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Evolving formative assessment for and with ubiquitous technologies

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Abstract
Formative assessment is a vital part of the learning process. It guides student learning and prepares them for summative assessment. The feedback that accompanies formative assessment is valuable for students' learning. The combination of formative assessment and feedback facilitate the development of self-efficacy. Technology is not only changing the way students study and learn but also how assessment is conducted and managed. Globalisation and corporatisation of universities has changed the way academics work and has had an effect on teaching, assessment and feedback. This paper looks at how formative assessment in an enabling mathematics course has been developed to take advantage of changing technologies in a changing academic world.

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Abstract

Formative assessment is a vital part of the learning process. It guides student learning and prepares them for summative assessment. The feedback that accompanies formative assessment is valuable for students’ learning. The combination of formative assessment and feedback facilitate the development of self-efficacy. Technology is not only changing the way students study and learn but also how assessment is conducted and managed. Globalisation and corporatisation of universities has changed the way academics work and has had an effect on teaching, assessment and feedback. This paper looks at how formative assessment in an enabling mathematics course has been developed to take advantage of changing technologies in a changing academic world.

Introduction

Technology is changing the way students learn and study as well as the way they interact with educational institutions. Mobile learning, as described by Roschelle and Sharples (2010, p. 4) utilises personal and portable technologies for effective education. These technologies are termed ubiquitous technologies. They have facilitated the breaking down of the boundaries in higher education and enabled universities to accept students from all over the world. Technologies that provide access to asynchronous learning have fostered anywhere, anytime learning (Kumar, 2014; Nyquist, Arbolino, & Hawes, 1977). It is well accepted that formative assessment and the associated feedback, guides the learning process, provides students with feedback vital for assurance or correction and encourages self-directed learning (Fletcher & Shaw, 2012; Rolfe & McPherson, 1995; Rushton, 2005).

This paper uses the evolution of the formative assessment in the CQUniversity Transition Mathematics (TM) courses as a case study to show how technology can both improve and hinder formative assessment.

Assessment

Humans are continually conducting assessment – on people, situations and objects – and assessment is a normal event in everyday life (Harris, Guthrie, Hobart, & Lundberg, 1995). Harris et al. (1995, p. 160) consider assessment to be a means by which an effort is made ‘to discover what and how well learners have learnt’. It is generally accepted by researchers that there are many types of assessment and assessment dichotomies. Examples of assessment dichotomies include: formal and informal assessments; formative and summative assessments; and criterion-referenced and norm-referenced assessments. In fact, according Gathercoal (1995, p. 59), ‘there may be as many assessment practices as there are teachers’.

It could be stated that assessment is the corner stone of education. Its purpose is multifaceted; it should prepare the student for the next task, create confidence that tasks are achievable and not be so difficult that the student becomes discouraged while still maintaining a certain
amount of complexity (Boud, 2000) as well as testing acquired knowledge. It is further described as essentially a professional process of collection, comparison and adjudication and the innate complement to teaching and training (Athanasou & Lamprianou, 2002, p. 3).

Athanasou and Lamprianou (2002, p. 32) believe it is important assessment is designed with an ‘assessment for learning philosophy’ as it is now accepted that the form of assessment used has an influence on the way students learn (Tait, 2005). Trigg (2013, p. 9) describes assessment as ‘all activities teachers use to help students learn and to gauge student progress’.

**Formative Assessment**

Formative assessment is a learning tool. Results are not used for grading purposes but rather to assist both student and instructor to identify weaknesses in students’ understanding of the concepts or tasks being taught. Formative assessment provides students with a chance to reflect on given feedback with the knowledge that it will improve their chance of achieving a better grade (Tait, 2005).

Formative assessment is the key to student success in mathematics Davis and McGowen (2006). To achieve excellence in education ‘teachers need to be aware of what each and every student is thinking and knowing’ (Hattie, 2009, p. 238). For external students, formative assessment provides the lecturer with an insight into the students’ level of understanding so that they are better able to assist them. Formative assessment is seen to guide the learning process providing feedback on learning achievement and is most effective when it influences a student’s self-assessment (Boud, 2000).

Formative assessment enables the student to receive feedback on their performance and understanding of the material as they work through a course. This ensures that misunderstandings and errors are corrected in a timely manner and hopefully rectified prior to undertaking any summative assessment. For external students formative assessment is extremely important. These students do not have ready access to the lecturer like the internal students do, nor is the lecturer able to informally assess their performance to ascertain their degree of understanding. Therefore formative assessment is the only way both parties can keep track of the student’s progress. In these situations formative assessment acts as a form of communication between the student and the lecturer allowing the lecturer to provide additional instruction and further guide the student through their problems (Dekkers, Adams, & Elliott, 2011).

When formative assessment is used to direct enabling mathematics students it provides scaffolding that reduces cognitive load. Cognitive load theory states the human working memory is incapable of processing more than a few elements but has no limitations when handling information retrieved from long term memory (Van Merrienboer & Sweller, 2005). Ideally then, formative assessment is structured so that the new mathematics learning builds upon the previous learning.

**Technology and formative assessment**

There are many ways in which technology has been used with formative assessment and feedback. Technology can remove some of the limitations that formerly made high-quality formative assessment difficult or impractical for a classroom teacher (Brown, Hinze, & Pellegrino, 2008). Several technologies have gained widespread use. Classroom response systems (clickers) enable structured simple multiple choice like formative assessment to be
answered in real time. There are several mobile phone apps available that enable the same technology to be freely available and capable of linking with Online Learning Management systems to provide distance students with the same synchronous learning as internal students. Socrative is one example of the freely available apps. The problem with using these applications to engage large numbers of students synchronously is that it is only highly interactive for one student at a time (Kelly, 2013). Also, much of the literature on classroom response systems fails to justify the pedagogy behind the technology (Beatty & Gerace, 2009). Beatty and Gerace (2009) have taken the clicker technology further to produce technology-enhanced formative assessment (TEFA) which enables question-driven instruction, dialogical discourse, formative assessment, and metalevel communication designed for teaching science and mathematics. TEFA provides the pedagogy behind the use of clicker technology which allows students to answer anonymously, thereby increasing the willingness of all students to participate.

Based on the findings of Buchanan (2000), several web-based assessment and test analysis systems, which proved beneficial to children in improving their learning achievements in the mobile learning environment, have been developed (Hwang & Chang, 2011). These systems provide learning environments that are challenging and encourage problem solving (Hwang & Chang, 2011).

A literature review conducted by Gikandi, Morrow, and Davis (2011) showed online formative assessment could engage both teachers and learners in significant educational experiences and offer a pedagogical strategy to change the assessment culture supporting diverse learning needs and fostering equitable education. Brown et al. (2008) asks how the possibilities of technology for formative assessment will be realised and how will it be used to enhance student learning.

Now the possibility seems endless as multimedia feedback makes its way to the fore. Herr and Tippens (2013) found the use of smartphone scanner apps could allow students to scan their working and send it to the lecturer; providing the lecturer with instant feedback on the students understanding of the class content in real time. Providing students with audio feedback was found to increase content retention, increase students’ satisfaction through personalisation and reduce marking time (Orlando, 2013). Multiple choice questions are being increasingly used in higher education due to ‘growing numbers of students, reduced resources, modularisation and the increased availability of computer networks’ (Nicol, 2007, p. 53). This increase is further facilitated by the increase in ubiquitous technologies and the corporation of universities.

**Background**

This paper brings together portions of several studies based at an Australian University, CQUUniversity, which has several campuses and study centres across Australia. The University caters to approximately 19000 students per year. Of these students approximately half study by distance education (do not attend face-to-face classes). For approximately thirty years the University has offered Transition Mathematics (TM) courses. These courses provide students returning to study or needing to ‘up-skill’ for undergraduate entry with three levels of mathematics to allow for all mathematics entry requirements. Traditionally these courses were offered as part of a timed internal programme, Skills for Tertiary Education Preparatory Studies (STEPS), or for purchase as individual untimed courses offered in distance mode (private students). All of the study materials and formative assessment were the same for both internal and private offerings. Formative assessment consisted of a one
Changing assessment to meet the needs of distance students

In 2006 the STEPS programme introduced a distance offering. As a consequence, there were two parallel modes of study, student study by distance in untimed mode (private students) and those studying by distance in timed mode (distance students). The time delays caused by traditional postal return methods had not caused problems for private students as there were no time restrictions on the course. The new timed courses for distance students forced the mathematics staff to examine the submission and return of all assessment associated with those courses, especially formative assessment. The first year maintained the traditional submission via post to a central location. The delay of the postal submission and return was exacerbated by one of the distance lecturers being on a regional campus (approximately 335km/208 miles away). This added a minimum of four working days to the turnaround time of tests. The result of postal submission and return was a turnaround time of in excess of two weeks. As the main goal of formative assessment is to provide timely feedback to students in order to correct and guide their learning, this turnaround time was excessive.

In 2007 students were encouraged to scan their assessment and submit by email; post and fax options were also available. Processing involved saving electronic tests (emailed) into a marking folder and scanning paper tests (posted or faxed) to convert them into electronic format to be saved into the marking folder. A shared drive was implemented to allow staff, regardless of their location, to access students’ assessments as soon as they were processed. Tablet PCs were used to mark assessment electronically. Using an annotation programme, markers were able to provide the same quality of feedback with digital ink as they could previously with ink on paper. Once marked, tests were saved in the individual student’s folder and a copy returned to the student via their student email account. This reduced the turnaround time of tests to several days.

This process had an added advantage of allowing the lecturer to keep a permanent record of each student’s exact submission as well as an exact copy of the feedback returned. This made it easy for distance students to discuss their progress and formative assessments with the lecturer; enabling students to be involved in the feedback process to increase learning. It is recognised by Darkenwald and Merriam (1982) that ‘Learning is more effective if the adult learner is actively rather than passively involved in the learning activity’. Involving the student in their on-going formative assessment not only encourages engagement and collaboration between students and lecturers but also prepares students for their summative assessment.

In 2009 the format of the tests were changed so that students completed the tests on the test paper in the space provided. Having the questions above the student’s answers made electronic marking much easier and more efficient. Previously students would submit test that were out of order with no labelling of questions, making it extremely difficult for the marker to match questions and answers.

To examine the impact of these changes a study was conducted in 2011. Approximately 850 distance CQUUniversity TM students, who had been or were enrolled in any of the TM courses during 2010 or 2011, were invited to anonymously complete a 10 minute online survey. The
survey was completed by 159 TM students; students were able to skip questions. It was found that the majority of students submitted their assessment by email (66.19% n=92/139). On average most assessment was returned in 2-4 days (47.86% n=67/140). For students submitting assessment by email, 75.00% (n=69) received their marked assessment in less than 4 days. Of the participants responding 89.21% (n=124) felt that their assessment was returned quickly enough. Students were asked if they felt the feedback was easy to read and understand – less than 3% (n=4/136) felt it was not. Less than 1% of the students surveyed did not think that the feedback provided was beneficial to their learning. The majority of this feedback was written, though occasionally students were provided with video feedback.

Changing assessment to meet the University requirements for on-line submission

In 2012 the University imposed compulsory submission and return of assessment through the On-line Learning Management System (Moodle). All assessment was now stored on the course Moodle site, requiring the students to download the assessment prior to attempting it. Once completed the student was required to upload the assessment. Assessment was then downloaded by administrative staff and stored on the shared drive for access by markers (some universities have markers access Moodle directly). Due to the large number of casual markers working from home and limited internet speeds in regional Queensland most markers download tests to their local drive and mark off-line. Once the tests are marked the results and the tests are uploaded through Moodle. For staff, uploading through Moodle proved to be far more time consuming than the former email method.Bandwidths and slow internets prevented bulk uploads. This greatly hindered the ability to work remotely.

In 2012 the students were surveyed on their opinions of electronic test submission through Moodle. One hundred and fifty-six students responded to the survey. Of these 99.36% (n=155) handwrote their solutions, scanned the test and then uploaded the electronic copy through Moodle. Though the majority of these students (88.36%, n=129) had access to a scanner others used various phone apps or the camera function to convert their test into electronic format. Most of the students (87.94%, n=124) found the process of converting and uploading assessment to be easy.

Changing assessment to overcome Moodle issues

Due to the number of casual staff working from home without fast internet and the University’s firewall further hindering speed away from a campus, uploading assessment through Moodle has proved to be far more time consuming than the former email method. Bulk uploads are difficult to perform with less than optimal internet speeds (away from the University), while uploading tests and entering grades individually is extremely time consuming. The consequence of these issues have resulted in less detailed feedback being supplied to students as much of the markers’ time is spent on the processing of the assessment rather than the marking of it. Course developers have begun to make changes to combat the issues associated with returning assessment through Moodle. The most obvious course of action has been taken, that is to reduce the number of assessments required to be submitted through Moodle. By combining the formative assessment, so that students only submit one test for every two modules, the number of Moodle submissions required, while halved, has reduced the frequency of the feedback to students.

A follow up study to the 2011 one has recently been approved and the findings will be report later in the year. This study also seeks the opinion of the staff involved in the feedback process as well as that of the student. One future project examines the use of Multiple Choice
Questions for formative assessment, with video support to provide feedback when a student selects an incorrect answer. It is envisaged that this will assist student learning by providing instant feedback in the form of a video with the instructor writing the solution and talking the student through the steps, including their thought processes involved in the mathematics. After watching the video, the student will be able to attempt a similar question, thus completing the feedback loop.

Conclusion

Formative assessment is a vital part of the learning process but to be effective the turn-around time for submission and the return of feedback must be prompt. Changes in available technologies have enabled turn-around time for formative assessment to be greatly reduced.

Continual evolvement of the processes and assessment is required to ensure neither students nor staff are disadvantaged by the acceptance or rejection of new technologies. The use of multimedia feedback may be a means of reducing the time taken to give quality personalised feedback while increasing student satisfaction and knowledge retention.

The modern university poses the problem of optimising the time of the teaching staff while still providing quality timely feedback that encourages and supports student learning.

References