With regard to students, they need time to be familiar with the technologies involved in order to correctly participate in assessments in an online environment (Bates, 2005). The technological precautions that can be taken to prevent plagiarism in an online environment and security measures that have to be taken with time, also have to be considered (Barker & Lee, 2007). In the mathematical e-assessment arena, the technological complexity is even greater, as e-assessment systems and tools beyond the simple MCQ are needed (Boyle et a. (2009).

Academic time in e-assessment has the same importance as with technological time. Academic time, with respect to teachers, is the amount of time for designing and creating the appropriate questions based on lessons according to different difficulty levels (Mory et al., 2007). From the students' point of view, it is the planning and management of time (Demeure et al., 2010) to complete the assessments given within the time allocated by interacting with the e-assessment system (Gur & Van, 2004). In maths related subjects, the need for sophisticated tasks implies a huge academic time. With respect to maths e-assessment systems, firstly, they have to allow the assessment of 'higher-order skills' more effectively than traditional methods, and, secondly, they have to facilitate formative assessment. Both arguments are different, but both are highly time-dependent.

DISCUSSION

Conducting e-assessments for mathematical subjects that requires a high level of skill and knowledge is a demanding task, where factors of time and e-assessment are two components, which are inter-related with each other. When it comes to e-assessments, time factors within regulator agents, which can be noted as academic time, technological time, time as perception, habits and time as a resource, are affected.

In mathematical e-learning, time is a central element to perform formative e-assessment. That time is a component of mathematical

e-assessment, dealing with immediate feedback, complex tasks, simulations techniques and intelligent tutoring systems interactions.

Temporal aspects on mathematical assessment have to be taken into account not only in relation to time restrictions for students to perform activities, but as a design component itself. Thus, mathematical e-assessment, besides its current high technological cost, could be the best solution, perhaps only enhanced by the presence of an individual tutor.

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