Staff Use of Technology-Enhanced Assessment in Higher Education:
A Systematic Review

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Introduction

There is a clear impetus at national and international levels to determine how higher education systems might stimulate, support and scale up purposeful use of digital technology in teaching, learning and assessment (European Commission, 2014; European Commission, 2018; Department of Education and Skills, 2016). The National Forum for the Enhancement of Teaching and Learning in Higher Education (National Forum) developed a Roadmap for Enhancement in a Digital World 2015-2017 which laid the foundation for a national drive to develop practices within the learning environment 'that leverage the potential of digital technologies to support student learning and substantially contribute to evidencing pedagogical excellence' (National Forum, 2015, p. 49).

Teaching staff in higher education have become more familiar with and competent in relevant digital technologies and pedagogies and, increasingly, with the use of technology in assessment. The National Forum's 2016-18 enhancement theme, which focused on Assessment OF/FOR/AS Learning, and the concurrent initial implementation of the National Professional Development Framework for All Staff Who Teach in Irish Higher Education (National Forum, 2016; 2017b), provided a catalyst for the development of high-impact assessment approaches, including technology-enhanced assessments (TEAs).

As such high-impact practices are developed, it is important that they are rooted in evidence; students should learn in an environment that is informed by research, scholarship and up-to-date practice and knowledge (Department of Education and Skills, 2011). While technology offers great potential for the enhancement of assessment practices, such as opening opportunities for experiential learning, collaborative learning, and instant feedback, if TEA is to be optimised, its practice must be informed by the available evidence.

Focus of report

The systematic review of literature presented in this report set out to explore the literature in the area of TEA, with a particular focus on staff experiences of various TEA approaches. The research questions stemmed from discussions with staff across the sector. The broad aim of the review was to explore and synthesise peer-reviewed evidence regarding technology-enhanced Assessment OF/FOR/AS Learning in higher education, with a view to informing practice.

The review took a broad perspective on technology, while also focusing on specific technology areas relevant to teaching and learning practice. The understandings of Assessment OF/FOR/AS Learning in higher education which underpin the review are those which were agreed by representatives from across Irish higher education as part of the National Forum's 2016-18 enhancement theme (National Forum, 2017a), as follows:

- Assessment OF Learning: the demonstration of the achievement of student learning
- Assessment FOR Learning: giving feedback on teaching and student learning, with students and teachers both as learners who are in a dialogue to improve their learning or their teaching
- Assessment AS Learning: empowering students to self-regulate and critically evaluate their learning and performance

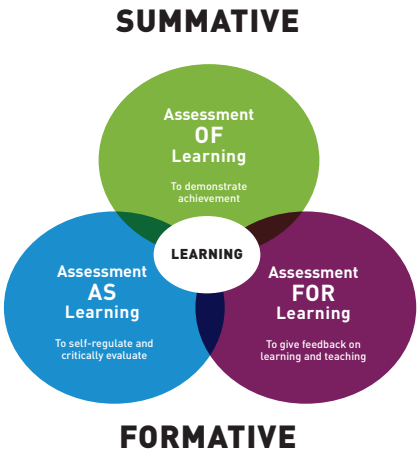

Figure 1 Sectoral understanding of Assessment OF/FOR/AS Learning (National Forum, 2017a)

Perspectives of Irish practitioners – A case-studies approach

As an addition to the systematic review, a sample of Irish higher education practitioners, who use TEA in their practice, were requested to respond to the research questions with regard to their own contexts. These case studies provide a supplementary perspective on the experience of Irish TEA practitioners. A summary of related case study perspectives appears at the end of each findings section. Case study participants were selected from among TEA-engaged practitioners known to the project team or the project advisory board and from attendees at a national workshop on TEA. Participants included representatives of universities, institutes of technology and the Higher Education Colleges Association[1].

1 Details of the case studies can be found in Appendix E.

Methodology

A systematic literature review is a type of rigorous, accountable approach to a literature review that collects and critically analyses multiple research studies or papers (Gough et al., 2012; Higgins & Green, 2011). The systematic review of literature presented in this report sought to identify studies that investigated technology-enhanced Assessment OF/FOR/AS Learning in higher education, particularly as it relates to staff experiences.

The review aimed to respond to the following research questions:

1. What models of assessment design can assist staff to harness the potential of technology to enhance student learning?
2. How can technology enhance staff efficiencies in the Assessment OF/FOR/AS Learning process?
3. What approaches could address staff concerns on the issue of student plagiarism that are often associated with technology-enhanced Assessment OF/FOR/AS Learning?
4. What types of learning environments do institutions need to provide to support technology-enhanced Assessment OF/FOR/AS Learning?

The review followed the style of a Cochrane systematic review (Higgins & Green, 2011) while also including a qualitative synthesis of the contribution(s) the included studies made to answering the specific research questions. The EPPI Reviewer tool (EPPI Centre, 2017), recommended by Cochrane, was used to undertake the systematic literature review and the qualitative synthesis.

Search strategy

The first step, following the Cochrane systematic review approach, was to locate and select studies for inclusion through search terminology definition and the development of a search strategy design.

The search string for the systematic review evolved over several iterations. An overarching search string was designed using principal keywords from the research questions, in addition to variant words pertaining to each of the initial topic areas. An initial search string was agreed, based on the combined knowledge of the project team and expert advice from information specialists. The basic search string was as follows[2]:

((feedback OR assess*) AND (technol* OR comput* OR software) AND ((higher education) OR universit*) AND (learn* OR teach*))

Preliminary analysis of the results from that search string highlighted some gaps, so the search string was further refined by ensuring that the search terms were found in the abstract or title of a paper. The words 'assignment' and 'examination' were also added to the search, as follows:

(((feedback OR assess* OR assignment OR examination) AND (technol* OR comput* OR software) AND ((higher education) OR universit*) AND (learn* OR teach*)))

The full search terminology used is presented in Appendix A.

The following databases were searched:

- Academic Search Complete
- ERIC
- Scopus
- PsycInfo
- IEEE

Inclusion/exclusion criteria

During the search strategy development process, additional parameters needed to be set for the search. The key inclusion criteria at the beginning of the search was to focus on high-quality peer-reviewed academic journal articles only. A decision was made, in consultation with the advisory board, to only include articles published in relatively well-ranked or subject-specific journals in order to increase the probability of retrieving good quality, subject-relevant materials[3]. It was also important to ensure a manageable number of studies within the project timeframe and it was decided to limit the search to papers pre-published online or assigned to journal issues between January 1st 2012 and June 1st 2017. The

2 In Boolean logic, an asterisk * can be added to the end of a word to encompass the differing variants for that word, for example assess* would widen the search to include variants on assess: assessment, assessing, etc.

3 A full list of journals mined is available on request.

beginning of 2012 was chosen as the start date to align with the timing of related technology developments and the acceleration of TEA being used and empirically studied in higher education. The overarching inclusion/exclusion criteria guiding the search are set out in Table 1.

Screening

When the search was complete, 1,490 papers had been retrieved and imported, with their bibliographic references, into EndNote and into EPPI Reviewer, in preparation for the screening process. The first phase of screening involved the project team screening references by title and abstract. This process was trialled by all three members of the team screening 10% of the papers concurrently, then discussing and reconciling the results to reach an agreement on the screening approach. The remaining papers were then shared between the team. Following the initial phase of screening of all papers by title and abstract, the project team convened to reconcile any disagreements and discuss the final results of this phase. This screening and discussion resulted in 252 papers being deemed suitable for full review. In addition to coding each reference as 'include' or 'exclude', each item was also coded according to the relevant technology topic to which it pertained, such as Web 2.0 and social media, intelligent tutorial systems, interactive multimedia systems, etc. This served to allow the full text of each paper to be reviewed by the project team member with the most relevant knowledge/expertise.

The full text screening phase involved reading each paper thoroughly to discern if it was suitable for inclusion based on whether it met the inclusion criteria, was evaluated to be of suitable quality, and answered some or all of the research questions. Many papers were systematically reviewed and then subsequently excluded because, on reading the full text, it transpired they did not have any relevant evidence to inform the qualitative synthesis.

A quality assessment was undertaken on all papers that underwent full text screening. Three quality assessment tools were used for different types of papers, as follows:

- A quality assessment tool for qualitative papers
- A quality assessment tool for quantitative papers
- A quality assessment tool for review papers, including systematic reviews

The questions used to guide each quality assessment tool are presented in Appendix C. The quality questions allowed papers to be categorised as either strong, moderate or weak. Weak papers were automatically excluded, many moderate papers made it into the final review, as did all strong papers that met the other inclusion criteria.

In all, 65 papers were included in the final review. The flowchart in Appendix B documents the search strategy and results.

Inclusion	Exclusion
Published on or after Jan 1st 2012	Published before Jan 1st 2012
English language	Not English language
From selected ranked/subject-specific journals	Not from selected ranked/subject-specific journals
Peer-reviewed	Grey literature/Not peer-reviewed
Explicitly addresses some type of TEA	Does not explicitly address TEA
Answers all or some elements of research questions	Does not contribute anything to answer research questions

Table 1 Inclusion/exclusion criteria

Data extraction and analysis

The process of data extraction and analysis was carried out using EPPI Reviewer (EPPI Centre, 2017). The extraction process involved reading and re-reading the data with all the research questions in mind and then extracting relevant data from the papers and coding them to specified codes using the EPPI Reviewer tool. General information on each study was collected via standardised systematic review codes generated automatically in EPPI Reviewer. This included information such as country, TEA used, major findings, and so on. All relevant material to answer the research questions was coded to the corresponding research question, with some papers being coded under more than one question. When the extraction phase was complete, EPPI Reviewer's coding reports tool was used to create reports that contained the following information for each included paper:

1. Systematic review extraction
2. Quality assessment
3. Qualitative data extraction

These reports provided the basis for analysis. The information gathered from the papers was analysed to discern common themes pertaining to each research question. Further descriptive analysis was undertaken on the extracted data to build a narrative of how TEA, as discussed in each paper, impacted on each of the areas of focus: assessment design, staff efficiencies, approaches to plagiarism, and learning environments[4].

Limitations

Although the review set out to respond to agreed research questions, it revealed a dearth of high quality peer-reviewed research focused on staff experiences of implementing TEA. The majority of identified papers focused on how TEA impacts on students. Further, a lack of longitudinal investigation of staff experiences of implementing TEA was evident; most included studies discuss or evaluate a TEA based on experiences of early-stage implementation. Although these are notable findings in themselves, they did limit the ability of the authors to respond comprehensively to the research questions.

4 Appendix D lists all included papers and the corresponding research questions to which they pertained.

Findings

The findings are presented in four sections, each pertaining to one research question. The sections focus on assessment design, staff efficiencies, approaches to plagiarism, and learning environments, and each section concludes with a summary of main findings and some commentary from the related case studies of practice.

Assessment Design

What models of assessment design can assist staff to harness the potential of technology to enhance student learning?

Designing assessment is the key starting point for ensuring effective assessment approaches. The first question in this review referred to models of assessment design. Models of assessment design were not found to be explicitly discussed in the included studies. Therefore, assessment design was explored more broadly across the 30 papers that had some focus on this topic. Studies that discussed assessment design often framed such discussions in terms of the motivations underpinning the design of TEA approaches. The most common motivations included (i) fostering collaborative learning, (ii) stimulating reflective learning, and (iii) using structured tasks to scaffold students' learning.

Fostering collaborative learning

The desire to foster collaborative learning was a key driver for assessment design across a number of papers. In the study by Blair et al., the focus was on the perspective of a teacher who developed screencasts 'to minimize the time spent on class lectures in order to get more participation from the students through in-class group activities' (Blair et al., 2016, p. 1468). The screencasts allowed for anytime access so no student would be unfairly disadvantaged by missing class as the material was available online. This also allowed class time to be spent on group activities and preparation for assessments. The teacher pointed out that having more time for group activities in class prepared students better for teamwork, which is necessary in the 'real world of work' (Blair et al., 2016, p. 1469). Similarly, in the study by Çakiroglu et al. (2016) the aim of the instructor's use of web conferencing video technology was to improve learning outcomes and classroom management and interaction.

The studies by Onrubia and Engel (2012) and Lafuente Martínez et al. (2015) both focused on collaborative tasks undertaken within a VLE, and emphasised that the design and scaffolding of group assessment tasks should maximise student collaboration and higher-order thinking processes.

Caple and Bogle (2013) examined a collaborative assessment task that was completed on a wiki by a large class in a first-year undergraduate course. They explored whether a wiki could help make the grading of group work more equitable due to the transparency of wiki editing and whether the wiki environment encouraged students to interact closely and directly with each other. The design of the study aimed to understand and acknowledge students' place in the wider multi-media networked environment and how that impacts on their acquisition and processing of knowledge. It also aimed to positively reinforce the concept of group work and determine how best to assign grades that adequately reflect students' contributions therein.

Zheng et al. (2015) used a design-based research approach to explore the creation and improvement of strategies for designing wiki-supported collaborative learning projects. For the study, a wiki-based learning activity was designed which introduced elements of a wiki-assisted assessment in subsequent iterations. Ultimately, over four iterations of the design-based research, the study developed nine instructional strategies in three categories to facilitate successful implementation of collaborative activities on wikis. The three categories were: (i) developing a learning community, (ii) supporting knowledge construction, and (iii) enabling cognitive apprenticeship.

Research by Goldstein and Peled (2016) focused on using wikis for teaching and learning. In most cases, the assignments for wiki-based assessment included the following steps:

> *Familiarising the students with the wiki environment; forming working groups (in some of the courses); choosing a topic and acknowledging it in the wiki; searching for meaningful resources; writing entries; giving feedback to peers' entries; rewriting the entry in light of the feedback from peers and instructor; creating cross-links between entries (in one course only).*
>
> (Goldstein & Peled, 2016, p. 475)

Use of the wikis was generally introduced to encourage and facilitate collaborative learning. The study identified several notable characteristics of wiki-based pedagogy including the following: (i) students are involved in collaborative learning, especially in giving feedback to peers, and (ii) the instructors' involvement and formative assessment contribute to students' active learning and the development of critical thinking (Goldstein & Peled, 2016, p. 480). This study also found that the role of the teacher is crucial in designing and implementing the wiki-based assessment.

The studies by Haines (2015), Pittenger and Olson-Kellogg (2012) and Waycott et al. (2013) also examine teaching and learning situations where the motivation for the introduction of wikis was to stimulate and facilitate collaborative learning.

Stimulating reflective learning

The second motivation framing discussions of assessment design centred on stimulating reflective learning through TEA. This motivation related to Assessment FOR and AS Learning; developing self-reflective and self-directed skills through feedback. The study by Chen et al. (2013) examined whether constructive feedback and connectivity techniques (using smartphones for pre-class activities and self-evaluation quizzes) had an influence on learning. Through an interactive multimedia learning environment, the researchers recorded 'all of the learner's learning activities through the smartphone, including content which has been visited and the results of self-evaluation quizzes. Using the recorded information, the learning system then generates suitable constructive feedback to help the learner' (Chen et al., 2013, p. 839). There were two types of constructive feedback that the learner received from the system, one reminding the learner to visit content which has not yet been visited and the other recommending appropriate digital content based on problems highlighted via the self-evaluation quizzes. The researchers found that this TEA providing directive feedback had the potential to help learners in reflecting on and taking control of their own learning.

Whitelock et al. (2015) documented the workings of the OpenEssayist software tool, which analyses essay texts and provides feedback. When students upload their essays, OpenEssayist extracts key phrases and structuring sentences to summarise the essay content. The system then delivers feedback to the student users that presents this key information in several ways, including graphics depicting the most prominent words used. The system prompts the user to reflect on whether these identified key words and phrases capture their main ideas for the essay. The feedback provided by the tool thus provides space for students to reflect on their work and respond and improve accordingly; it also has the potential to provide staff with higher quality work, which may be easier to grade.

Mettiäinen (2015) linked practice, competencies and reflection through e-assessment. An electronic assessment and feedback tool called eTaitava was described in this study. The tool is used to send a series of questions to the student and training supervisors to monitor and assess students' learning. In the case reported in the study, data was mainly based on students' self-evaluation of professional nursing skills competencies. The focus was on promoting continuous self-assessment (every day after their placement activities), on computer or smartphone, and engendering reflective learning practice.

Liou et al. (2016) examined how to enhance students' learning and knowledge acquisition in material science through the use of innovative technologies that can be used outside class time which allow students to undertake self-directed and reflective learning. A cloud-

based classroom was developed that was accessible via smartphone as well as other means and was designed to be more interactive than traditional flipped classrooms. In the study, the teacher used augmented reality software to design a 'crystal structure' for the material science class, which was subsequently designed as an interactive mobile app and uploaded to Dropbox for the students to download onto their own mobile devices (Liou et al., 2016, p. 462). The students were expected to use the app for self-study and interaction with the image/model, leaving the classroom time for more typical in-class discussion and learning activities.

Structured tasks to scaffold students' learning

Another common motivation for harnessing the potential of technology to enhance student learning through assessment design was the imperative to structure student activity in a scaffolded and coherent manner. Well-structured, incremental tasks which allowed for the scaffolding of learning were seen to free class time and enhance the ability of staff to foster collaborative learning and stimulate self-directed, reflective learning. The timing and structuring of tasks was seen as key to ensuring the achievement of intended learning goals. Structured tasks that integrate technology throughout a module can provide students opportunities for practice in a way that gradually builds towards the achievement of module learning outcomes.

Sun et al. (2014) examined whether the incorporation of different electronic response or feedback systems affected specific types of student engagement in the context of Plenty-of-Time Teaching (PoTT) and Just-in-Time Teaching (JiTT) approaches. The authors describe JiTT as being framed by three core principles: (i) maximizing the effectiveness of the class time discussion, (ii) making non-class time beneficial for students, and (iii) fostering and perpetuating peer interactions. PoTT expands on the JiTT approaches further by engaging 'the purposeful use of pre-class activities, such as open-ended and multiple-choice questions, conducted via the Internet, that are aimed at engaging students with the content prior to a class discussion' (Sun et al., 2014, p. 235). Consequently, harnessing the potential of PoTT provides teachers with the potential to take advantage of technology, such as web-based polling tools. The teachers designed structured tasks using web-based polling tools, which can allow teachers to assess their students' comprehension of course materials before class time. This can also serve to provide the teachers with the time and space to amend lectures accordingly, if necessary.

Similarly, Flosason et al. (2015) examined whether structuring a task that encourages students to discuss questions in small groups in class before they responded to clicker questions (during class) improved responses to similar questions in examinations. The study highlighted how in-lecture multiple choice questions (responded to via clickers) could be 'a valid measurement of concept learning and application' (Flosason et al., 2015, p. 324). The software used in the study, TurningPoint, 'automatically stores each response made with a clicker, by individual students, and assigns points for each response as prescribed during question construction' (Flosason et al., 2015, p. 325). The teachers found that the task using the clickers generally yielded positive results; it resulted in good in-class discussions and pertinent questions from the students.

Çakiroglu et al. (2016) suggested that the design of structured programming tasks carried out using web conferencing tools could help students to develop further knowledge as a result of peer interaction within the task. Both structured and unstructured tasks informed the assessment design of the asynchronous and synchronous classrooms described in the study by Chao et al. (2012). The study described the design of the 3C platform which hosts an 'instructor's office' accessed only by teachers, and a 'cyber classroom' which can be accessed by both teachers and students/learners. Within that, there are two types of cyber classroom: (i) the asynchronous classroom, which is available 24 hours a day and hosts audio-, video-, and text-based learning resources, including discussion boards etc., and (ii) the synchronous classroom, which acts more like a live real-time online classroom. Assessment within the synchronous classroom includes synchronous quizzes, practicum, essays and oral assessments (Chao et al., 2012).

Similarly, Summers et al. (2014, p. 76) used a synchronous online classroom to administer structured tasks online in a dance studies course. The classroom was moderated by a teaching assistant and comprised chatrooms to host discussion sessions, video tours that present lectures and allow students to answer and discuss questions directly using the Zaption tool, student blogs and wikis that cover course materials, timed online exams which include open-book quizzes taken online, an ePortfolio of dance practice that functions as a personal online journal/blog, and a final exam administered online through ProctorU (an online exam proctor service monitored by webcam).

The study by Maher et al. (2013) provided some evidence of how incorporating a learning aid, such as a letter-writing checklist, into a mobile app can improve the quality of output and lead to the enhancement of students' skill level. The paper discussed the development and effectiveness of a mobile app to assist in improving students' ability to write hospital discharge letters. While the checklist did not provide explicit structure for the task, it did offer the student a scaffold for their activity, supporting Assessment AS Learning (Maher et al, 2013). The app in the Liou et al. study (2016), discussed in the previous section, also contributed to an assessment design which involved structured tasks.

By incorporating structured tasks that also permit several retakes of the online exam, the study by Sullivan (2016) combined social and technological principles to use online assessment retake opportunities to reduce occurrences of cheating. This assessment task is dependent on the exams being different yet allowing for demonstration of achievement of the same learning (Sullivan, 2016).

Studies where assessment design incorporates scaffolded opportunities to practice and engage in self-directed activities often use self-assessment tools designed to foster Assessment AS learning as a principle goal, such as in the Liou study (2016). Assessment design often involves the use of online quizzes and multiple-choice tests (MCQs) for this purpose (Bennett et al., 2017; Sweeney et al., 2017). Some assessment designs which incorporate game-based learning (Blackburn, 2017; Caminero et al., 2016; Neely & Tucker, 2013; Tao et al., 2012) also use structured tasks within the game to achieve Assessment AS Learning goals. Specific TEA tools that were found to have an explicit Assessment AS Learning focus included OpenEssayist (Whitelock et al., 2015), the letter-writing checklist app (Maher, 2013), and automated tools, such as that used by Sullivan (2016), which allow for assessments to be retaken to reduce cheating. However, most assessment designs aiming to foster Assessment AS Learning relied on online quizzes and MCQs.

Key Findings

As models of assessment design were not explicitly discussed in any of the reviewed studies, the review examined the motivations framing discussion of assessment design in the included papers. The dominant motivations were: (i) fostering collaborative learning, (ii) stimulating reflective learning, and (iii) structuring tasks to scaffold students' learning.

The strongest examples of TEA being used to foster collaborative learning were those which incorporated Web 2.0-Social Media technologies. When the motivation was to stimulate reflective learning, the underpinning designs often focused on different levels of electronic analysis and feedback tools which aim to achieve Assessment FOR Learning. Where assessment design was focused on structuring tasks to scaffold students' learning, the emphasis was often placed on developing Assessment AS Learning while also freeing up class time via interactive and/or self-directed learning. However, many TEAs endeavouring to develop students' ability to self-regulate their learning (Assessment AS Learning) focused on lower-order skills through the use of simulations/games, online quizzes and MCQs.

Perspectives on TEA design from Irish practitioners

Each of the six case study participants explicitly named a theoretical perspective informing their assessment design. Most aligned with a social constructivist approach and had pedagogical goals in mind when designing their TEA. Developing Assessment FOR Learning was the most common emphasis in designing TEA, with some having a secondary emphasis on Assessment AS Learning. Across all six case studies, there was an evident desire to design TEA in such a way that encouraged students to be responsible for their own learning and to use and respond to feedback. The use of reflective learning was emphasised strongly in the case studies, encouraging students to self-monitor while undertaking self-assessments.

Motivations cited by participants for including TEA in their assessment design included the development of practical, critical thinking, and reflective practice skills amongst students and the scaffolding and structuring of student learning so students could benefit more deeply from the assessments and coursework. One case study, for example, prompted students to create outputs, such as a digital resource, allowing for both the development of technical skills and for deeper engagement with coursework and theory. A goal common among the case studies was that students would ultimately use the learning and feedback gained through the TEAs to improve their knowledge and work and to perform better in future assessments. This design emphasis often resulted in a focus on facilitating student's ability to stay engaged with the class outside of class time.

Staff Efficiencies

How can technology enhance staff efficiencies in the Assessment OF/FOR/AS Learning process?

Of the included papers, 46 had an emphasis on how technology can enhance staff efficiencies in the Assessment OF/FOR/AS Learning process. The evidence demonstrated that technology could serve to enhance aspects of staff efficiencies predominantly through (i) efficiencies of time and workload, (ii) increased transparency and visibility of student activity and (iii) the fostering of student autonomy. However, the evidence also suggested that such efficiencies are not always realised, are not without shortcomings and can vary from one technology to another.

Efficiencies of time and workload

One evident outcome of implementing TEA is the potential to reduce workload for staff, through, for example, reducing time on assessment tasks and facilitating better use of class time. This was found to be most apparent in the use of online quizzes, and in particular MCQs (Bennett et al., 2017; Bogarra Rodriguez et al., 2012; Chao et al., 2012; Chen et al., 2013; Flosason et al., 2015; Griff & Matter, 2013; Hsiao et al., 2016; Kim, 2015; Malau-Aduli et al., 2014; McNeill et al., 2012; Mettiäinen, 2015; Mora et al., 2012; Nguyen et al., 2013; Schaffer et al., 2017; Sullivan, 2016; Summers et al., 2014; Sweeney et al., 2017; Whitworth & Wright, 2015). Online quizzes and/or MCQs were the most commonly cited use of TEA with the goal of enhancing efficiency, particularly so when introduced in the context of large classes.

The Bennett et al. (2017) study found that most of their interviewees who introduced online quizzes to move towards TEA cited efficiency as one of the key reasons for doing so. The study by Whitworth and Wright (2015), within science education, examined the effects of their adaptation of a traditional practical-based laboratory report to an online test with automated marking. They estimated that the set-up of the online test took one day and ultimately saved two weeks of marking per learning cycle for 300 students. The authors' search for more efficient assessment methods was prompted by a tenfold increase in student numbers (Whitworth & Wright, 2015). Mora et al. (2012) indicated that the MCQ that they introduced in planar mechanics made their workload more manageable. However, neither study gave an indication of time cost of MCQ design, data generation or question creation, nor did they indicate any upfront or maintenance costs for the system (Mora et al., 2012; Whitworth & Wright, 2015). Nguyen et al. (2013) trialled and evaluated a static test generation system, which generates optimal test papers automatically from a question database based on multiple assessment criteria such as total time, topic distribution, degree of difficulty and degree of discrimination. The authors suggested that the proposed system could outperform others and that automatic test generation would generate staff efficiencies, particularly if the test is then automatically assessed (Nguyen et al., 2013). Similarly, in the study by Griff and Matter (2013), which focused on an adaptive online learning system in undergraduate anatomy and physiology, the rationale for predicting efficiency from the bespoke MCQ TEA was that the students' work would be machine-assessed with the possibility for provision of automated feedback, and redirection to content, thereby potentially reducing grading time for academics.

The reviewed studies also illustrated that workload efficiencies are often noted in systems that incorporate automated feedback (Achumba et al., 2013; Blackburn, 2017; Buckley & Cowap, 2013; Caminero et al., 2016; Heinrich & Milne, 2012; Kim, 2015; Kuikka et al., 2014; Link et al., 2014; Mora et al., 2012; Pittenger & Olson-Kellogg, 2012; Whitelock et al., 2015).

Chew et al. (2015) proposed that the plagiarism detection software tool Turnitin may be capable of enhancing staff efficiencies if the tool is recast as a developmental writing tool. They suggest that the originality report feature could be used as a self-service review, allowing the teacher's role to be less focused on grammatical and spelling errors and instead more focused on 'critical writing content and other disciplinary skills' (Chew et al., 2015, p. 460). Similarly, Link et al. (2014) suggested that the Criterion writing evaluation software can provide feedback to students on their writing, particularly focusing on low-level spelling and

grammatical errors, which could then free up class time, allowing teachers to focus their time on higher-level writing topics.

Other studies illustrated how technologies can assist with staff classroom management efficiencies in less direct and more limited ways. For example, Sun et al. (2014) encouraged students to use web-based polling tools before class, which led to students being better prepared for class and coming to class more informed. Similarly, Flosason et al. (2015) looked at online quizzes facilitated using clickers in the classroom. Participating teachers saw benefits arising from clicker use through the generation of wider class discussions and more informed questions from students. The technology use in these two studies could be seen to enhance staff efficiencies because staff found themselves working with students who had a better grasp of class content and lecture time could therefore be used to greater effect.

Another area where TEA was shown to have potential to generate staff efficiencies was in the use of technologies to support and facilitate grading and feedback. The study by Bennett et al. (2017) suggested that teachers can find ePortfolios a quicker way to mark and easier to manage relative to some other assessment methods. Almpanis (2015) highlighted similar efficiencies resulting from the use of ePortfolios, with a particular reference to reduced demands on staff time through this method. Nevertheless, the central focus of the paper is how the use of TEA is 'a means to achieve an improved student experience and to raise levels of student satisfaction' (Almpanis, 2015, p. 385). Thus, all efficiencies in the study are framed primarily in relation to student experience rather than in relation to benefiting explicitly staff.

Mechanisms that support the provision of feedback, such as marking rubrics and comment banks (Buckley & Cowap, 2013; Heinrich & Milne, 2012), were also found to support workload efficiencies for staff, as was the use of TEA that encompasses the delivery of generic feedback via video (Crook et al., 2012). Chao et al. (2012) discussed how teachers can influence the design of online courses by adjusting the technology to enhance the efficiency of associated assessment tools and potentially serve the goal of reduced workload. The study suggested that it is incumbent on teachers involved in facilitating synchronous classrooms and designing assessments to 'make an effort to learn the know-how of when and what to adopt as optimal assessment options in their own online courses in order to align the assessment procedures with the nature and requirements of the course in question' (Chao et al., 2012, p. 393). This points to the need for related professional development for staff.

Many of the studies discussed aspirations towards staff efficiences rather than providing strong evidence for such efficiencies.

Transparency and visibility

Amongst the reviewed studies, there was some evidence of TEA fostering staff efficiencies through increasing the transparency and visibility of student activity. There was a sense that having wider transparency/visibility of student work can aid the assessment process as staff can see students' interactions with the TEA which can help them to gauge where issues may be arising, and support might be best focused. Consequently, a relatively common theme in the studies related to staff efficiencies was the idea that efficiencies in staff and student interaction may be generated through increased visibility of student activity, whereby the teacher can monitor each students' interaction with the technological tool (Caminero et al., 2016; Flosason et al., 2015; Lafuente Martínez et al., 2015; Zou, 2013). For example, in the Flosason study (2015), the use of clickers in the classroom afforded the teacher a real-time tool with which to see and monitor the students' engagement with and understanding of the coursework. In the Caminero et al. study (2016), the authors described a virtual lab environment embedded in a VLE for distance education. They found that the virtual labs, which were integrated somewhat into the VLE, allowed for better communication between staff and students. It also allowed for time savings as the staff had greater visibility of what the students did in the system and could troubleshoot more effectively in diagnosing and solving student queries and problems with assignments (Caminero et al., 2016). Lafuente Martínez et al. (2015) presented two case studies of assessments, one in a blended and one in a virtual environment, each with different mechanisms for allowing visibility of the

student (collaborative) learning process on assessment tasks facilitated through the VLE. Similarly to Caminero et al. (2016), they found that higher transparency through visibility of students' activity on a VLE improved the potential to diagnose and address challenges experienced by students more efficiently, in real time.

While Web 2.0-Social Media tools are often utilised in TEA with a view to facilitating collaborative learning practices, as discussed in the assessment design section of this report (Gray et al., 2012; McNeill et al., 2012; Waycott et al., 2013), Waycott et al. (2013) saw increased visibility of students' work as helpful in developing a learning community amongst the students and teachers and making it easier for teachers to monitor student activity. The study also found that the development of peer-review skills (a key aspect of Assessment AS Learning) and the provision of opportunities to co-author work are facilitated through increased visibility of students work via Web 2.0-Social Media TEA tools.

Fostering student autonomy

The use of TEA was shown to have the potential to enhance staff efficiencies through the scaffolding of student activity, and through encouragement and support for the development of student autonomy, the key concern within Assessment AS Learning. Using TEA can help teachers to foster better understanding of course content amongst students, which can create efficiencies that benefit the teacher. The evidence here falls into three categories: (i) opportunities to access course materials, (ii) opportunities to practice, and (iii) opportunities to receive feedback.

Good examples of staff efficiencies generated through fostering student autonomy by providing opportunities to access course material are found in studies previously discussed under assessment design. For example, in the study by Blair et al. (2016), although somewhat more oriented towards technology-enhanced learning than assessment, the development of screencasts to allow students to access course material any time and minimise time spent in class on lecturing was discussed. Similarly, the studies by Chao et al. (2012) and Summers et al. (2014) described use of asynchronous and synchronous classrooms to provide opportunities for students to access course materials and for staff to administer structured tasks online and provide support.

Many of the electronic assessment and feedback tools that feature in the reviewed studies have the capacity to provide opportunities for practice, allowing for Assessment AS Learning (self-regulation/self-monitoring). In the study by Bogarra Rodriguez et al. (2012), the automatic assessment tool used for MCQs provided both the questions and the randomisation of inputs. It also provided an opportunity for practice which staff could regulate if they so wished. The feedback provided by the systems detailed by Malau-Aduli et al. (2014) and Hsiao et al. (2016) offered similar opportunities for Assessment AS Learning. Several papers also presented tools that could be classified as automatic writing evaluation software. A key benefit of such software is that it can allow students opportunities to practice writing, on which they subsequently receive feedback. For example, Link et al. (2014) suggested that the Criterion automatic writing evaluation tool could support the development of learner autonomy by providing automated feedback on draft writing. In the study by Buckley and Cowap (2013), the authors used Turnitin and a commenting function as both a plagiarism detection tool and a formative learning tool. This allowed for specific feedback to be delivered to students thus also providing Assessment AS Learning opportunities and potential to improve their writing (Buckley & Cowap, 2013). Likewise, the study by Whitelock et al. (2015) focused on OpenEssayist, the tool that analyses essay texts and provides feedback, pointing to its potential use for students in Assessment AS Learning. Reilly et al. (2014) presented an automatic essay scoring tool which could have similar potential to contribute to Assessment AS Learning.

Another way in which TEA was shown to foster student autonomy and increase staff efficiency is its ability to provide and deliver feedback to students. The automated feedback provided by some of the systems discussed above, whether as a score or as more detailed feedback, for example on writing, can provide an encouragement to students to make use of the opportunities to practice offered by the tools. More generally, the provision of feedback aims to improve and direct student learning.

The mobile app described in the study by Maher et al. (2013) demonstrates how a well-designed app can develop Assessment AS Learning skills among students. The study found that using a 'letter-writing checklist mobile application (CLAS) can improve the overall quality, content, structure and clarity of hospital discharge letters written by medical students' (Maher et al., 2013, p. 16). In the VLE examined by Lafuente Martínez et al. (2015), transparent assessment tasks were used in order to promote better feedback from staff with a view to contributing to student autonomy. Crook et al. (2012) outlined the benefits of providing generic feedback by video to a student cohort. However, they noted that the students did not perceive the video feedback as an alternative to individual written feedback but rather as an addition to it, thus decreasing rather than increasing staff efficiencies. The use of technology was seen as advantageous to some teachers as they used the learning management system to deliver group feedback, which saved time (Bennett et al., 2017). Meadows et al. (2016) found that in-class feedback tools were perceived by students as valuable for engaging verbally. The Bennett study (2017) discussed efforts to introduce TEA with a view to enhancing staff efficiencies and noted that the common first step by staff was the introduction of or increased use of online quizzes. Although interviewed staff were sometimes ambivalent about the use of online quizzes, they recognised the value of the quizzes in allowing for immediate feedback and for students to self-assess. The analysis found that the use of online quizzes was 'pedagogically satisfactory rather than optimal' (Bennett et al., 2017, p. 679).

Factors limiting the potential for staff efficiencies

Despite evidence that demonstrates how TEA can enhance staff efficiencies, there was also evidence to suggest that there are limiting factors in the use of such TEAs for staff efficiencies.

The positive views expressed in reviewed papers regarding the collaborative benefits and increased visibility/transparency of student activity resulting from the use of Web 2.0-Social Media tools for TEA were counterbalanced by evidence suggesting an increased workload necessary to manage, monitor and assess the work within such tools. Many of the reviewed studies point to this workload as causing some problems for teachers at some if not all stages of the process (Caple & Bogle, 2013; Goldstein & Peled, 2016; Gray et al., 2012; Lafuente Martínez et al., 2015; McNeill et al., 2012; Mettiäinen, 2015; Rodríguez-Gómez et al., 2016; Wanner & Palmer, 2015; Waycott et al., 2013; Zdravkova et al., 2012). In some cases, this increased workload was only challenging at the beginning and implementation stages of the TEA process (Blackburn, 2017; Chew et al., 2015; Mettiäinen, 2015; Rodríguez-Gómez et al., 2016; Wanner & Palmer, 2015). In other cases, such as when using wikis and other high volume assessments, the increased workload persisted as long as students were engaging with the TEA tool (Gray et al., 2012; Lafuente Martínez et al., 2015; Waycott et al., 2013; Zdravkova et al., 2012). Nevertheless, there was a lack of any explicit statements of the time commitments involved. Furthermore, some studies reported that staff-student relations and/or student motivation were negatively impacted by insufficient monitoring or input from staff regarding student input (Lafuente Martínez et al., 2015; Wanner & Palmer, 2015). Taken together, these points indicate a need to manage staff and student expectations in relation to staff engagement with the Web 2.0-Social Media content as it is generated.

Looking more at distance/online courses, Dargusch et al. (2017) also highlighted a trade-off that can exist for staff in order to enhance efficiencies through technology. These authors indicated that staff may need to put a lot of preparatory effort into utilising technologies so that students accept their use as part and parcel of the course and ultimately start to engage with the technology in the way that the course design intends (Dargusch et al., 2017).

The included studies that focused on MCQs did not quantify the time required or the cost to build and maintain a question database or to design MCQ tests. Many of the studies focused only on the perceived efficiencies without investigating or evaluating any potential shortcomings of the system. For example, the study by Nguyen et al. (2013), while demonstrating efficiencies regarding automated test generation, also drew attention to the need for large test item databases that are tagged for difficulty, reliability, and so on.

Regarding tools such as interactive lectures and screencasts, the study by Meadows et al. (2016) illustrated how staff can sometimes be concerned about how their teaching comes across in such tools. Comments from staff in this study emphasised that not all staff were comfortable with the remove created by using video for interactive lectures and feedback.

Another issue found across the studies, particularly pertaining to automated assessment and intelligent tutorial systems, was that many of the included studies did not provide a robust account of the reliability and validity of assessment, nor the quality of feedback. Further, Link et al. (2014) noted difficulties arising from misalignment of staff and student beliefs about the validity of the automated scoring of their writing. The authors reported issues arising in staff-student relations because students felt the automatic scores were more accurate and less biased than the human scoring of their instructors. However, the automatic scores reflected surface-level accuracy rather than broader quality of writing measures (Link et al., 2014).

Furthermore, the issue of how feedback is acted upon by students is not addressed in detail in the studies. TEA in the studies is used in a number of cases to provide feedback (i.e. to support Assessment FOR Learning). However, the studies did not investigate whether or to what degree students engaged with this feedback or whether they were supported to do so. Therefore, while the studies may demonstrate some staff efficiencies in the provision of feedback, they did not explore the impact of such feedback.

Key Findings

The potential of TEA to contribute to staff efficiencies was evident through (i) efficiencies of time and workload, (ii) increased transparency and visibility of student activity and (iii) the fostering of student autonomy.

TEA in the automated assessment/intelligent tutorial systems domain was shown to have the clearest potential for efficiencies for staff in terms of reduced workload around assessment, particularly so if the assessment process is valid and reliable and provides automated feedback.

The evidence also suggested that potential efficiencies were often counterbalanced by limiting factors such as the workload and management involved in setting up and maintaining TEAs, in particular for social media, and some perceived issues regarding the reliability and validity of TEAs or the quality of feedback received.

It is important to reiterate here that most of the studies discussed or evaluated a TEA based on experiences of early implementation; there were no longitudinal studies documenting efficiencies sustained over time.

Perspectives regarding TEA and staff efficiencies from Irish practitioners

Case study participants highlighted the increased workload involved in the initial stages of implementing TEAs. For example, regarding online quizzes/MCQs, it was pointed out that time has to be dedicated to sourcing and collating a strong question bank as well as familiarising students with the purpose and content of the TEA. Time for the teacher to familiarise themselves with the technology was also noted as necessary. One case study emphasised the need to guide students through how to use the TEA, to ensure they are clear about the content to be created and to mitigate against the students becoming focused more on the technology than on their learning. Another case study gave a specific breakdown of the time commitment involved in setting up and maintaining one online quiz assessment, estimating it at 3.5 days overall. It was pointed out that this initial time investment eventually evolves into time spent on maintenance, which is less time-consuming but still adds to a teacher's workload.

Nevertheless, there was consensus across the case studies that, once embedded, each TEA did help reduce workload in some respects. Motivations for choosing the different TEAs across the case studies often centred on engaging students and being in a position to provide timely, actionable feedback. Many TEA tools allowed students to check on their own learning, while also providing ongoing visibility to the teacher regarding how the students were progressing. All of this was seen to provide some efficiencies to the teacher in the long run.

Approaches to Plagiarism

What approaches could address staff concerns on the issue of student plagiarism that are often associated with technology-enhanced Assessment OF/FOR/AS Learning?

Approaches to address staff concerns on the issue of student plagiarism, which are often associated with technology-enhanced Assessment OF/FOR/AS Learning, were dealt with to varying degrees in 20 of the included studies. Studies that focused on this area were predominantly in the technology areas of Automatic Assessment/Intelligent Tutorial Systems and Web 2.0-Social Media, with some minor discussion relating to other TEAs.

Automatic assessment/intelligent tutorial systems

The most common approach taken to address staff concerns regarding plagiarism in the studies reviewed was to use plagiarism detection software (Akçapınar, 2015; Buckley & Cowap, 2013; Chew et al., 2015; Penketh & Beaumont, 2014), such as Turnitin or, as in the case of Akçapınar (2015), a bespoke system. The use of such tools has also been cited as helping to raise student's awareness around the issue of plagiarism, and plagiarism detection (Akçapınar, 2015; Buckley & Cowap, 2013; Chew et al., 2015; Penketh & Beaumont, 2014).

In a study by Buckley and Cowap (2013), staff participated in training sessions on how to use the Turnitin and GradeMark plagiarism detection systems, which were facilitated by an academic team leader. A cohort of students also received one focused seminar on academic misconduct demonstrated through the use of Turnitin, and then were required to submit three assignments electronically via Turnitin, receiving electronic feedback via the GradeMark system. Staff reported satisfaction with the training and were particularly happy that 'it covered Turnitin processes that were directly applicable to marking' (Buckley & Cowap, 2013, p. 566). The study found that the focused training seminar helped to raise students' awareness of academic misconduct. The study pointed to the use of Turnitin as a formative learning tool, due to its ability to highlight unacceptable practice to students automatically, and in cases where faculty allow students to access their originality report on a pre-submission draft, it can provide reassurance regarding worries about unintentional plagiarism (Buckley & Cowap, 2013; Chew et al., 2015).

The studies by Chew et al. (2015) and Penketh and Beaumont (2014) both investigated the potential of Turnitin to act as a support for giving feedback to students (Assessment FOR Learning) as well as to carry out its primary plagiarism detection function. Chew et al. proposed Turnitin as a developmental writing tool utilising the originality report feature as a self-service review with the teacher's role subsequently more focused on 'critical writing content and other disciplinary skills' (Chew et al., 2015, p. 460). Similarly, Penketh and Beaumont (2014) found that from the teacher's perspective Turnitin had the means to encourage and develop students' writing. Nevertheless, while both studies found little evidence of mistrust of Turnitin, they noted that many students did view these tools rather negatively due to their regulatory role. Penketh and Beaumont (2014) noted the potential for this to negatively impact on staff-student relations. The four studies that focused on Turnitin and other bespoke plagiarism detection software predominantly focused on the effectiveness of these approaches to act as preventative tools, with students potentially less likely to take chances in relation to plagiarism if they know they must submit assignments through the tool (Akçapınar, 2015; Buckley & Cowap, 2013; Chew et al., 2015; Penketh & Beaumont, 2014).

Studies that concentrated on automatic assessment using MCQs examined the issue of cheating. Many of these studies examined approaches using randomisation or personalisation of tests/question banks to combat any deceptive behaviour by students. A study by Nguyen et al. described their approach to supporting large-scale web-based testing through using 'static test generation, which generates a test paper automatically according to user specification based on multiple assessment criteria' (Nguyen et al., 2013, p. 46), a mechanism which could counter cheating. Similarly, the study by Bogarra Rodriguez et al. (2012) examined a tool called WIRIS which can generate personalised tests from questions deriving

from randomised data. It is worth noting that while self-assessment quizzes assist staff in giving feedback to students (Assessment FOR Learning), their use by staff remains confined to relatively low stakes assessments and they are less likely to address higher order learning (McNeill et al., 2012).

The study by Sullivan (2016) presented an alternative approach that provides potential solutions to academic dishonesty, particularly in asynchronous MCQ online assessments. The study advocated strategies that have the aim of making cheating impractical and reducing test anxiety, hopefully resulting in the promotion of a more positive learning culture (Sullivan, 2016). The strategies included: (i) an algorithm within the LMS that shuffled and thus randomized the questions and answers from a large question bank, (ii) continuous expansion and development of the question banks, and (iii) multiple versions of an exam (Sullivan, 2016). Notably, within the exam itself they allowed for open book/notes and the ability to retake the exam up to five times to mitigate against the temptation to cheat (Sullivan, 2016).

In the study by Whitworth and Wright (2015), the authors trialled an assessment that allowed for an unlimited number of retakes for part 1 of the assessment. Students had to get the two questions in Part 1 correct for Part 2 to become available, then they were only permitted to have one attempt at Part 2. This contributed to students having less of a desire to 'beat the system' (Whitworth & Wright, 2015, p. 1209); there was no trend of attempting to beat the system identified. Consequently, there was a formative (Assessment FOR Learning) aspect to Part 1 as it necessitated that students had a good grasp of basic concepts before they were tested on more advanced concepts in Part 2 (Whitworth & Wright, 2015).

Many of the automated systems for plagiarism support featured in the included studies require training for both students and staff; most papers did not elaborate on the time investment required for this training. Of note in all the papers discussed here pertaining to different modes of automatic assessment/intelligent tutorial systems is the fact that there was an absence of measurement of the accuracy of the reliability or validity of the automated systems in the studies.

Web 2.0-Social Media

The multiplicity and open access nature of Web 2.0-Social Media modes of TEA prompted various concerns among staff regarding plagiarism and cheating. The included studies addressed staff concerns on the issue of student plagiarism in both direct and indirect ways and their discussions often focused on how these modes of TEA have become compromised by some negative behaviours.

One of the mentioned advantages of using Web 2.0-Social Media modes of TEA is that they facilitate collaborative learning, allowing students to work together in an open online environment (Gray et al., 2012; Waycott et al., 2013; Zheng et al., 2015). However, the studies by Zheng et al. (2015), Gray et al. (2012), Waycott et al. (2013), and Caple and Bogle (2013) all demonstrated that issues can arise with these modes of TEA, particularly relating to immediacy, quantity, quality, transparency and visibility of content. In the study by Waycott et al. 'lecturers reported that making students' work visible to others enhanced learning by increasing opportunities for students to collaborate, share knowledge and ideas with each other, and to write for an external audience' (2013, p. 89). The study by Gray et al. (2012) is an earlier paper from the same study as Waycott et al. (2013) and reports similar findings. Students participating in collaborative work via Web 2.0-Social Media reportedly felt more connected to each other and had the potential to build a learning community (Gray et al., 2012; Waycott et al., 2013). They also developed skills in peer review, a key component of Assessment AS Learning, by having to review each other's work (Waycott et al., 2013). However, the teacher struggled to develop and implement an appropriate code of conduct for students in the online environment. Consequently, much time was spent on engendering and governing the concept of 'netiquette' amongst the cohort (Waycott et al., 2013, p. 90). Some teachers perceived students as being concerned about others copying their work, a phenomenon they term internal plagiarism (Waycott et al., 2013). Meanwhile, other teachers reported that some students who were used to getting high grades delayed adding their work to the blog assessment until the last minute to mitigate against anyone copying their work (Waycott et al., 2013). Students reporting incidents of copying despite no demonstrated

evidence of copying was also viewed as an issue within wiki-writing in the Waycott study (2013). In another study, by Caple and Bogle (2013), that dealt with a collaborative wiki-writing assessment, these issues were handled by insisting that students had a unique user name with which to contribute to the wiki. Students who did not have any contributions or edits attributed to their username were given a grade of zero, so 'free-riding' was thwarted in this regard (p. 206). Other approaches that staff took in these situations included closely monitoring activity, and intervening or moderating for an array of problem behaviours including inappropriate language, sabotage of other students' work, arguments, and cyberbullying (Gray et al., 2012; Waycott et al., 2013). These issues were seen to lead to an increased workload for the teacher involved, which was compounded if the content also had to be graded, particularly as grading in this environment is often time-critical (Gray et al., 2012; Waycott et al., 2013). These examples highlight a tension evident in the papers between the benefits of open, collaborative, knowledge-sharing tasks and the challenges, which can be less openly visible than in traditional assessments.

The issue of external plagiarism was also a concern associated with the use of Web 2.0-Social Media technologies for TEA. This can include preparing essays with direct copying from websites, although in the study by Zdravkova et al. (2012) making the essays a collaborative task appeared to help mitigate against this.

The most popular approach was the implementation of an online behaviour policy document and in-class discussions on how to develop and promote appropriate online conduct (Caple & Bogle 2013; Waycott et al. 2013; Zheng, Niiya, & Warschauer 2015; Gray et al. 2012; Zdravkova et al., 2012). Further approaches included the use of warning emails about online conduct, particularly related to persistent copiers (Zdravkova et al., 2012) and the assigning of lower grades to students who indulged in external plagiarism (Zdravkova et al., 2012). Though these studies by Gray (2012), Waycott (2013), Caple and Bogle (2013), Zheng, Niiya, and Warschauer (2015) and Zdravkova et al. (2012) all set out some approaches to assist in addressing concerns regarding plagiarism and/or dishonest/inappropriate behaviour, they stopped short of evaluating the effectiveness of such approaches or the workload implications beyond noting that they could be extensive.

Other TEAs

Other approaches to reduce cheating/plagiarism were suggested, although not evaluated, in several of the studies. Three of the studies that focused on automatic assessment practices within distance and blended learning, suggest the idea of limiting the window of time within which an online exam can be taken or restricting the websites a student can access during an exam (Almpanis, 2015; Chao et al., 2012; Sullivan, 2016). Conversely, three other studies suggested allowing open internet access while undertaking online exams, an approach which aims to facilitate students to demonstrate a wider (higher-order) understanding of the course, rather than just testing recall (Bennett et al., 2017; Kuikka et al., 2014; Sullivan, 2016). This requires careful assessment design to integrate higher-order thinking processes as part of the assessment tasks.

Summers et al. (2014) discussed use of a service called ProctorU which the students must sign up to which allows them to be monitored online whilst undertaking an exam: 'a live proctor observes the students taking the final exam through their webcam in order to ensure that they are not discovering their information from another source (online or in their own environment)' (Summers et al., 2014, p. 78). There is no evaluation in the study of the live proctor, its effectiveness, or the time considerations.

Caminero et al. (2016) described a virtual lab environment system that is embedded in a VLE for distance education, discussing possible concerns that students may not be verifiable while undertaking the tasks. They suggested the possible use of biometrics for identification in future versions of their system.

The one study in the review that focused exclusively on MOOCs relied on a binding honesty agreement between students and the institution to abide by rules pertaining to plagiarism and cheating (Admiraal et al., 2015). Peer assessor students were also instructed to assign a zero grade to any plagiarised work (Admiraal et al., 2015).

Key Findings

The most straightforward approach to combatting plagiarism is through using plagiarism detection software, such as Turnitin. Some studies found that the use of plagiarism detection software helped to raise student awareness of plagiarism, with the software used as a preventative mechanism. There was some discussion around the concept of recasting the likes of Turnitin to be used as an Assessment FOR Learning tool. There was also a concerning absence of the measurement of accuracy of the automated systems in the studies.

Automated assessment systems that used MCQs addressed cheating primarily through randomisation of questions or randomisation/personalisation of question content or data. Other trialled or suggested approaches to reduce cheating and plagiarism included time limits/website restrictions for online exams, use of a virtual proctor, use of biometrics for identification and binding honesty agreements between students and the institution.

The use of Web 2.0-Social Media TEA tools raised particular concerns regarding cheating and plagiarism. This resulted in staff having to expend more time policing student activity resulting in an increased workload for staff. Approaches to mitigate against these concerns included the implementation of a governance policy on collaborative online spaces to ensure a code of practice and appropriate online conduct, managing, monitoring and intervening, sending warning emails to persistent copiers, and giving lower grades where copying was detected.

Many of the studies highlighted that the best approaches to tackling plagiarism and cheating were rooted in strong and sensible institutional policy and governance on plagiarism and cheating in the open information world.

Perspectives from Irish practitioners regarding plagiarism and TEA

The case studies were consistent in taking an approach which sought to create assessments that negated the need for plagiarism. In many cases, the TEA was designed in a way that made plagiarism neither feasible nor beneficial. All the case studies involved TEAs designed to facilitate Assessment FOR Learning, and to a lesser degree Assessment AS Learning, rather than Assessment OF Learning. Therefore, the primary purpose of the TEAs was to promote learning rather than to demonstrate its achievement.

Learning Environments

What types of learning environments do institutions need to provide to support technology-enhanced Assessment OF/FOR/AS Learning?

The final research question that shaped the review focused on the types of learning environments that institutions need to provide to support technology-enhanced Assessment OF/FOR/AS Learning. For the purpose of the review, learning environments were viewed in broad terms and, as such, were discussed in 32 of the included papers. These studies provided evidence related to the following aspects of learning environments: (i) institutional policy; (ii) training and professional development; (iii) financial investment; (iv) integration and ease of use; and (v) time.

Institutional policy

Many studies point to the need for learning environments to be bolstered by underlying institutional support in order for technology-enhanced Assessment OF/FOR/AS Learning to thrive. Such institutional support includes policies focused on specific issues in TEA such as plagiarism and/or data protection (Akçapınar, 2015) and more wide-ranging institutional outlooks that provide key support for TEAs (Blackburn, 2017; Marín et al.. 2016; Whitelock et al., 2015). Akçapinar (2015) highlighted the need for institutional policy surrounding the use of plagiarism detection software, as some software retains the analysed work, raising copyright issues. Whitelock et al. (2015) illustrated the process of developing new policies and structures to ensure that students are suitably supported in their distance learning endeavours (Whitelock et al., 2015). In the context of a teaching development project in a university in Finland, Marín et al. (2016) aimed to 'develop pedagogically high-quality learning possibilities for students, to support their activities as learners' (Marín et al., 2016, p. 55), and to facilitate using TEA for learning and assessment. Their concept of seamless learning environments is focused predominantly on using mobile devices for learning and assessment (Marín et al., 2016). The components of seamless learning environments include 'diversity of spaces, flexibility of time, a context for the designed activities, different actors in the learning community and mobile devices and applications as cognitive tools and expected artefacts produced by the learners' (Marín et al., 2016, p. 63). Blackburn (2017) presented the best example of an overarching institutional policy that focuses on developing TEA and the environment to support its use. The paper described problem based learning (PBL) resources that were introduced for TEA and learning as part of a university-wide eLearning strategy. As part of the strategy implementation, a three-year eLearning coordinator post was created to steer the project and a community of practice was established. The goal of the community of practice was to build cross-faculty support communities amongst teaching staff across the university to aid them to introduce PBL resources and use them for TEA. A similar helpful example of the development of policy and structures that support and foster technology adoption for TEA was the Cochrane et al. study (2013). In this study, a learning and teaching fellow role was funded within a department to support Web 2.0-Social Media technology use within a journalism course. Initially, a community of practice was developed, comprising two course lecturers and the technology steward, to help support and design pedagogical change to facilitate the use of technologies. Due to the reported success of the community of practice, funding was secured for further expansion. Mettiäinen (2015) similarly demonstrated how investment and allocation of resources to staff to learn and implement software can have an impact on the adoption of TEA.

Training and professional development

The review clearly highlighted the importance of learning environments being conducive to the training and professional development needs of staff and students. Many of the included studies stressed the need to provide support, time, training and continuing professional development to staff as they learn to integrate and optimise any new TEA system (Bogarra Rodriguez et al., 2012; Buckley & Cowap, 2013; Carruthers et al., 2015; Chew et al., 2015; Kuikka et al., 2014; McNeill et al., 2012;

Mettiäinen, 2015; Penketh & Beaumont, 2014; Zou, 2013). The need to prepare and support students in the use of technologies they will be using to complete assessments was also emphasised in a number of studies (Bennett et al., 2017; Bogarra Rodriguez et al., 2012; Buckley & Cowap, 2013; Carruthers et al., 2015; Chew et al., 2015; Penketh & Beaumont, 2014). In relation to using alternative modes of feedback (audio), Carruthers et al. (2015) noted the need for both staff and student training, and for needs to be identified in advance. They stipulated that training must address both the technology and the feedback process and they provided recommendations on good practice in using audio feedback (Carruthers et al., 2015).
Zou (2013) suggested that appropriate use of TEA tools requires training and that it is not enough to simply encourage or require use of a TEA tool without the tool being embedded within a given course or institutional structure, along with the appropriate training. Further, the study stated that providing appropriate training opportunities and ongoing supports for teachers improves the impact of TEAs. Similarly, Kuikka et al. (2014) stated that staff training is critical when introducing electronic exams, particularly to ensure quality of assessment practices. They suggested regular workshops to keep teachers' skills up-to-date. They also highlighted the importance of institutional support to facilitate TEA and to ensure alignment of assessments with pedagogical goals and outlooks.

Learning environments that are conducive to TEA were shown to provide training and support that aligns the TEA with associated pedagogy (Heinrich & Milne, 2012; Meadows et al., 2016; Schoonenboom, 2012; Steenbergen-Hu & Cooper, 2014; Wimpenny et al., 2012; Zou, 2013). McNeill et al. (2012) noted the need to address higher order learning and to make use of technologies that facilitate this. They suggested the importance of staff development around 'frameworks for evaluating technologies' in order to build the confidence and skills of staff in selecting assessment technologies that align with their curriculum design (McNeill et al., 2012, p. 294). Heinrich and Milne (2012) focused specifically on assignment marking, presenting a case study of the use of a tool, Lightwork, within a Moodle-based VLE. Regarding training, they highlighted the need for 'excellent support structures on technical and pedagogical levels' (Heinrich & Milne, 2012, p. 12) to ensure effective use of the TEA. The study by Buus (2012) stressed the significance of being cognisant of the tensions that can exist between educational practices and specific technologies, and suggested that training needs to incorporate and respond to such tensions. Bennett et al. (2017) also raised the issue of how training infrastructures need to consider knowledge and communication gaps that can exist between technical and academic staff.

Buckley and Cowap (2013), focusing on introducing plagiarism detection software and e-marking into a university department, stated that 'staff training is crucial to the successful adoption of e-marking" (p. 564). They recommended that training be tailored to how staff will use the technology or TEA in their everyday work, rather than generic technology functionality training.

Evidence in some studies demonstrated limited, early stage and low stakes assessment-oriented adoption (Gray et al., 2012; Haines, 2015; McNeill et al., 2012; Mettiäinen, 2015). Further, some indicated limited impact from the provision of training and workshops to stimulate TEA adoption (Buus, 2012; Mettiäinen, 2015). For example, in the study by Mettiäinen (2015), seventy nursing teachers received training in the eTaitava tool but only twelve actually started to use the new tool. It is notable that many studies did not interrogate the technological capabilities of staff/students, or indeed the institutions themselves, to support implementation and use of TEA. The studies point collectively to a need to investigate further the training and professional development needs within specific disciplinary, institutional and pedagogical contexts.

Financial investment

Financial investment to support the implementation, maintenance and development of TEA appears to be necessary, but costs were generally not considered in the included studies. Bennett et al. (2017), having interviewed university teachers about their assessment design experiences, found that cost, particularly unanticipated costs, was often a key barrier to implementing TEA tools. However, there were no cost-benefit analyses of

technologies for TEA. Some of the studies that focused on MCQs via online quizzes alluded to, but did not elaborate on, potentially high set-up and maintenance costs.

Some studies listed the equipment used for the TEA (Chao et al., 2012; Crook et al., 2012; Hutchings & Quinney, 2015; Summers et al., 2014) without description of details such as how it was sourced, what it cost or how it was integrated with existing infrastructure. An example is this excerpt from Hutchings and Quinney (2015):

> *Resourcing requirements also included use of a 300 capacity lecture theatre complex including flexible learning spaces that could accommodate group work for student contact days necessitating timetabling the in class contact days at a different campus, booking of computer labs for the computer based assessment, technical support for facilitation of the ARS voting pads, and provision of a robust and secure online assessment platform for delivery of the online exam.* (Hutchings & Quinney, 2015, p. 113).

While the study did explore some of the necessary components regarding change management in flipping the classroom, it did not investigate thoroughly how they garnered the political or financial support of the institution to facilitate the resources used (Hutchings & Quinney, 2015).

Schaffer et al. (2017) argued for the investment of design costs in automated assessment for large student cohorts and MOOCs. They pointed out that fixed costs provide economies of scale for very large student cohorts in MOOCS. However, this claim was not evaluated in the paper. The study by Blackburn (2017) included a rigorous investigation of various products, including consideration of cost, in choosing a suitable PBL product for their university. They evaluated many factors in choosing the appropriate tool, including: 'risk mitigation against an unstable system, scalability, the need for richer functionality, vendor stability, availability and capability of product specialists, active change management, proven project management, having a web-based solution and importantly cost' (Blackburn, 2017, p. 151). They found that 'central strategic funding' was a 'critical component' in the successful implementation of the PBL product; securing funding was a direct outcome of receiving the support of senior management (Blackburn, 2017, p. 161). This study demonstrated how a shared pedagogical vision can translate into overarching support, including financial support, for the purchase and implementation of a TEA tool.

Integration and ease of use

Related to issues of financial investment is the need for investment in appropriate equipment to develop infrastructure and integrate and support the use of TEA. Ease of use (Heinrich & Milne, 2012; Kuikka et al., 2014; Rubin et al., 2013) and ensuring choice of TEA that will integrate well with existing learning management systems (Kuikka et al., 2014; Wang et al., 2013) are important considerations. Kuikka et al. (2014) noted that a key requirement for staff for an e-assessment system is that it integrates with an existing LMS and has a simple user interface. Furthermore, they noted the need for reliability in an e-assessment system, an obvious but not often noted factor (Kuikka et al., 2014). Heinrich and Milne (2012) made a similar point, that ease of use of TEA software delivers better quality assignment marking and consistency, emphasising that while functionality is important, ease of use is key. Rubin et al. (2013) echoed this finding by identifying ease of use as a key factor in the adoption of an LMS. Bennett et al. (2017) reported the concerns of some university teachers that tools appropriate to the TEA pedagogy are sometimes not available and TEA tools are sometimes not capable of facilitating the intended teaching and learning practice.

Wang et al. (2013), considering how assessment and feedback are integrated into principles of good teaching, suggested that integration of principles of good teaching within a faculty are influenced by the reconfigurability of an LMS system (interface, interaction and content) and this in turn impacts on staff perceptions of the benefits of a tool. In selecting an LMS, the ability to configure the system to each user's needs will impact on teaching practices and perceived benefits; this in turn will influence staff adoption. The ability to reconfigure interaction possibilities (how students and staff interact) was found to have the strongest impact on integration of assessment and feedback into teaching.

Time

Many of the studies strongly emphasise the need for appropriate allocations of time to facilitate TEA. For set up and implementation (Blair et al., 2016), training and development for both staff and students (Çakiroglu et al., 2016), maintenance, upkeep and upskilling, time is imperative. In the study of Blair et al. (2016), the authors documented the amount of time it took for them to implement screencasts to supplement class lectures. Developing the screencasts required three months preparation in the summer months to record and edit the sessions, the editing removed mistakes and unnecessary pauses reducing one hour of class time to a twenty-minute screencast session. The study found that the time invested in preparing the screencast sessions saved valuable time later when engaging with students' coursework (Blair et al., 2016). Similarly, but with a much shorter set-up time, Whitworth and Wright (2015) adapted their traditional practical-based laboratory report into an online test with automated marking and estimated a time saving of two weeks for a cohort of 300 students with a one-day set-up time. Çakiroglu et al. (2016) advised that staff and teachers spend adequate time developing and designing learning environments to optimise the enhancement of students' interaction and their engagement with learning tasks. Various studies emphasise a need for sufficient learning design time, inclusive of time for numerous iterations to allow for learning and development and for the evolution of the TEA in line with pedagogical goals (Marín et al., 2016; Summers et al., 2014; Zheng et al., 2015; Çakiroglu et al. 2016). Zheng et al. (2015) and Summers et al. (2014) both detailed the different iterations and differing needs of their TEAs as the projects evolved.

Key Findings

The evidence demonstrated that learning environments that support the development of technology-enhanced Assessment OF/FOR/AS Learning are those which are underpinned by supportive institutional policies, provide appropriate and adequate training and professional development for students and staff, are in a position to provide the financial investment needed to facilitate the use of TEAs, give due consideration to the integration of TEAs with existing systems and the ease of use of TEAs more generally, and provide adequate time for staff to develop and implement TEAs within their local contexts and over various iterations. While none of the reviewed studies evaluated these considerations, they did provide insights into the full range of supports needed.

Perspectives from Irish practitioners regarding learning environments to support TEA

A commonality amongst most of the case study participants was that they had chosen to implement TEA into their teaching practice themselves outside of any institutional guidelines, incentives, or pressures. One case study was an exception in that it was set in the context of an online college environment, which has a strategy in place that supports the implementation and use of TEA. For most case study participants, their implementation and use of TEA was facilitated by their own comfort with using technology. In most instances, their level of technical knowledge precluded the need for any dedicated training. Two other case studies were set within an institutional context where software licences and tools were freely available as TEA resources to staff. An example was given in another case study of a particular piece of equipment being purchased by their institution on their behalf to facilitate their embedding of TEA in their work. Many of the participants noted that generally, institution-wide, the existing VLE or LMS was perceived as adequate to support and facilitate TEA, but that this view did not always carry through to those implementing TEA in practice. Likewise, a lack of specific training for teachers and students was seen to potentially limit TEA implementation. Nevertheless, two case studies noted the availability of appropriate workshops and supports in their respective institutions which aided their TEA implementation. All the TEA developments emerging from these case studies were designed to integrate, to at least some extent, with the existing VLE or LMS in the institutions.

Summary and Conclusion

This systematic literature review sought to explore the evidence base underpinning the use of technology in assessment in higher education within the context of a drive to harness technology to enhance teaching and learning. In particular, it explored the evidence base in relation to designing assessments that incorporate technology, the use of technology to enhance staff efficiencies, the relationship between technology and plagiarism, and the types of learning environments needed to support the effective use of technology in assessment.

Specific models of assessment design were not an explicit focus in any of the 65 reviewed papers. This absence is notable and may suggest that the literature on technology for assessment is not fully integrating the theory and evidence base on assessment more generally. However, many papers discussed the pedagogical motivations for designing technology into assessment. Such motivations included fostering collaborative learning, stimulating reflective learning, and structuring tasks to scaffold students' learning and provide opportunities for practice. The main examples of TEA being used to foster collaborative learning were those which incorporated Web 2.0-Social Media technologies. In cases where the stimulation of reflective learning was the focus, the underpinning designs often focused on different levels of automated analysis and feedback tools to support Assessment FOR Learning. Where assessment design was focused on structuring tasks to scaffold students' learning, the emphasis was often placed on developing Assessment AS Learning, students' self-directed engagement with learning, while also freeing up class time via interactive and/or self-directed learning. The focus on Assessment FOR and AS Learning in assessment design was associated with a predominance of low stakes assessment. Indeed, the majority of the TEAs focused on tasks carrying low grades and, in some cases, focused on lower-order skills, particularly through the use of online quizzes, MCQs and simulations/games.

The potential of TEA to contribute to staff efficiencies was evidenced through efficiencies of time and workload, increased visibility of student activity, and the fostering of student autonomy. The time and workload efficiencies were focused mainly on supports for grading, plagiarism detection and provision of feedback. The potential efficiencies however were often counterbalanced by limiting factors such as a high workload involved in setting up, managing and maintaining TEAs. This was particularly evident in assessments involving social media, where the visibility of student work and the affordance of the technology could cause unexpected and challenging online student behaviour that had to be monitored and managed. Automated assessment/intelligent tutorial systems demonstrated the clearest potential for efficiencies for staff in terms of reduced workload around assessment, particularly so if the systems provided automated feedback. While the potential of automation was elaborated in several papers, the scale of efficiencies generated relative to time and resource costs was not quantified in any study. Furthermore, there was limited evaluation in these studies of the reliability or validity of the systems or the quality of the feedback students received, or their engagement with such feedback. The evidence gathered on this topic suggests that, while there may be potential for staff efficiencies to be enhanced through the use of technology, there is a need to investigate this more thoroughly through longitudinal research examining whether efficiencies develop over TEA iterations from set-up, to initial implementation through to maintenance, taking account of the human and financial resources required.

While plagiarism was not a focus of many papers, some studies did point to staff concerns and actions regarding this issue. As expected, the most straightforward approach to combatting plagiarism was shown to be the effective use of plagiarism detection software, such as Turnitin. The included studies pointed to the potential of plagiarism detection software to help raise student awareness of plagiarism and to act as a regulatory or preventative mechanism. Where MCQs were used, staff addressed the danger of cheating primarily through randomisation or personalisation of question content or data, time limits, website

restrictions for online exams, use of a virtual proctor, use of biometrics for identification, and binding honesty agreements between students and institutions. Within Web 2.0-Social Media TEA tools, student academic misconduct at times manifested as unacceptable online behaviour which required significant staff input resulting in an increased workload. The approaches used to mitigate against these concerns included the design and implementation of an online governance code of practice, managing, monitoring and intervening, and flagging and penalising inappropriate behaviour such as copying. The papers detailing such approaches provide a valuable perspective on how to design TEA approaches in ways that improve understanding, encourage integrity and minimise plagiarism.

While assessment design, the efficiencies it can generate and the need to counter plagiarism in assessment are all important considerations, the environment within which assessment is planned and the supports surrounding staff and students are fundamental to the quality and effectiveness of assessment efforts. The papers included in this report suggest that TEA should be designed in a holistic learning environment with supportive institutional policies, appropriate investment of time and finances to support implementation and maintenance, and a strong alignment between the technology tools used and the pedagogical purposes of the assessments. The provision of adequate professional development for staff was noted as important, focusing not on the technology alone but on pedagogical goals and the use of the technology in context. Education for students was also mentioned as important in supporting their optimal engagement with TEA. Integration and ease of use were key to staff adoption, beyond the functionality of the technologies used. While the included papers demonstrated some consideration of these aspects of the learning environment, there were no papers that evaluated learning environments from these perspectives.

Most of the studies included in this review focused on innovative, early-adopter staff and provided critical and rich insights into how these staff have engaged with technologies in designing Assessment OF, FOR and AS Learning. However, the review pointed to a number of gaps in the literature. There is a need for longitudinal investigations of sustainable and successful implementations of TEA in higher education, from which more definitive lessons might be learned about how to effectively and efficiently embed technology in assessment design and implementation. More research evaluating the degree to which learning environments in higher education currently enable enhanced TEA practices would also be helpful. A solid body of empirical work and comparative studies would provide more concrete empirical evidence on which to base assessment decisions. The review did identify key approaches to generate staff efficiencies and enable effective practices, particularly in relation to Assessment FOR and AS Learning practices. However, the range of technologies and assessments under the TEA umbrella, and the current stage of adoption of technology, within higher education in general and within assessment in particular, mean that, while this review provides insights into current practice, more substantive findings will only be available when a critical mass of empirical evidence has been published.

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Zdravkova, K., Ivanović, M., & Putnik, Z. (2012). Experience of integrating web 2.0 technologies. *Educational Technology Research & Development, 60*(2), 361-381. doi:10.1007/s11423-011-9228-z

Zheng, B., Niiya, M., & Warschauer, M. (2015). Wikis and Collaborative Learning in Higher Education. *Technology, Pedagogy and Education, 24*(3), 357-374.

Zou, B. (2013). Teachers' Support in Using Computers for Developing Students' Listening and Speaking Skills in Pre-Sessional English Courses. *Computer Assisted Language Learning, 26*(1), 83-99.

Appendices

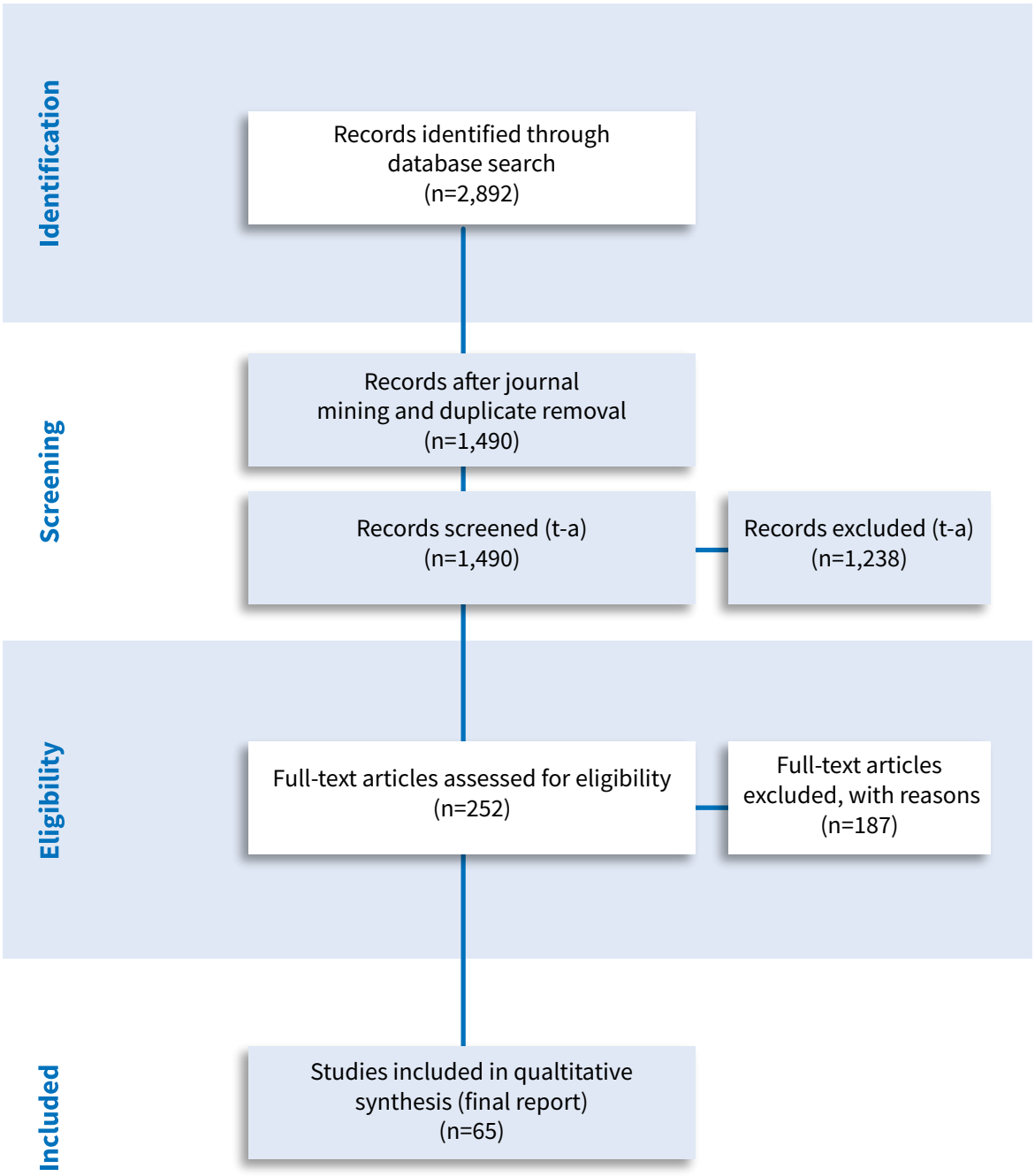
Appendix A: Database Search Strategy

Database/ Repository	Terms Searched	Additional Qualifiers	Papers Retrieved	
			Initial search	Revised search
Academic Search Complete	AB (((assignment OR exam* OR feedback OR assess*) AND (technol* OR online OR comput* OR software OR e-learning OR elearn* OR digital OR multimedia OR virtual OR immersive Or m-* OR interactive OR automat* OR robot* OR "artificial intelligence" OR analytics OR hyper* OR podcast OR simulat* OR gam* OR "social media" OR web* OR internet OR twitter OR facebook OR MCQ OR wiki* OR blog* OR forum OR *cast OR smart* OR ipad* OR reposit* OR MOODLE OR augmented OR turnitin OR e-portfolio* OR video* OR audio*) AND ((higher education) OR universit*) AND (learn* OR teach*))) OR TI (((assignment OR exam* OR feedback OR assess*) AND (technol* OR online OR comput* OR software OR e-learning OR elearn* OR digital OR multimedia OR virtual OR immersive Or m-* OR interactive OR automat* OR robot* OR "artificial intelligence" OR analytics OR hyper* OR podcast OR simulat* OR gam* OR "social media" OR web* OR internet OR twitter OR facebook OR MCQ OR wiki* OR blog* OR forum OR *cast OR smart* OR ipad* OR reposit* OR MOODLE OR augmented OR turnitin OR e-portfolio* OR video* OR audio*) AND ((higher education) OR universit*) AND (learn* OR teach*)))	Refined by January 2012 to April 2017 English Language only Academic Journals Peer Reviewed Scholarly	1,956	830
PsycInfo	AB (((assignment OR exam* OR feedback OR assess*) AND (technol* OR online OR comput* OR software OR e-learning OR elearn* OR digital OR multimedia OR virtual OR immersive Or m-* OR interactive OR automat* OR robot* OR "artificial intelligence" OR analytics OR hyper* OR podcast OR simulat* OR gam* OR "social media" OR web* OR internet OR twitter OR facebook OR MCQ OR wiki* OR blog* OR forum OR *cast OR smart* OR ipad* OR reposit* OR MOODLE OR augmented OR turnitin OR e-portfolio* OR video* OR audio*) AND ((higher education) OR universit*) AND (learn* OR teach*))) OR TI (((assignment OR exam* OR feedback OR assess*) AND (technol* OR online OR comput* OR software OR e-learning OR elearn* OR digital OR multimedia OR virtual OR immersive Or m-* OR interactive OR automat* OR robot* OR "artificial intelligence" OR analytics OR hyper* OR podcast OR simulat* OR gam* OR "social media" OR web* OR internet OR twitter OR facebook OR MCQ OR wiki* OR blog* OR forum OR *cast OR smart* OR ipad* OR reposit* OR MOODLE OR augmented OR turnitin OR e-portfolio* OR video* OR audio*) AND ((higher education) OR universit*) AND (learn* OR teach*)))	Refined by January 2012 to April 2017 English Language only Academic Journals Peer Reviewed Scholarly	962	887

Database/ Repository	Terms Searched	Additional Qualifiers	Papers Retrieved	
			Initial search	Revised search
Scopus	(ABS(((feedback OR Assignment OR examination) AND (technol* OR comput* OR software) AND ((higher education) OR universit*) AND (learn* OR teach*))) OR TITLE(((feedback OR Assignment OR examination) AND (technol* OR comput* OR software) AND ((higher education) OR universit*) AND (learn* OR teach*)))) AND DOCTYPE(ar) AND PUBYEAR > 2009 AND (LIMIT-TO (EXACTKEYWORD,"Teaching") OR LIMIT-TO (EXACTKEYWORD,"Education") OR LIMIT-TO (EXACTKEYWORD,"E-learning") OR LIMIT-TO (EXACTKEYWORD,"Learning") OR LIMIT-TO (EXACTKEYWORD,"Higher Education") OR LIMIT-TO (EXACTKEYWORD,"Controlled Study") OR LIMIT-TO (EXACTKEYWORD,"Questionnaire") OR LIMIT-TO (EXACTKEYWORD,"Computer Aided Instruction") OR LIMIT-TO (EXACTKEYWORD,"Internet") OR LIMIT-TO (EXACTKEYWORD,"Computer-Assisted Instruction") OR LIMIT-TO (EXACTKEYWORD,"Educational Technology") OR LIMIT-TO (EXACTKEYWORD,"Learning Systems") OR LIMIT-TO (EXACTKEYWORD,"Technology") OR LIMIT-TO (EXACTKEYWORD,"Online Learning") OR LIMIT-TO (EXACTKEYWORD,"Teaching And Learning") OR LIMIT-TO (EXACTKEYWORD,"Blended Learning") OR LIMIT-TO (EXACTKEYWORD,"Computer Program") OR LIMIT-TO (EXACTKEYWORD,"Information Technology") OR LIMIT-TO (EXACTKEYWORD,"Virtual Reality") OR LIMIT-TO (EXACTKEYWORD,"Computer Simulation") OR LIMIT-TO (EXACTKEYWORD,"Simulation") OR LIMIT-TO (EXACTKEYWORD,"Questionnaires") OR LIMIT-TO (EXACTKEYWORD,"Comparative Study") OR LIMIT-TO (EXACTKEYWORD,"Software") OR LIMIT-TO (EXACTKEYWORD,"Collaborative Learning") OR LIMIT-TO (EXACTKEYWORD,"Social Networking (online)") OR LIMIT-TO (EXACTKEYWORD,"E-Learning") OR LIMIT-TO (EXACTKEYWORD,"User-Computer Interface") OR LIMIT-TO (EXACTKEYWORD,"Research") OR LIMIT-TO (EXACTKEYWORD,"Universities") OR LIMIT-TO (EXACTKEYWORD,"Computer Interface") OR LIMIT-TO (EXACTKEYWORD,"Social Media") OR LIMIT-TO (EXACTKEYWORD,"Technology Enhanced Learning") OR LIMIT-TO (EXACTKEYWORD,"Web 2.0") OR LIMIT-TO (EXACTKEYWORD,"Online Systems") OR LIMIT-TO (EXACTKEYWORD,"World Wide Web") OR LIMIT-TO (EXACTKEYWORD,"Online System"))	Refined by January 2012 to April 2017 English Language only Academic Journals Peer Reviewed Scholarly	1,335	658

Database/ Repository	Terms Searched	Additional Qualifiers	Papers Retrieved	
			Initial search	Revised search
ERIC Search 1	(((((((technol* AND ((higher education) OR universit*)) AND schol(yes) AND peer(yes) AND la.exact("English") AND lv("postsecondary education" OR "higher education")) AND SU.EXACT.EXPLODE("Assignments") AND SU.EXACT.EXPLODE("Educational Technology") NOT (SU.EXACT.EXPLODE("EVALUATION") OR feedback* OR assess*) AND la.exact("English") AND lv("postsecondary education" OR "higher education")) AND rtype.exact("080 Journal Articles") AND pd(>20100101)) AND rtype.exact("080 Journal Articles")) AND schol(yes)) AND peer(yes)) AND rtype.exact("080 Journal Articles") AND pd(>20100101)		2,437	517
ERIC Search 2	((technol* AND ((higher education) OR universit*)) AND schol(yes) AND peer(yes) AND la.exact("English") AND lv("postsecondary education" OR "higher education") AND (SU.EXACT.EXPLODE("Prognostic Tests") OR SU.EXACT.EXPLODE("Situational Tests") OR SU.EXACT.EXPLODE("Objective Tests") OR SU.EXACT.EXPLODE("Screening Tests") OR SU.EXACT.EXPLODE("Aptitude Tests") OR SU.EXACT.EXPLODE("Maturity Tests") OR SU.EXACT.EXPLODE("Teacher Made Tests") OR SU.EXACT.EXPLODE("Creativity Tests") OR SU.EXACT.EXPLODE("Nonverbal Tests") OR SU.EXACT.EXPLODE("Field Tests") OR SU.EXACT.EXPLODE("Timed Tests") OR SU.EXACT.EXPLODE("High Stakes Tests") OR SU.EXACT.EXPLODE("Standardized Tests") OR SU.EXACT.EXPLODE("Licensing Examinations (Professions)") OR SU.EXACT.EXPLODE("Vision Tests") OR SU.EXACT.EXPLODE("Exit Examinations") OR SU.EXACT.EXPLODE("Norm Referenced Tests") OR SU.EXACT.EXPLODE("Performance Tests") OR SU.EXACT.EXPLODE("Mathematics Tests") OR SU.EXACT.EXPLODE("Occupational Tests") OR SU.EXACT.EXPLODE("Science Tests") OR SU.EXACT.EXPLODE("Criterion Referenced Tests") OR SU.EXACT.EXPLODE("Diagnostic Tests") OR SU.EXACT.EXPLODE("Auditory Tests") OR SU.EXACT.EXPLODE("Verbal Tests") OR SU.EXACT.EXPLODE("Achievement Tests") OR SU.EXACT.EXPLODE("Cognitive Tests") OR SU.EXACT.EXPLODE("College Entrance Examinations") OR SU.EXACT.EXPLODE("Culture Fair Tests")) NOT (SU.EXACT.EXPLODE("EVALUATION") OR feedback* OR assess*) AND SU.EXACT.EXPLODE("Educational Technology")) AND schol(yes) AND peer(yes) AND rtype.exact("080 Journal Articles") AND la.exact("English") AND lv("postsecondary education" OR "higher education") AND pd(>20100101)			
		Total	6,690	2,892
		Total after refining of journal results		**1,490**

Appendix B: Flowchart of Screening and Selection Process



Search, retrieval and screening flowchart (modified from Moher et al., 2009)

Appendix C: Quality Assessment Tools Used in Systematic Review

QA Tool 1 - Quality assessment for qualitative papers, based on an adaptation of Keane et al. (2016) and Kiersey et al. (2017)

Q	Topic	Question	Y/N
1	Purpose-Research Question	Was the purpose and/or research question stated clearly?	
2	Study Context	Is the study context clearly described?	
3	Sampling	Is the sampling method clearly described and appropriate to the research question?	
4	Method of Data Collection	Is the method of data collection clearly described and appropriate to the research question?	
5	Method of Analysis	Is the method of analysis clearly described and appropriate to the research question?	
6	Sufficiency	Are the claims made supported by sufficient evidence, i.e. did the data provide sufficient depth, detail and richness?	

QA Tool 2 - Quality assessment for quantitative papers, as per quality tool on EPPI Reviewer

Q	Topic	**Rate as Follows:** Strong = 1; Moderate = 2; Weak = 3
1	Selection Bias	
2	Study Design	
3	Blinding	
4	Data Collection Method	
5	Withdrawals and Dropouts	

QA Tool 3 - Review of reviews, based on McMaster University21 Health Evidence Quality Assessment Tool

Q	Topic	Question	Y/N
1	Meta-Analysis	Is the study a meta-analysis?	
2	Clearly Focused Question – PICO	Is there a clearly focused research question? Problem - Intervention - Comparator - Outcome	
3	Inclusion Criteria	Were appropriate inclusion criteria provided for the review question	
4	Search Strategy	Was there an appropriate and comprehensive search strategy?	
5	Time Period	Is there a sufficient time period covered?	
6	Study Design	Are the study designs of included studies clearly identified?	
7	Quality Assessment	Was the methodological quality of the primary studies assessed?	
8	Quality Transparency	Are quality assessments transparent?	
9	Combining Findings	Was it appropriate to combine the findings of results across studies?	
10	Methods for Combining Studies	Were appropriate methods used for combining or comparing results across studies?	
11	Author's Interpretation	Do the data support the author's interpretation?	

Appendix D: Included Papers Associated with Each Research Question

A list of the papers included in the systematic review and the corresponding research questions to which they related are presented in the table below.

Author & Year	Assessment Design	Staff Efficiencies	Plagiarism	Learning Environments
Achumba et al. (2013)		X		
Admiraal et al. (2014)			X	
Akçapınar (2015)			X	X
Almpanis (2015)		X		
Bennett et al. (2017)	X	X		X
Blackburn (2017)	X	X		X
Blair et al. (2016)	X	X		X
Bogarra Rodriguez et al. (2012)		X	X	X
Buckley & Cowap (2013)		X	X	X
Buus (2012)	X			X
Çakiroglu et al. (2016)	X			X
Caminero et al. (2016)	X	X	X	
Caple & Bogle (2013)	X	X	X	
Carruthers et al. (2015				X
Chao et al. (2012)	X	X	X	X
Chen et al. (2013)	X	X		

Author & Year	Assessment Design	Staff Efficiencies	Plagiarism	Learning Environments
Chew et al. (2015)		X	X	X
Cochrane et al. (2013)	X			X
Crook et al. (2012)		X		X
Dargusch et al. (2015)		X		
Flosason et al. (2015)	X	X		
Goldstein & Peled (2016)	X	X		
Gray et al. (2012)	X	X	X	
Griff & Matter (2013)		X		
Haines (2015)	X			
Heinrich & Milne (2012)		X		X
Hsiao et al. (2016)		X		
Hutchings & Quinney (2015)				X
Kim (2015)		X		
Kuikka et al. (2014)		X	X	X
Lafuente Martínez et al. (2015)	X	X		
Link et al. (2014)		X		
Liou et al. (2016)	X			

Author & Year	Assessment Design	Staff Efficiencies	Plagiarism	Learning Environments
Liou et al. (2016)	X			
Maher et al. (2013)	X	X		
Malau-Aduli et al. (2014)		X		
Marín et al. (2016)				X
McNeill et al. (2012)	X	X		X
Meadows et al. (2016)		X		X
Mettiäinen (2015)	X	X		X
Mora et al. (2012)		X		
Neely & Tucker (2013)	X			
Nguyen et al. (2013)		X	X	
Onrubia & Engel (2012)	X			
Penketh & Beaumont (2014)			X	X
Pittenger & Olson-Kellogg (2012)	X	X		
Reilly et al. (2015)		X		
Rodríguez-Gómez et al. (2016)		X		
Rubin et al. (2013)				X
Schaffer et al. (2017)		X		X

Author & Year	Assessment Design	Staff Efficiencies	Plagiarism	Learning Environments
Schoonenboom (2012)				X
Steenbergen-Hu & Cooper (2014)				X
Sullivan (2016)	X	X	X	
Summers et al. (2014)	X	X	X	X
Sun et al. (2014)	X	X		
Sweeney et al. (2017)	X	X		
Tao et al. (2012)	X			
Wang et al. (2013)				X
Wanner & Palmer (2015)		X		
Waycott et al. (2013)	X	X	X	
Whitelock et al. (2015)	X	X		X
Whitworth & Wright (2015)		X	X	X
Wimpenny et al. (2012)				X
Zdravkova et al. (2012)		X	X	
Zheng et al. (2015)	X		X	X
Zou (2013)		X		X

Appendix E: Included Case Studies

The table below lists the details of included case studies.

Name	Institution	Case Study Title
Mary O'Toole	Griffith College	TEL Assessment
Barry Ryan	Dublin Institute of Technology	Alignment of Multiple Technologies to Enable Student Understanding by Technology Enabled Assessment OF and AS Learning.
Colin Cooney	Dundalk Institute of Technology	The Implementation of Technology-Enhanced Formative Assessment in a Business & IT Module
Louise Heeran Flynn	Hibernia College	Modelling Best Practice in Terms of Inclusive & Reflective Technology-Enabled Assessment Practices on a Blended Learning Initial Teacher Education Programme (Teaching Subject Mastery Module)
Muireann O'Keeffe	Dublin Institute of Technology	Using YouTube to Initiate a Dialogic Feedback Process with Students
Cicely Roche	Trinity College Dublin	Addiction Pharmacy and the Professionalization Process: Technology-Enhanced Assessment of Reflective Practice and Teamwork

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