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Video Enhanced Multiple Choice Questions – Personalising eLearning

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ABSTRACT

Instructional videos have been successfully used to teach mathematical concepts to distance students. These videos allow the students to see and hear their lecturer with an added advantage of being able to stop and rewind or replay until the concept is understood. While videos facilitate student understanding, formative assessment provides both lecturer and student with an indication of the latter's mastery of a mathematical concept.

Formative assessment with handwritten feedback is viewed as preferential because changing university culture means few academics have the time to provide comprehensive handwritten feedback to large numbers of students for every concept. Further, for this feedback to be useful it needs to be delivered to the student in a timely manner. The ability to provide instant feedback is one of the major advantages of online quizzes using multiple choice questions (MCQs).

There are mixed attitudes towards MCQs within academia. For each attribute of MCQs, research can be found to both support and condemn it. Feedback from MCQs is undoubtedly fast but is it effective? Using video enhanced feedback for online quizzes may provide the best of both worlds.

Keywords: Mathematics education, assessment, feedback, Multiple Choice Questions, assessment technology

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INTRODUCTION

Universities around the world have undergone changes in their identities and roles; education has become an internationalised, global commodity, with reduced government funding and increased emphasis on market driven university funding (Parker, 2011). The 2015-2016

Australian Federal Budget (Australian Government, 2015) facilitates further commercialisation of Australian universities by removing the cap on student fees and decreasing the government's contribution for government supported students.

The Australian Government is encouraging universities to increase their enrolments and admit greater numbers of non-traditional students (Gillard, 2009). As a result, Australian universities have relaxed their entry requirements, reducing the necessity for high school students to complete traditional science subjects (Lyons & Quinn, 2010). The Australian Academy of Science identifies these changes as 'one of the key contributors to declines in mathematics enrolments at the senior high school level' (Lyons & Quinn, 2010, p. 109). Students are completing high school unprepared for their tertiary studies, increasing the burden on universities to provide bridging and remedial courses (Falkiner, 2012) or provide extra academic assistance.

This goes against the perception that a university's 'purpose is not to transfer knowledge but to create environments and experiences that bring students to discover and construct knowledge for themselves, to make students members of communities of learners that make discoveries and solve problems' (Barr & Tagg, 1995, p. 13). When students enter undergraduate programmes without the assumed knowledge, learning is affected. Given that learning is 'a planned process to modify attitude, knowledge or skill behavior through learning experience to achieve performance in an activity or range of activities' (Hargreaves & Jarvis, 1998, p. 53) it is important that students can identify gaps in their assumed knowledge to plan this process for themselves. Diagnostic tests and formative assessment can alert students to gaps in their mathematical knowledge or comprehension.

Multiple Choice Questions (MCQs) are able to provide quick feedback to students, though this is often limited to an indication of the answer being correct or not. Combining MCQs and proven forms of feedback can provide students with quality feedback immediately.

LITERATURE REVIEW

Assessment and Feedback

Assessment and feedback are vital components of learning and teaching - it could be stated that assessment is the corner stone of education. It prepares the student for the next task and creates confidence that tasks are achievable (Boud, 2000). Assessment should not be so difficult that the student becomes discouraged but should still maintain a certain amount of complexity (Boud, 2000) while testing acquired knowledge.

Formative assessment is any assessment that is used to acquire information for the purpose of adjusting learning and teaching (Killen, 2005). This form of assessment provides students with a chance to reflect on feedback with the knowledge that it will improve their chance of achieving a better grade (Tait, 2005).

Distance students and their lecturers gain valuable insight into the former's level of understanding, highlighting any need for assistance. 'The importance of feedback provided through formative assessment is not only an important part of the learning process but is also reciprocal' (Dekkers, Adams, & Elliott, 2011, p. 4). Formative assessment has the ability to improve students' confidence and their ability to learn (Boud, 2000) by giving them feedback and the opportunity to improve. 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 (Rolfe & McPherson, 1995; Rushton, 2005; Fletcher & Shaw, 2012).

Self-assessment is the means by which the student or the learner determines, through their own means, whether or not they have grasped the concept or the task being learnt. It is an important part of becoming a successful student. Students who are capable self-assessors experience favourable learning and internal motivation (Athanasou & Lamprianou, 2002). The acquisition of self-assessment skills not only improves learning in a particular subject but also establishes the foundation for lifelong learning (McDonald & Boud, 2003).

A study examining students seeking mathematics assistance found 52% (23/44) did so because they recognised their failure to comprehend a concept, topic or problem in a lecture, tutorial or in their textbook (Adams, Hayes, Dekkers, Elliott, & Atherton, 2012, p. 28). Accurate self-assessment is especially crucial in higher education, though several factors limit the student's ability to accurately self-assess (Dunning, Heath, & Suls, 2004). These factors are:

- Information deficits — the lack of knowledge or expertise to accurately assess competence.
- Unknown errors of omission — the inability to recognise knowledge gaps.
- Information neglect — the failure to take into account information that is at hand.

Students that are not effective self-assessors face impediments in learning and performing well on other assessments which also hinder their ability to cope with change (Boud, 2000, 2007). Formative assessment in the form of diagnostic tests may be one way to assist students to self-assess and determine any knowledge gaps that they may have.

The gaps between students' present knowledge and required knowledge can be lessened or closed through formative assessments (Boston, 2002). For formative assessment to be effective, a minimal turn-around time is required to correct students' fundamental errors prior to them commencing subsequent topics, which are built on mathematical knowledge. Timely feedback is important in the student's learning process (Irons, 2007) as it can strengthen correct understanding and encourage long-term recollection (Smith & Kimball, 2010) as well as correct errors.

Students are motivated by detailed feedback but are less satisfied when the feedback is generic (Malau-Aduli, Assenheimer, Choi-Lundberg, & Zimitat, 2013). Quality of the feedback is central to learning (Sadler, 1998). Quality, timely feedback is required to assist self-directed learning (Pilling-Cormick, 1997) and it has been suggested that regardless of the sophistication of the feedback system associated with the use of technology, it is unable to provide the personalized feedback required by students (Siozos, Palaigeorgiou, Triantafyllakos, & Despotakis, 2009). It is important then that the use of technology in education benefits both student and lecturer.

Technology in Education

Technology is now increasingly used to make higher education accessible to students (Shea, Pickett, & Li, 2005). It is changing the way students learn and study as well as the way they interact with educational institutions. In fact, students now expect that electronic materials will be available for their subjects via the internet (Golden & Lee, 2007). 'One vision of the future of universities is that virtualization and remote working technologies will enable us to study at any university in the world, from home' (MacKeogh & Fox, 2009, p. 147). Distance study is moving into the mainstream of higher education, with increases in technological development causing rapid expansion during the past decade (Harry, John, & Keegan, 2013).

The use of Information communication technologies (ICTs) has increased across every facet of our lives. This has resulted in universities adopting online learning environments as a means of delivering subjects (Fleming, 2010). 'Improving the quality of learning is no light undertaking and does not happen just because teaching goes online. A high-quality learning system with real potential for improving student performance would entail a quite substantial investment - human, intellectual, financial…' (Skilbeck, 2001, p. 62). This will require 'lecturers to provide the interface between the 'educational technology' of the learning and teaching environment and the 'technological literacy' demands of society' (Dekkers, Howard, Adams, & Martin, 2013, p. 165).

Even though integrating technology into a mathematics classroom results in improved attitude and increased engagement with the mathematics, these positive effects are dependent on how well the technology is used (Ozel, Yetkiner, & Capraro, 2008). Within the Australian context this is hindered by the fact that mathematics teachers have little experience with computer-based learning design (Geiger, Forgasz, Tan, Calder, & Hill, 2012). Despite being taught their subject matter through the use of technology, many pre-service teachers have not learnt to teach with technology and therefore few teachers feel comfortable including technology in their teaching (Niess, 2005).

Mobile learning utilises personal and portable technologies for effective education (Roschelle & Sharples, 2010). These technologies are termed ubiquitous technologies. They have facilitated the breaking down of the boundaries in higher education and enabled eLearning regardless of location. Technologies that provide access to asynchronous learning have fostered anywhere, anytime learning (Kumar, 2014). It is a concept that predates the use of ubiquitous technologies (Nyquist, Arbolino, & Hawes, 1977).

The use of ubiquitous technologies is encouraged by the use of eLearning systems at the university level. Universities now place all of their learning materials, assessment and support facilities on a Learning Management System (LMS) such as Moodle. The LMS provides students with activities, readings, videos, recorded lecture videos and accompanying PowerPoint® slides.

The Tablet PC enables PowerPoint®, and other programs to be used in a more interactive way; 'digital inking' enables the user to write on the computer using a digitiser pen. No attempt is made by the computer to convert the writing into text (*Figure 1*). Combining this ability with Camtasia®, allows videos to be created that not only convey the mathematics concepts and ideas but also the mental processes involved in problem solving (Adams, Elliott, & Dekkers, 2010). It is important that students be able to mentally plan a sequence of tactical decisions when forming a strategy for solving equations (Robson, Abell, & Boustead, 2009). These videos enable students to experience the teaching of mathematics as if they were in a classroom.

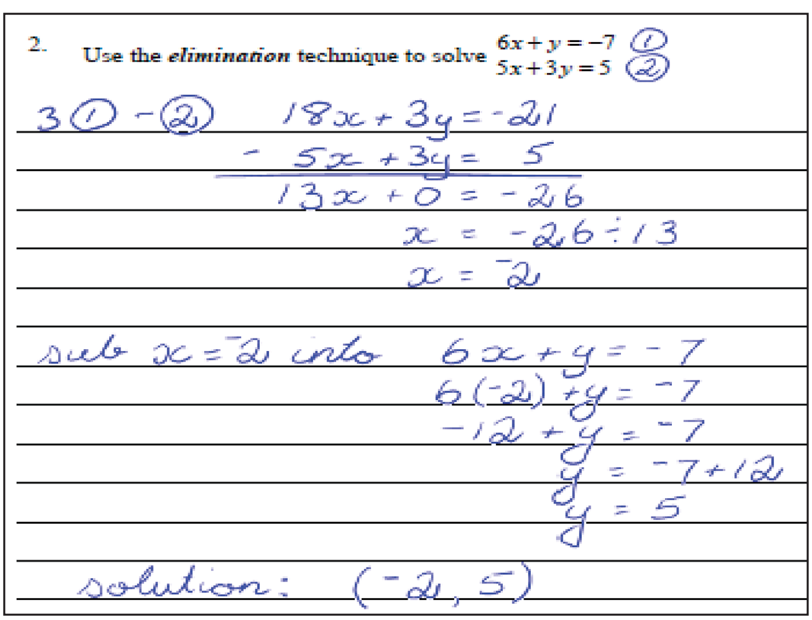

Figure 1. Handwritten solutions created using the Tablet PC

Videos provide more effective learning and reduced cognitive overload if they are limited to a maximum of 7 minutes (Miller, 1994; Adams et al., 2010). To avoid passive viewing and engage the students, each video should first present the topic, demonstrate through examples and then provide an activity for the student. The ability to provide digital handwritten feedback and solutions makes the Tablet PC an exceptional tool for providing feedback on assessments.

Technology and Assessment and Feedback

Technology has been utilised in many ways for formative assessment and feedback. It has the ability to remove various limitations that formerly rendered high-quality formative assessment difficult or impractical (Brown, Hinze, & Pellegrino, 2008). Online formative assessments can provide teachers and students with significant educational experiences via a pedagogical strategy to change the assessment culture so that diverse learning needs and equitable education are supported (Gikandi, Morrow, & Davis, 2011).

The possibility of incorporating multimedia feedback into assessments seems only to be limited by the imagination. Smartphone scanner apps allow students to scan their work and share it with the lecturer using Dropbox, providing the lecturer with instant feedback on the students' understanding of the class content in real time (Herr & Tippens, 2013). Providing students with audio feedback was found to increase content retention, increase students' satisfaction through personalization and reduce marking time (Orlando, 2013). Electronic marking has also been conducted using a Tablet PC to annotate student assessment. Once annotated, the assessment is saved as a Word or PDF document which can be viewed on any LMS by the student (French, 2007). The Tablet PC allows personalized handwritten feedback for mathematics to be provided electronically to all students (Hayes & Adams, 2009). Handwritten feedback is preferable to computer generated marking and comments as it is more authentic and provides guidance for a solution. (Harrison, Pidcock, & Ward, 2009). Handwritten solutions have been found to be more beneficial to student comprehension than typed solutions (Jordan, Loch, Lowe, Mestel, & Wilkins, 2012), and instructional videos even more so (McNamara & Barnett, 2012).

Multiple Choice Questions

Multiple Choice Questions (MCQs) have been used in assessment since 1914 when they were designed by Frederick J. Kelly of the University of Kansas (Mathews, 2006). The MCQs are quick to mark and relatively easy to setup, though writing good MCQs is not so easy. It is important that assessment be both reliable and valid, as these attributes will provide consistent results across comparable cohorts. Both MCQs and true-false questions are considered to be highly reliable when they contain a sufficient number of valid questions (Palmer & Devitt, 2007). Good MCQs are difficult to write and have been found to be time consuming to construct correctly. When conducted online they are difficult to authenticate (McNamara & Barnett, 2012). The MCQs often contain item-writing flaws attributed to the lack of training provided to educators (Tarrant & Ware, 2008). One such flaw is cueing (Fenderson, Damjanov, Robeson, Veloski, & Rubin, 1997).

Two types of cueing are recognised: positive cueing (correct answer directed cue) and negative cueing (incorrect answer directed cue) (Schuwirth, van der Vleuten, & Donkers, 1996). Positive cueing is more evident in difficult items, with easy items more often displaying negative cueing. Recognising cuing is just one of the methodologies adopted by students in their attempt to game play MCQ examinations (McNamara & Barnett, 2012). Despite this game play, it has been found that student feel disempowered by MCQs and would prefer to answer the questions in their own words (Paxton, 2000). Some students find the language used in MCQs confusing and have difficulties distinguishing between answers that are quite similar in meaning (Paxton, 2000). Item-writing flaws tend to benefit borderline students but disadvantage others (Tarrant & Ware, 2008).

The increasing popularity of MCQs in higher education may be due to ‘growing numbers of students, reduced resources, modularization and the increased availability of computer networks’ (Nicol, 2007, p. 53). This increase in popularity is further facilitated by the growth in ubiquitous technologies and the corporatisation of universities. The fact that MCQs are comparatively less time consuming ‘to set, to answer, to correct, to provide feedback and to administer’ contributes to their acceptance (Chan, Tam, & Li, 2011). Marking is usually completed electronically, making MCQ tests and examinations preferable for subjects with large cohorts. The problem with many MCQs is that the only feedback they provide to students is the correct answer. This provides minimal assistance in helping students to learn from their mistakes. Additionally, single attempt MCQs provide no opportunity for students to verify if they have overcome their misunderstanding and mastered the concept. Single or short answer on-line quizzes also experience similar problems. The MCQs have the advantage of being easily incorporated into e-Learning platforms.

The LMS enables various forms of media and multimedia to be incorporated into an online quiz. Providing video solutions to MCQs engages students’ senses and enables them to more easily comprehend the concept. It is envisaged that this will also remove the ‘multiple-guess’ problem associated with MCQs as students will have the opportunity to watch a video explaining the mathematical concept, through a similar example, when an incorrect answer is selected. Just watching a video is not sufficient for learning mathematics. It is important that the feedback loop is completed and students require the opportunity to practice. This can be achieved by enabling the student to attempt a similar question after watching the video. The student is then able to reattempt questions to affirm their understanding.

Equally important as completing the feedback loop is ensuring that the feedback facilitates this completion. Merely indicating that an answer is correct is not very helpful as it is unable to provide the feedback that is valuable for learning (Paxton, 2000). Discovering what is known and unknown directs learning. While suitable feedback on performance is beneficial for learning, discovering what is unknown and being provided with the resources to learn can lead to increased confidence.

High levels of self-confidence and self-efficacy lead to greater success in undergraduate mathematics and mathematics assessment (Goodwin, Ostrom, & Scott, 2009). These findings are more significant for women than for men. Traditionally, males performed better than females on multiple choice tests, though this gap is closing (Liu & Wilson, 2009). This may be due to better test preparation and an increased willingness by females to guess where they would have left a question blank. Gender biases in multiple choice questions may lay in what is tested rather than how it is tested (Goodwin et al., 2009). Performance in MCQs is also related to the marking schemes adopted.

Researchers and educators are undecided on the most appropriate method for applying marks for MCQs. The simplest marking form rewards correct answers only. Some marking schemes attempt to compensate for guessing (Scharf & Baldwin, 2007). Negative marking for incorrect answers is mainly adopted to discourage guessing (Burton, 2005), but all students are negatively affected by negative marking (Bond et al., 2013). To overcome this, a method of applying confidence measurements to each MCQ answer was developed (Farrell & Leung, 2004) and also for the same reason, Elimination testing, claimed to discriminate between all possible knowledge levels (Bond et al., 2013). Regardless of these attempts, discouraging guessing is difficult and using MCQs for formative assessment seems the most appropriate.

When MCQs are used for formative assessment and delivered online, students are able to practise, receive feedback and reflect on their learning (Wei & Johnes, 2005).

The Project and Preliminary Results

This research builds on previous research investigating the use of videos to teach mathematics to students and the resulting changes in students' confidence levels (Adams et al., 2010; Adams, Elliott, & Dekkers, 2011; Adams & Elliott, 2013; Adams, Hayes, Dekkers, & Johnston, 2013; Adams, Dekkers, & Elliott, 2012, 2014; Adams & Porter, 2014). These initial results were formulated with very basic statistical applications and further investigation is required.

This projects investigates optimising the feedback provided by MCQs and the learning capacity through the incorporation of video feedback for incorrect answers. Upon selecting an incorrect answer (*Figure 2*) the student may choose to watch a video on a similar question or download a related module (text chapter). The use of a similar question for the video was to improve students' application and transference skills.

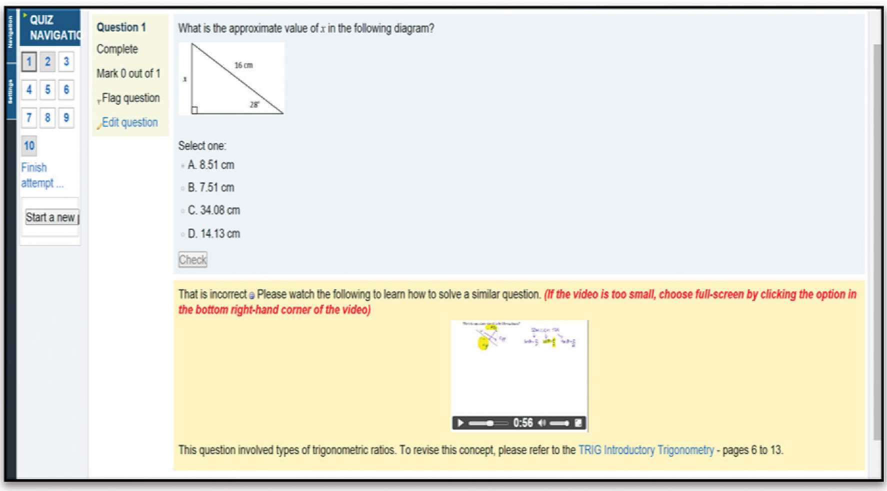

Figure 2. Incorrect answer with video

The initial pilot of the video enhanced multiple choice questions (VEMCQs) project commenced in term 2, 2014, and was a first-year introductory undergraduate subject. The subject included some very basic mathematics for Built Environment students. There were initially 35 students enrolled in the subject. Eleven students dropped the subject before census date (last day to withdraw without academic or financial penalty) and a further two students withdrew after this date; these two students did not attempt the VEMCQ test. Three of the students withdrawing before census attempted the VEMCQ test, one of these students withdrew from the subject on the same day the test was completed.

There was a total of 18 students who attempted the test (not all attempts were completed); 6 of these students attempted the test multiple times. All of the students attempting the test more than once improved on subsequence attempts. The first attempt could not be used to predict the final test score as it was unknown what action students took as a result of attempting the test. The small number of students that did complete the survey provided minimal insight into some actions taken (*Figure 3*).

I did not finish the test as I wasn't doing too well and commenced some study through the ALC but did not re-commence the test as I got caught up studying for other topic quizzes/assignments.

It's the first time I have encountered so much help. It is truly amazing.

Figure 3. Student comments

The survey consisted of seven questions comprising multiple choice questions, scaled questions and open-ended responses. Only 5 students completed the survey and they believed that the inclusion of the VEMCQ test into the subject assisted them with their understanding of the assumed knowledge content and all would like to see similar types of tests, with video support, incorporated into their other subjects. Figure 3 shows the students' comments. It can be seen from the first comment that at least one student used the test to highlight the gaps in his or her knowledge and seek assistance (the ALC provides individual mathematics assistance).

Though the number of students in the pilot study was small, valuable insight into the setting up and implementation of the project was gained. The study will be repeated in subjects with larger cohorts and the knowledge gained from the pilot will be used to improve subsequent implementations.

CONCLUSION

Building on research investigating the use of videos to teach mathematics to distance students and register changes in their confidence levels, this project combines this with the ability of MCQs to give immediate feedback. Videos have been found to be a convenient and worthwhile way to teach mathematics to distance students. It was found that scaffolding mathematics subject with both instructional videos and personalised feedback increased student confidence and reduced their fear of mathematics.

Providing students with MCQ diagnostic testing prior to the commencement of a subject can assist students in discovering any gaps they may have in their assumed knowledge. While conceptually the use of video feedback for MCQs should assist students to highlight and fill assumed knowledge gaps, data collected have not been able to provide insight into its effects. The pilot has however, highlighted the need to improve the survey instrument and increase participant numbers to provide insight into student experience.

REFERENCES

Adams, N., Dekkers, A., & Elliott, S. (2012). *Supportive frameworks that increase mathematical knowledge and confidence in students*. Paper presented at the ISTE International Conference on Mathematics, Science and Technology Education, Kruger National Park, South Africa.

Adams, N., Dekkers, A., & Elliott, S. (2014). *Preparing enabling students for undergraduate study through the use of ubiquitous technologies*. Paper presented at the 17th International First Year in Higher Education Conference, Darwin Convention & Exhibition Centre.

Adams, N., & Elliott, S. (2013). *The Tablet PC: Bridging mathematics*. Paper presented at the Computer-Based Math Education Summit, UNICEF Headquarters, New York, USA.

Adams, N., Elliott, S., & Dekkers, A. (2010). Videos that click: helping bridging mathematics students make the connection. In J. Terrell (Ed.), *Making the links: learning, teaching and high quality student outcomes: proceedings of the 9th conference of the New Zealand Association of Bridging Educators*. Auckland, N.Z.: Unitec New Zealand.

Adams, N., Elliott, S., & Dekkers, A. (2011). *Utilising technology to increase student engagement and success in bridging mathematics*. Paper presented at the 1st International Australasian Conference on Enabling Access to Higher Education, Adelaide, Australia.

Adams, N., Hayes, C., Dekkers, A., Elliott, S., & Atherton, J. (2012). Obtaining learning independence and academic success through self-assessment and referral to a Mathematics Learning Centre. *The International Journal of the First Year in Higher Education, 3*(2), 21-32.

Adams, N., Hayes, C., Dekkers, A., & Johnston, D. (2013). *Assimilating Transformative Learning amongst a Diverse Cohort of Enabling Mathematics Students*. Paper presented at the 20th International Conference on Learning, Rhodes, Greece.

Adams, N., & Porter, A. (2014). *Evolving formative assessment for and with ubiquitous technologies*. Paper presented at the 12th International Conference of The Mathematics Education into the 21st Century Project, Herceg Novi, Montenegro.

Athanasou, J. A., & Lamprianou, I. (2002). *A teacher's guide to assessment*. Social Science Press.

Australian Government (2015). *Budget | 2015 - 2016*. Retrieved from http://www.budget.gov.au/2015-16/index.htm.

Barr, R. B., & Tagg, J. (1995). From teaching to learning—A new paradigm for undergraduate education. *Change: The magazine of higher learning, 27*(6), 12-26.

Bond, A. E., Bodger, O., Skibinski, D. O. F., Jones, D. H., Restall, C. J., Dudley, E., & van Keulen, G. (2013). Negatively-Marked MCQ Assessments That Reward Partial Knowledge Do Not Introduce Gender Bias Yet Increase Student Performance and Satisfaction and Reduce Anxiety. *PLoS ONE, 8*(2), e55956.

Boston, C. (2002). The concept of formative assessment. *Practical Assessment, Research & Evaluation, 8*(9), 1-5.

Boud, D. (2000). Sustainable assessment: rethinking assessment for the learning society. *Studies in continuing education, 22*(2), 151-167.

Boud, D. (2007). Reframing assessment as if learning were important. In D. Boud & N. Falchikov (Eds.), *Rethinking assessment in higher education: Learning for the longer term* (pp. 14–25). London and New York: Routledge.

Brown, J., Hinze, S., & Pellegrino, J. W. (2008). Technology and formative assessment. *21st Century education, 2*, 245-255.

Burton, R. F. (2005). Multiple-choice and true/false tests: myths and misapprehensions. *Assessment & Evaluation in Higher Education, 30*(1), 65-72.

Chan, C. K. Y., Tam, V. W. L., & Li, C. Y. V. (2011). A comparison of MCQ assessment delivery methods for student engagement and interaction used as an in-class formative assessment. *International Journal of Electrical Engineering Education, 48*(3), 323-337.

Dekkers, A., Adams, N., & Elliott, S. (2011). *Using technology to provide a supportive mathematical pathway into university*. Paper presented at the 8th Delta conference on the teaching and learning of undergraduate mathematics and statistics, Rotorua, New Zealand.

Dekkers, A., Howard, P., Adams, N., & Martin, F. (2013). Strategies to remove barriers and increase motivation to use the Tablet PC in formative assessment. In F. Alam (Ed.), *Using Technology Tools to Innovate Assessment, Reporting, and Teaching Practices in Engineering Education*. Hershey: IGI Global.

Dunning, D., Heath, C., & Suls, J. M. (2004). Flawed self-assessment implications for health, education, and the workplace. *Psychological science in the public interest, 5*(3), 69-106.

Falkiner, A. (2012). *National trends in Year 12 course completions*. Australian National University.

Farrell, G., & Leung, Y. K. (2004). Innovative online assessment using confidence measurement. *Education and Information Technologies, 9*(1), 5-19.

Fenderson, B. A., Damjanov, I., Robeson, M. R., Veloski, J. J., & Rubin, E. (1997). The virtues of extended matching and uncued tests as alternatives to multiple choice questions. *Human Pathology, 28*(5), 526-532.

Fleming, J. (2010). *A Framework for Academic Staff Online Course Development*. Faculty of Arts, Business, Informatics and Education, Central Queensland University.

Fletcher, A., & Shaw, G. (2012). How does student-directed assessment affect learning?: Using assessment as a learning process. *International Journal of Multiple Research Approaches, 6*(3), 245-263.

French, J. H. (2007). Beyond the tablet PC: using the tablet PC in a collaborative learning environment. *Journal of Computing Sciences in Colleges, 23*(2), 84-89.

Geiger, V., Forgasz, H., Tan, H., Calder, N., & Hill, J. (2012). Technology in mathematics education. In *Research in Mathematics Education in Australasia 2008–2011* (pp. 111-141). SensePublishers.

Gikandi, J. W., Morrow, D., & Davis, N. E. (2011). Online formative assessment in higher education: A review of the literature. *Computers & Education, 57*(4), 2333-2351.

Gillard, J. (2009). *Funding boost helps low-SES higher education student places*. Retrieved from http://www.deewr.gov.au/ministers/gillard/media/releases/pages/article_091215_102745.aspx.

Golden, K., & Lee, S. (2007). *The Impact of Web-Based Materials on Student Learning and Course Delivery in Engineering Mathematics.* Paper presented at the International Conference on Engineering Education–ICEE.

Goodwin, K. S., Ostrom, L., & Scott, K. W. (2009). Gender differences in mathematics self-efficacy and back substitution in multiple-choice assessment. *Journal of Adult Education, 38*(1), 22-42.

Hargreaves, P., & Jarvis, P. (1998). *The human resource development handbook*: Kogan Page.

Harrison, M., Pidcock, D., & Ward, J. (2009). Using Technology to Help Engineers Learn Mathematics. *Electronic Journal of Mathematics & Technology, 3*(2), 165-175.

Harry, K., John, M., & Keegan, D. (2013). *Distance education: New perspectives*. Routledge.

Hayes, C., & Adams, N. (2009). *Use of Tablet PCs at CQUniversity to create a paperless environment for courses.* Paper presented at the Australasian Tablets in Education Conference (ATiEC).

Herr, N., & Tippens, M. (2013). *Using Scanning Apps on Smart Phones to Perform Continuous Formative Assessments of Student Problem-Solving Skills During Instruction in Mathematics and Science Classes*. Paper presented at the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education.

Irons, A. (2007). *Enhancing learning through formative assessment and feedback*. Routledge.

Jordan, C., Loch, B., Lowe, T., Mestel, B., & Wilkins, C. (2012). Do short screencasts improve student learning of mathematics? *MSOR Connections, 12*(1), 11-14.

Killen, R. (2005). *Programming and assessment for quality teaching and learning*. Social Science Press.

Kumar, N. P. (2014). Information and communication technology (ICT) in education. *International Journal of Research in Advent Technology, 2*(1), 1.

Liu, O. L., & Wilson, M. (2009). Gender differences in large-scale math assessments: PISA trend 2000 and 2003. *Applied Measurement in Education, 22*(2), 164-184.

Lyons, T., & Quinn, F. (2010). Choosing science. *Understanding the declines in senior high school science enrolments.* Armidale, NSW: University of New England.

MacKeogh, K., & Fox, S. (2009). Strategies for Embedding e-Learning in Traditional Universities: Drivers and Barriers. *Electronic Journal of e-Learning, 7*(2), 147-154.

Malau-Aduli, B. S., Assenheimer, D., Choi-Lundberg, D., & Zimitat, C. (2013). Using computer-based technology to improve feedback to staff and students on MCQ assessments. *Innovations in Education and Teaching International, 51*(5), 510-522..

Mathews, J. (2006). Just whose idea was all this testing. *The Washington Post, 14*.

McDonald, B., & Boud, D. (2003). The impact of self-assessment on achievement: the effects of self-assessment training on performance in external examinations. *Assessment in Education: Principles, Policy & Practice, 10*(2), 209-220.

McNamara, N., & Barnett, E. (2012). Learning in law: using MCQs for summative assessment in core law courses. *International Journal of Organisational Behaviour, 17*(3), 46-61.

Miller, G. A. (1994). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological review, 101*(2), 343-352.

Nicol, D. J. (2007). E-assessment by design: using multiple-choice tests to good effect. *Journal of Further and Higher Education, 31*(1), 53-64.

Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education, 21*(5), 509-523.

Nyquist, E., Arbolino, J., & Hawes, G. (1977). *College Learning Anytime, Anywhere*. New York: Harcourt Brace Jovanovich.

Orlando, J. (2013). Learning 2.0: Online Voice Feedback for Better Learning. *Online Classroom, 13*(11), 4-6.

Ozel, S., Yetkiner, Z. E., & Capraro, R. M. (2008). Technology in K-12 Mathematics Classrooms. *School Science and Mathematics, 108*(2), 80-85.

Palmer, E. J., & Devitt, P. G. (2007). Assessment of higher order cognitive skills in undergraduate education: modified essay or multiple choice questions? Research paper. *BMC Medical Education, 7*(1), 49.

Parker, L. (2011). University corporatisation: driving redefinition. *Critical Perspectives on Accounting, 22*(4), 434-450.

Paxton, M. (2000). A linguistic perspective on multiple choice questioning. *Assessment & Evaluation in Higher Education, 25*(2), 109-119.

Pilling-Cormick, J. (1997). Transformative and Self-Directed Learning in Practice. *New Directions for Adult and Continuing Education, 1997*(74), 69-77. doi: 10.1002/ace.7408

Robson, D., Abell, W., & Boustead, T. (2009). Scaffolding for Learning Equation Solving. In R. Hunter, B. Bicknell & T. Burgess (Eds.), *Crossing Divides (Proceedings of the 32nd Annual Conference of the Mathematics Education Research Group of Australasia) 978-1-920846-20-6* (Vol. 1). Wellington, New Zealand: Mathematics Education Research Group of Australasia Inc.

Rolfe, I., & McPherson, J. (1995). Formative assessment: how am I doing? *The Lancet, 345*(8953), 837-839.

Roschelle, J., & Sharples, M. (2010). Guest editorial: Special issue on mobile and ubiquitous technologies for learning. *IEEE Transactions on Learning Technologies, 3*(1), 4-5.

Rushton, A. (2005). Formative assessment: a key to deep learning? *Medical Teacher, 27*(6), 509-513.

Sadler, D. R. (1998). Formative assessment: revisiting the territory. *Assessment in education, 5*(1), 77-84.

Scharf, E. M., & Baldwin, L. P. (2007). Assessing multiple choice question (MCQ) tests-a mathematical perspective. *Active Learning in Higher Education, 8*(1), 31-47.

Schuwirth, L., van der Vleuten, C., & Donkers, H. (1996). A closer look at cueing effects in multiple-choice questions. *Medical Education, 30*(1), 44-49.

Shea, P., Pickett, A., & Li, C. S. (2005). Increasing access to higher education: A study of the diffusion of online teaching among 913 college faculty. *The International Review of Research in Open and Distance Learning, 6*(2).

Siozos, P., Palaigeorgiou, G., Triantafyllakos, G., & Despotakis, T. (2009). Computer based testing using "digital ink": Participatory design of a Tablet PC based assessment application for secondary education. *Computers & Education, 52*(4), 811-819.

Skilbeck, M. (2001). *The university challenged: A review of international trends and issues with particular reference to Ireland*. Dublin: Higher Education Authority.

Smith, T. A., & Kimball, D. R. (2010). Learning from feedback: Spacing and the delay–retention effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 36*(1), 80-95.

Tait, P. (2005). Assessment drives learning. *Journal of Pharmacy Practice and Research, 35*(3), 211.

Tarrant, M., & Ware, J. (2008). Impact of item-writing flaws in multiple-choice questions on student achievement in high-stakes nursing assessments. *Medical Education, 42*(2), 198-206.

Wei, Y., & Johnes, J. (2005). Internet tools in teaching quantitative economics: why gaps between potential and reality? *Journal of Further and Higher Education, 29*(2), 125-141.