Development and acceptance of online assessment in higher education: Recommendations for further research

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Article Info

Abstract

Online assessment is now used commonly in higher education institutions. While this approach to assessment has several advantages over paper-based assessments, its introduction often precipitates concerns from users, in particular, students and academic staff members. This paper traces the development of online assessment and reviews studies published on student and teacher perceptions of online assessment over a 15-year period. Studies suggest that while students' perceptions are generally found to be positive, academic staff members' perceptions have been more mixed. Recommendations for future research into teachers' responses to online assessment tools are made.

Introduction

Educational technologies have evolved over the years to become an integral part of teaching and learning processes in the higher education sector. The early 1960s marked the first attempt to use computers to assist education assessment processes (Woolley, 1994), with web-based online testing software then introduced in the 1990s (Bull & Stephens, 1999). In more recent times, with reduced teaching resources and increased student numbers, teachers across all levels of education have needed to do more with less by adopting technology (Donnelly, 2014; Nicol, 2007). This trend has given rise to the rapid growth of online learning and assessment approaches within the higher education sector. As a consequence, over the last two decades, online assessment has come to replace paper-based assessments in many colleges and universities (Boitshwarelo et al., 2017).

The novel coronavirus (COVID-19) pandemic saw education systems around the world confront tremendous challenges due to the shutting down of schools and university campuses. In this context, such institutions were forced to find ways to continue teaching and learning activities without the physical attendance of staff members or students (UNESCO, 2020). Inevitably, many schools and universities turned to online learning platforms to address this need. The same challenges were seen in terms of implementing student assessments, and UNESCO (2020) listed a shift to online assessment as one of the five main strategies that countries had adopted to manage high-stakes assessments during the COVID-19 crisis.

In the next few sections, we discuss the development of online assessment different forms of online assessment, as well as the potential of online assessment to enhance processes and outcomes in education institutions. This includes a consideration of how students and teachers have been reported to respond to online assessment, based on the existing literature. We then propose the need for an integrated theoretical model to direct future research on users' acceptance of online assessment approaches. The paper focuses exclusively on the use of online assessment within higher education, given that the challenges confronted by end-users within schools are likely to differ from those of users based in colleges and universities.

Online assessment

In recent years, the delivery of educational assessments in many institutions has been shifted from traditional pen-and-paper methods to various forms of online assessment with the use of computer technology (Cavus, 2015; Diprose, 2013; Dube et al., 2009; Stone & Zheng, 2014). The term *online assessment* is often used interchangeably with the terms *electronic assessment* or *e-assessment* (Jordan, 2013), computer-assisted assessment (Bull & McKenna, 2003; Sim et al., 2004), computer-mediated assessment (Huot, 1996) and computer-based assessment (Fluck et al., 2009). The primary characteristic of all of these approaches is the use of some computerised technology to deliver assessment tasks (Bull, 1999; Chalmers & McAusland, 2002). Typically, online assessment is used as the delivery mode for multiple-choice questions, online or electronic submission and computerised adaptive testing (Collares & Cecilio-Fernandes, 2019; Wang & Kingston, 2019). Assessments at any stage of the learning process (i.e., for formative, diagnostic or summative purposes) can be delivered in an online format.

Within university settings, online assessment allows faculties to have large number of candidates selecting answers to questions on a computer that is connected to an internet site that contains a database. Instant and detailed feedback may or may not be enabled, depending on the intent of the assessment (i.e., whether it is a formative or summative task). The increased efficiency of online assessment means that educational institutions can do more with less (Alruwais et al., 2018). As Gipps (2005) noted, enhanced efficiency and the potential to enhance pedagogical processes are the main reasons for using online assessment. With automated marking and feedback, online assessment is viewed as efficient, fast and reliable, making it useful, particularly in cases where large numbers of students are being tested.

Computer-assisted assessment and online assessment

Computer-assisted assessment, by definition, is the use of computers for assessing student learning (Bull & McKenna, 2003). Various authors have differentiated amongst types of computer-assisted assessment, with one example shown in Figure 1. In broad terms, computer-assisted assessment is defined as the use of computers for assessing student learning and covers the whole process of assessment involving test marking, analysis and reporting (Chalmers & McAusland, 2002; Conole, & Warburton, 2005; Bull & McKenna, 2004). For example, Optical Mark Reading (OMR) and portfolio collection are considered to be forms of computer-assisted assessment. OMR, also known as "mark sensing", remains one of the widely used computer-assisted assessment methods at present. OMR uses a computer to mark scripts composed initially on paper. It is a technique to sense the presence or absence of marks by recognizing the depth of darkness on an answer sheet, usually filled with a pencil or ballpoint pen (Deng et al., 2008). Electronic portfolio collections, another form of computer-assisted assessment, is the use of a computer to collect scripts or written work (McLoughlin, 2003).

Computer-based assessment, on the other hand, involves using a computer programme to mark answers that are entered directly into a computer (Fluck et al., 2009). This form is characterized by the interaction between the student and computer during the assessment process (Charman & Elmes, 1998). In computer-based assessment, test delivery and feedback provision are performed through the use of a computer. This form can be subdivided into standalone applications that only require a single computer, applications that work on private computer networks, and those that are designed to be delivered across public networks such as web-based online assessment (Conole & Warburton, 2005).
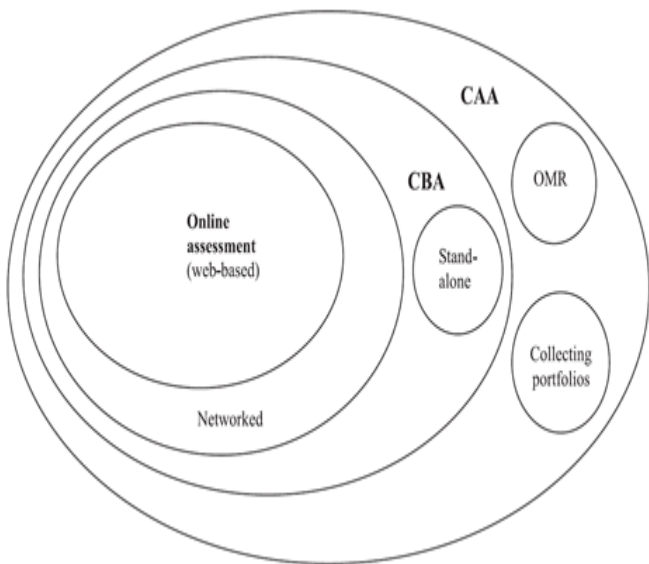
Figure 1. Different types of computer-assisted assessment. Note: Adapted from Conole & Warburton (2005).

From computer-based assessment to online assessment

In order to take a closer look at online assessment, it is essential to differentiate various related terms that have been used in association with this term in recently published works. To this end, a 'desktop research' study was initially carried out to gather data on the terms used in the last two decades (from 2001 to 2020). The benefit of using a desktop research approach is that it allows for a longitudinal analysis to understand how the term "online assessment" has been used over the last two decades. It provided a basis for comparison as the technologies used in assessment have evolved over time. The desktop research helped the authors understand that although terms like "computer-based assessment" and "online assessment" are used interchangeably, there was a trend towards using the latter. In this study, a search was first conducted using the Education Resources Information Center (ERIC) database for abstracts containing terms related to online assessment. Each search consisted of one and only one specific phrase. For example, the phrase containing only "online assessment" was searched, and the number of times this term had appeared in abstracts between 2001 and 2020 was recorded.

From the search, "Online Assessment" appeared most frequently in all publications listed, followed by "Computer-assisted Testing". Other frequently appearing terms included "Online Testing", "Computer-assisted Assessment" and "Online Examination". In Figure 2 and Figure 3, the search results from the ERIC database in 2020 are shown. "Online Assessment" remains the most frequently used term, followed by "Online Testing", "Computer-assisted Testing", "Electronic Assessment" and "Computer-assisted Assessment". Therefore, for discussion in this paper, the phrase "online assessment" will be used consistently to refer to assessments conducted either online or with the aid of a computer device.
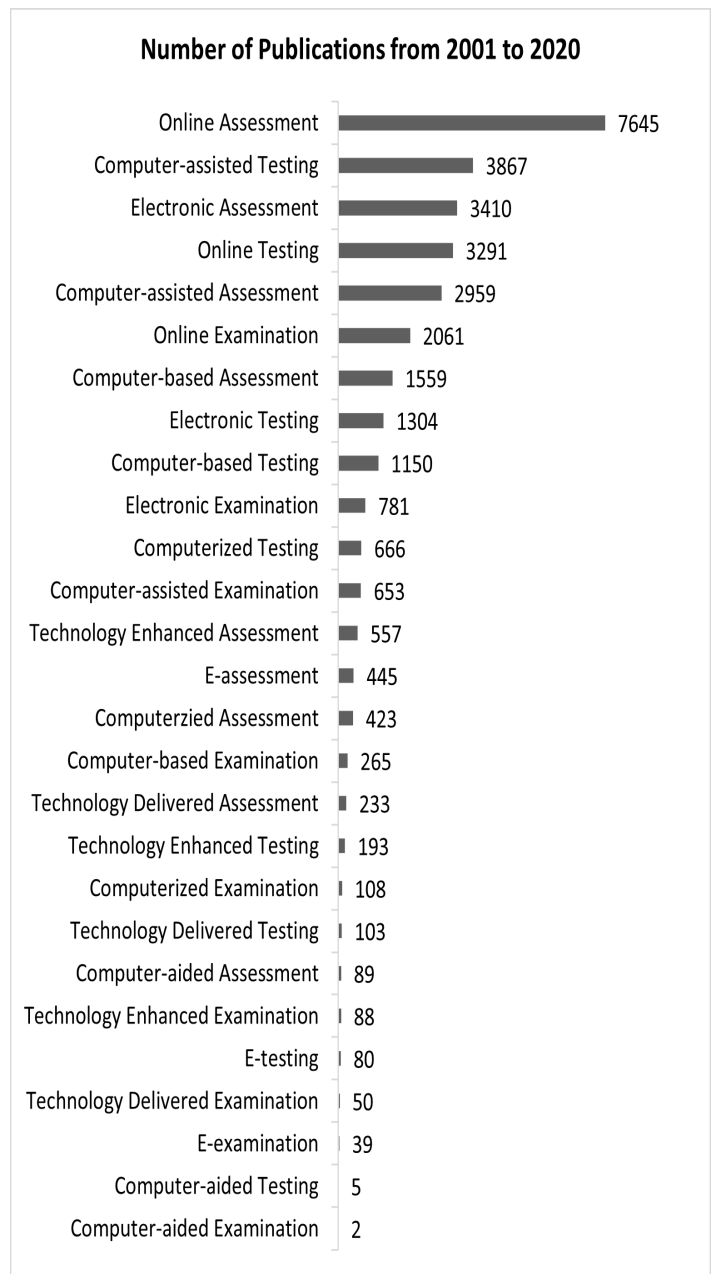

Figure 2. ERIC Database search on assessment-related abstracts from 2001 to 2020. Note: Number of Publications from 2001 to 2020; data extracted on 8 September 2020 From ERIC Database; https://www.eric.ed.gov/

Development phases in online assessment

Historically, three main phases can be seen in the development of online assessment (Figure 4). The first phase from the 1960s to 1990s involved the use of computers in assisting assessment. The second phase from the 1990s to 2000s saw the emergence of adaptive testing and the rise of the learning management systems. In the third phase that commenced in the 2000s, the use of Web 2.0 tools, artificial intelligence and analytics was introduced.

Number of Publications in 2020

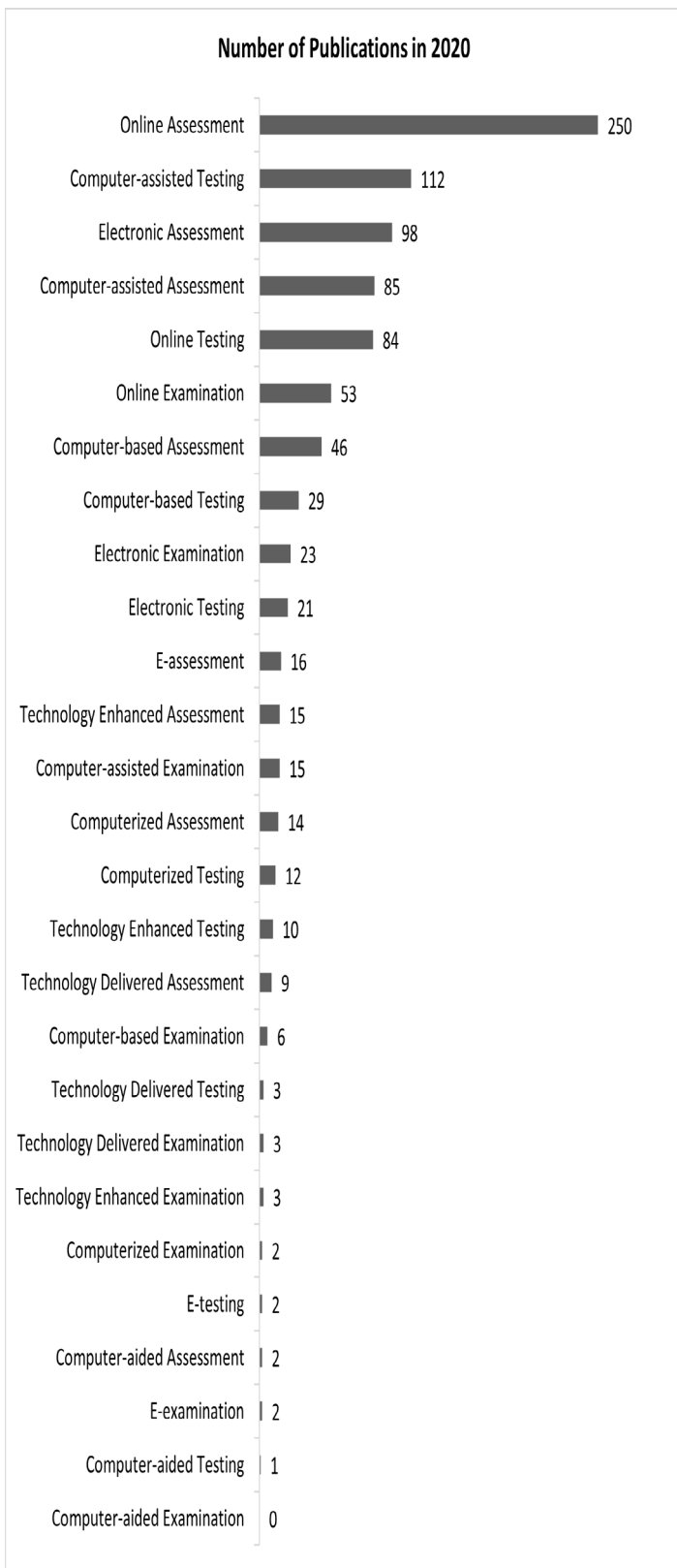| Category	Count
Online Assessment	250
Computer-assisted Testing	112
Electronic Assessment	98
Computer-assisted Assessment	85
Online Testing	84
Online Examination	53
Computer-based Assessment	46
Computer-based Testing	29
Electronic Examination	23
Electronic Testing	21
E-assessment	16
Technology Enhanced Assessment	15
Computer-assisted Examination	15
Computerized Assessment	14
Computerized Testing	12
Technology Enhanced Testing	10
Technology Delivered Assessment	9
Computer-based Examination	6
Technology Delivered Testing	3
Technology Delivered Examination	3
Technology Enhanced Examination	3
Computerized Examination	2
E-testing	2
Computer-aided Assessment	2
E-examination	2
Computer-aided Testing	1
Computer-aided Examination	0

Figure 3. ERIC Database search on assessment-related abstracts in 2020. Note: Number of Publications in 2020; data extracted on 8 September 2020. From ERIC Database; https://www.eric.ed.gov/

Phase 1: Computer-assisted and computer-based assessment (1960 – 1990)

In the period from 1960 to 1990 (Phase 1), computers were the conventional electronic means of delivering online assessment, and assessments or testing were primarily
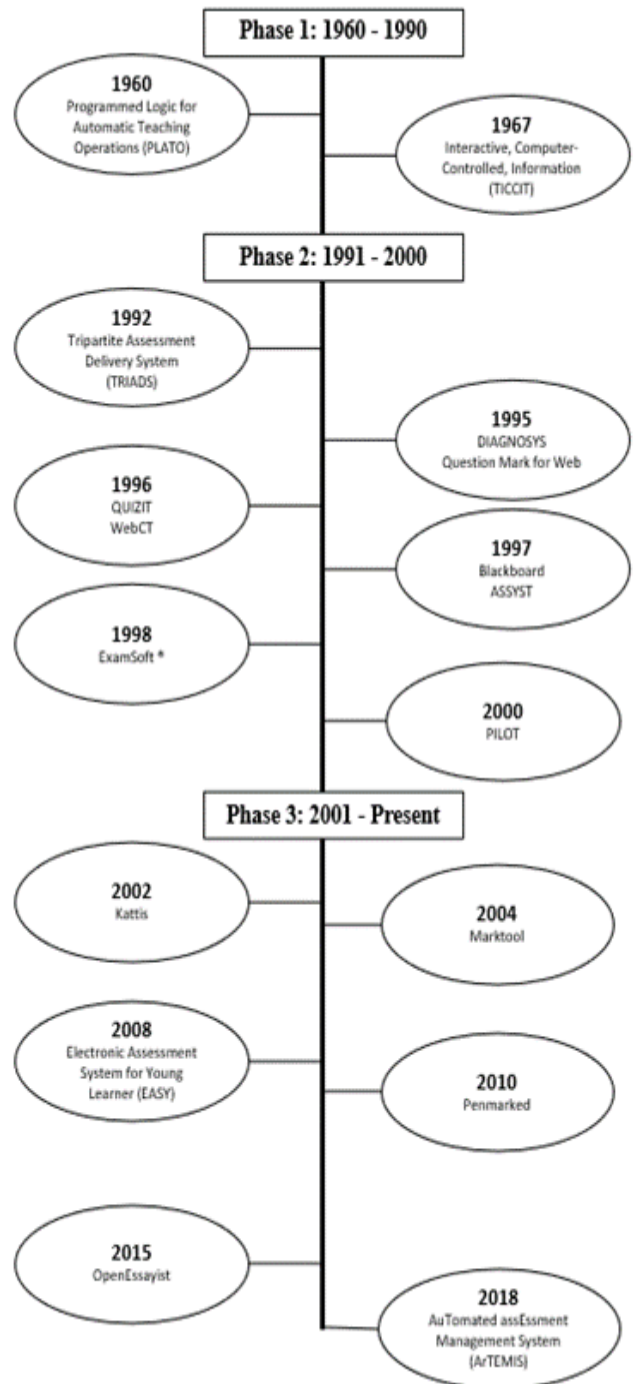
Figure 4. Computer-based examination systems, online assessment systems and assessment tools (1960 to present).

computer-assisted or computer-based. Examples of computer-assisted and computer-based tools used during this phase included databases, spreadsheets and expert systems. The first apparent attempt to use computers to assist the assessment process in the early 1960s was the Programmed Logic for Automatic Teaching Operations (PLATO) project, initiated by the University of Illinois (Smith & Sherwood, 1976, Woolley, 1994). The users of PLATO ranged from grade school students learning reading and mathematics, to graduate students learning complex concepts in the medical sciences.

The other example of a large-scale assessment project that used computers during this period was the Time-Shared, Interactive, Computer-Controlled, Information Television (TICCIT) in 1967 (Anderson, 1976). Other earlier attempts included the use of computers to automatically assess student programming assignments (Douce et al., 2005; Forsythe & Wirth, 1965; Hollingsworth, 1960). The assessment process was then affected by the revolution of microcomputers in the 1980s (Reiser, 2001). In the 1980s, there was an increased interest in using computers in instruction, and computers were used in automating instructional design tasks (Rottmann & Hudson, 1983). During the same period, large-scale multiple-choice tests were administered through the means of machine-readable forms, known as Optical Mark Recognition (OMR) forms, which are still in use today. In assessments facilitated by the use of OMR forms, students who are taking examinations shade their answers to selected-response questions on sheets that have been specifically designed for such a purpose (Jordan, 2013).

Phase 2: Adaptive testing and web-based assessment (1990 – 2000)

Phase 2 took place from 1990 to 2000, when computer capabilities increased to provide a broader range of options such as data processing and simulations. During the same period, many other sophisticated systems had emerged like the Tripartite Assessment Delivery System (TRIADS) from the University of Derby in 1992, which included varied question types to test higher-order skills (Allen, 1998; Boyle & Hutchison, 2009; Burrow et al., 2005; Cox et al., 2008). TRIADS is still in development today.

Another sophisticated system that emerged then was DIAGNOSYS, an adaptive testing software designed to prepare undergraduates for the study of physics and engineering (Appleby et al., 1997). Such adaptive testing systems measure users' abilities by 'building', dynamically, an individualised test for each user (Chang & Ying, 1996). DIAGNOSYS, first developed in 1995, is based on a hierarchy of skills, in which each question delivered to a user depends upon on the previous answer given. The test items are selected sequentially, according to the current user's performance. As a consequence, the test is tailored to each user's ability by adjusting the difficulties of the items delivered to the responses given by the user. This means that higher-achieving users can avoid responding to a large number of easy items, and lower-achieving users are not confronted with a large number of items that are too difficult. During the same period that DIAGNOSYS was developed, there was the increased use of the World Wide Web, which led to the first commercial launch of web-based testing software, Question Mark for Web (Bull & Stephens, 1999).

Towards the end of Phase 2, a decline in computer-assisted or computer-based approaches could be seen, with an increasing emphasis on web-based assessments. The exponential growth of internet usage seen at this time was a key factor in the decline observed. For instance, Blackboard, a widely used web platform released in 1997, had the capability to provide automatic grading of multiple choice and True/False questions. Systems such as QUIZIT (Tinoco et al., 1997), WebCT (Goldberg & Salari,1996), ASSYST (Jackson & Usher, 1997), ExamSoft® (Wadley et al., 2014) and PILOT (Bridgeman et al., 2000) were also examples of web-based systems with the ability to deliver and facilitate online testing and grading. These applications reduced emphasis on the more traditional forms of computer-assisted or computer-based approaches that had been developed previously.

Phase 3: Web 2.0 tools, artificial intelligence and analytics (2000 – present)

Phase 3 began in 2001 and incorporates developments to the present day. During this period, e-learning took the forms of virtual classrooms, computer-mediated communications and online cooperative learning. Examples of online assessment tools that appeared over these years included the use of e-portfolios, blogging, social networking and web authoring systems (Conole & Alevizou, 2010). In 2005, WebCT was acquired by Blackboard, and the web-based system was retired in 2013 (Seepersaud, 2011). Over the last two decades, other prominent learning management systems with proprietary assessment capabilities were also released. For example, the Moodle learning management system, an open-source virtual environment, had a significant influence on the development of online assessment tools (Jordan, 2013).

Besides the growth in the number of learning management systems with online assessment features, many online assessment tools have also emerged in the market in recent years. These online assessment tools focused more on supporting teachers' assessments and grading than on automated evaluation. For instance, MarkTool (Heinrich & Lawn, 2004) introduced an onscreen marking tool that allows markers to annotate PDF documents sent by students with formative feedback. The annotations are either textual and graphical and can be recorded and linked to each student. Penmarked (Plimmer, 2010), another software solution, supports the marking and annotating of students' assignments with free-form ink annotations and associated marking tasks, like gathering and returning assignments, and recording grades.

The last decade also ushered in systems that utilized more advanced techniques to enrich the assessment process, such as semantics, artificial intelligence, natural language processing, or personalised questionnaires. For instance, Hirata and Brueckner (2008) used AI devices such as neural networks, decision trees, and inference engines to support the creation of questions and to keep track of students' learning. They proposed a framework for an Electronic Assessment System for Young learners (EASY). The approach generates results at the end of an assessment and permits revision, as well as a follow-up stage, by using the records of the answers. The specific methods used are: (1) clustering techniques, which enable the system to group the characteristics of the learning objects; (2) forward chaining, which is used to identify objects that users are thinking of when using the system; and (3) backward chaining, which checks the answers and allows for revisions based on these answers.

In another example of an advanced assessment system, Jordan and Mitchell (2009) proposed a natural language-based system, Intelligent Assessment Technologies (IAT), deployed by the UK Open University, to create and mark short-answer, free-text assessment tasks. Evaluations of the answer matching process provided by this system has been demonstrated to have similar or higher accuracy to that of expert human markers. Students attempt the questions online and are given detailed feedback on incorrect and incomplete responses, and can repeat the task immediately to learn from the feedback provided. Also in the area of natured language-based systems, the Supportive Automated Feedback for Short Essay Answers (SAEeSEA) project uses a Natural Language Analytics engine to provide feedback on students' essays for summative assessment (Ras at al., 2015). OpenEssayist, which was part of the SAEeSEA, is a real-time learning analytics tool which provides automated feedback on a draft essay, operating through a linguistic analysis engine that is imbedded within a web-based application.

In the context of assessing computer programming abilities, automated assessments for computer science courses were also developed such as the Kattis in 2002 (Basnet et al., 2018; Enström et al., 2011). Krusche and Seitz (2018) also introduced AuTomated assEssment Management System (ArTEMiS) that automatically assesses solutions to programming exercises and provides instant feedback so that students can iteratively solve the problems presented. ArTEMiS provides an online code editor with interactive exercise instructions. The system is programming language agnostic and applies to a variety of computer science courses. Using ArTEMiS, students gain experiences in version control, dependency management and continuous integration while attempting to solve programming tasks. ArTEMiS is suitable for beginners in programming, and helps students to realise their progress and gradually improve their programming solutions. In doing so, it can also reduce workloads for computer science instructors with large classes, and enhance students' learning experiences.

As we trace the development phases of online assessment, from the first use of computers to assist assessment to the current auto-marking web-based assessment, it is clear that technology has had a significant impact on assessment. As more and more educational institutions adopt online assessment, it raises questions on how teachers and students accept and use new assessment approaches. However, numerous questions have not yet been addressed on the subject of how these new approaches are being adopted in practice by educational institutions. According to Stödberg (2012), who examined a total of 76 articles published in three journals from 2006 to 2012, empirical studies on e-assessment had mainly focused on formative assessments by that time. Research approaches in this field have been highly disparate, and have typically focused on specific applications within particular contexts. As a result, it is often not possible to compare results across studies. Thus, in addition to an obvious need for further research on how teachers and students accept new technologies in assessment, there is also a need for a more systematic approach to the study of online assessment adoption in research.

Forms and potential advantages of online assessment

The term online assessment is often used interchangeably with the terms, electronic assessment or e-assessment (Jordan, 2013), computer-assisted assessment (Bull & McKenna, 2003; Sim et al., 2004), computer-mediated assessment (Huot, 1996) and computer-based assessment (Fluck et al., 2009). While there are subtle differences in the way that these terms are used across publications, all refer to the use of some computerised technology to deliver assessment tasks (Bull, 1999). Various types of computer-assisted assessment have been described in the research literature, including:

- Optical mark reading (OMR), also known as "mark sensing", in which a computer is used to mark scripts composed initially on paper. This is a technique which senses the presence or absence of marks by recognising their depth of darkness on an answer sheet, filled with a pencil or ballpoint pen (Deng et al., 2008).

- Online or e-portfolios, in which a computer is used to collect scripts or written work (McLoughlin, 2003).

- Computer-based assessment, which involves a computer program marking answers, entered directly into digital form (Fluck et al., 2009). This approach can be subdivided into stand-alone applications that only require a single computer with applications that work on private networks, and those designed to be delivered across public networks such as web-based online assessment (Conole & Warburton, 2005).

Online assessment approaches have been reported to offer several advantages over paper-based assessment. These include:

(i)   Providing immediate and anonymous feedback to students on assignments and assessments (Barkley, 2002; Llamas-Nistal et al., 2013; Spivey & McMillan, 2014; Ridgway et al., 2004). Immediate feedback rewards well-prepared students and encourages students who did not perform well to enhance their performance. Teachers also have more control over when feedback is given using this approach. For example, teachers can set feedback to be delivered after a specific time interval once questions are completed. Varying degrees of feedback such as test scores, test scores with correct answers, or test scores with detailed solutions may be provided.

(ii) Making assessment more efficient, particularly in cases where a large number of candidates is assessed (Gipps, 2005). With online assessment, teachers can test students on a wide range of topics in one short test easily (Boitshwarelo et al., 2017; Brady, 2005). The ability to create, manage, and deploy online assessment means that a large part of the manual grading work can be automated. This not only reduces the instructional and administrative costs of teaching courses with large enrolments, but also indirectly affects the amount of learning that takes place in the course by lowering the costs of administering more frequent assessments.

(iii) Reducing costs. Placing course material online can result in significant cost savings because paper, copying, and distribution expenses are all reduced or sometimes eliminated. Copying and delivery of assignments to classes with massive enrolments are often costly and inefficient (Barkley, 2002). Faculties wanting to reduce expenditures are likely to support the transition from paper assignments and assessments to online assessment.

(iv) Increasing assessment reliability. Online assessment has been found to improve examination and testing reliability with machine marking, improved impartiality, and enhanced question styles that incorporate interactivity and multimedia (James et al., 2002; Mora et al., 2012).

(v) Moving examinations out of regular class time, allowing teachers to cover more content or the same content in more depth (Barkley, 2002; Barua, 1999). Online assessment also allows the offering of flexible testing times, delivery periods and frequent testing (Spivey & McMillan, 2014).

(vi) Facilitating distance-learning courses. As online assessment only requires a computer device and internet connection, there is no need for students to be on campus. As such, online assessment has the potential to transform teaching and learning by removing the constraints of time, distance and space (Cirit, 2015; Lei & Gupta, 2010).

Students' acceptance of online assessment

Various studies have affirmed that testing format typically has little or no effect on actual academic performance (Anakwe, 2008; Bloom et al., 2018; Escudier et al., 2011; Spivey & McMillan, 2014; Wadley et al., 2014; Zandvliet & Farragher, 1997). Based on the results of this kind, students do not appear typically to be disadvantaged through the use of online assessment approaches. Despite these findings and the potential advantages of the approach, the success and adoption of online assessment in education settings will inevitably hinge upon its acceptance by end-users - namely, the educators and students. As a result, we must look at how educators and students perceive and respond to this approach, as well as its impact on the teaching and learning process.

The majority of student acceptance studies that have appeared with respect to online assessment have focused on its use in medical and/or health education (Bloom et al., 2018; Boevé et al., 2015; Deutsch et al., 2012; Jawaid et al., 2014; Lewis & Sewell, 2007; Usir & Ahamad, 2017; Wadley et al., 2014), with a smaller number examining its use in subject areas such as engineering (Riera Guasp et al., 2018), foreign language studies (Fageeh, 2015) and social science education (Hewson & Charlton, 2019). This section presents a brief review of studies that have appeared internationally across these discipline areas.

Deutsch et al. (2012) conducted a study at Leipzig Medical School, in which all enrolled fourth-year medical students in one year took a web-based 'mock' examination. The majority of participants indicated that they felt confident in dealing with computers, with female students being significantly less convinced of their abilities in this regard. Students' views of online assessment were also found to improve after completing the assessment, with respect to their overall attitudes towards online assessment; its perceived ease of use; the perceived objectivity of the assessment; and their acceptance of computer or web-based methods in the teaching and learning process. Differences in attitudes across male and female students seemed to be attributable to differences in their perceptions of computer self-efficacy. Initially, females' reservations about technical problems affecting the accomplishment of online assessment were significantly higher than those of males. However, female students' overall attitudes towards online assessment were found to shift positively after undergoing the assessment. Although different before the test, male and female students' attitudes were found to be similar after the exposure to the web-based examination.

Kumar et al. (2013) surveyed 126 first-year medical students on the use of an online portal for assessment in India. Results indicated that students felt comfortable in using the online assessment approach and that they had favourable attitudes toward the immediate feedback this approach afforded. Other comments from students indicated that they saw additional advantages to the approach, which included the reduced potential for errors, the potential to enhance the testing of knowledge depth, and the flexibility afforded by the approach (e.g., the ease with which respondents can deselect answers on re-considering their choices).

Jawaid et al. (2014) conducted a study with 173 Dow University of Health Sciences postgraduate residents on their perceptions of online assessment and their preferences for paper-based or online assessment. Results indicated that while 23.6% of the residents were not entirely confident in using the approach before sitting the online assessment, 64.8% were either confident or extremely confident in undertaking online assessments after their initial experiences with it. A common problem (28.9%) encountered by students was logging in, which would typically be an issue that is easily addressed. In all, 61.8% rated online assessment as better overall than paper-based assessment after experiencing it for the first time.

Several studies have been conducted to examine students' responses to online assessment in other health science disciplines (Bloom et al., 2018; Bernardo et al., 2004; Rajab et al., 2020). For example, in 2013, the Campbell University College of Pharmacy and Health Sciences adopted the use of ExamSoft® assessment program in all required courses in the Doctor of Pharmacy program (Bloom et al., 2018). In a survey of 269 students who completed the assessments, findings showed no significant differences in perceived comfort with the approach based on gender, age, or prior experience with online courses or assessment. Although the student population as a whole felt comfortable using ExamSoft®, there was evidence that specific sub-populations held different perceptions. Younger male students were found to be more likely to be comfortable with ExamSoft®, which was attributed to a higher level of prior familiarity with computers. Students using computers for daily routine tasks, like taking notes in the class were also more likely to report that the feedback provided after the online exam was useful for understanding their performance. The same group of students was also less likely than those who reported difficulties in using ExamSoft® to perceive a negative impact on their examination performance.

Cirit (2015) conducted a study with pre-service teachers to access their perceptions towards paper-based, online and alternative assessments and to examine whether their attitudes changed toward the types of assessment after Web 2.0 tools were implemented. The analysis of the survey data with 155 participants showed a positive attitude towards the use of online assessment methods. In particular, participants felt that online assessment appealed to different types of learners, and was helpful because teachers did not have to be in the same physical location as the students. The participants reported a highly positive attitude towards online assessment for English language and teaching skills. They felt that online assessment could provide authentic tools that other assessment methods could not in English methodology courses. Most importantly, these participants agreed they would like to use online assessment methods in their English courses when they graduated and become teachers.

A few studies on attitudes toward online assessment have also appeared focusing on students in engineering, computer science, foreign language and social science education. In one study focusing on first-year engineering students, Riera Guasp et al. (2018) studied perceptions of online examinations in the context of blended assessment with 463 students from Universitat Politècnica de València, Spain. In this study, Auto-scored Computer-Based Assessment (ACBA) was used as part of the blended assessment in the subject of physics for first-year Engineering degrees. Results showed that there was an overall positive perception of the ACBA tool, especially with respect to its ease of use, and its utility during the learning process, because the ACBA tests helped students prepare for their examinations. Despite this, students were critical of the rigidity of the automatic scoring process used.

In the area of foreign language studies, Fageeh (2015) reported that students were willing to convert to web-based assessment activities in a study of students' and faculty members' attitudes towards online testing using the Blackboard learning management system. The survey was conducted with 400 students and 25 faculty members, at the Faculty of Languages & Translation, King Kalid University. Findings indicated that the students were confident in taking the online assessments, and enjoyed using Blackboard for this purpose. They reported perceiving this approach as useful for undertaking their language assessments.

In contrast to the positive results reported above, in a study with 401 first-year psychology students at the University of Groningen in the Netherlands, Boevé et al. (2015) found that approximately 50% of the students they surveyed indicated a preference for paper-based multiple-choice examinations before taking their first computer-based examinations, with 25% indicating no preference for the medium of assessment, and only 25% indicating a preference for computer-based assessment. After completing their first computer-based assessment, 16% remained positive, 43% of students felt more positive, 12% remained negative, 14% felt more negative, and 15% remained indifferent towards computer-based examinations.

It is clear from this review that while the majority of studies conducted thus far have suggested an overall positive response from students toward online assessment, findings from others have been more mixed. Such mixed responses accumulated from system usage problems faced by students as well as the negative and indifferent attitudes towards online assessment system, and the automatic scoring process within (Boevé et al., 2015; Jawaid et al., 2014; Riera Guasp et al., 2018). While the level of detail provided in these papers did not allow for the identification of the critical factors that moderated students' responses, it is likely that the specific characteristics of the online assessment approaches or systems used in each study contributed to this variability.

Teachers' acceptance of online assessment

While various studies have appeared on students' perceptions of, and attitudes towards, online assessment, studies on teachers' responses to online assessment have been more scarce. Among these studies, Jamil et al. (2012) surveyed 314 teachers in Pakistan universities on their perceptions on computer-based and paper-based examinations. Results indicated that while the majority of the teachers disagreed with the statement that computer-based testing was the 'worst' tool for assessment, they did note the need for a 'master plan' to introduce computer-based examinations at the national level. Collectively, they also agreed that using computers minimised clerical mistakes and that computer-based examinations allowed them to assess more students in less time.

In an online study with a random sample of 25 teachers from the English department in King Khalid University, Fageeh (2015) confirmed that most teachers were willing to convert to web-based assessment activities using the Blackboard learning management system. Findings showed that teachers had positive attitudes to apply e-testing technology in delivering formative and summative assessment online, believing that this technology was an assistive learning

tool that was complementary to e-learning. However, when the effect of age on attitudes on online assessment was examined, there was a difference in attitudes towards online testing across different age groups of teachers. The findings did not indicate which age group was more positive. This finding, however, does suggest a potentially important moderator variable in educators' attitudes to the introduction of online assessment methods.

Hamsatu et al. (2016) conducted a study with 30 teachers in a Nigerian higher institution and found that although these teachers agreed that online assessment was helpful, the potential benefits were not reflected in students' assessment performances. Teachers commented in this study that the use of online assessment might provide too much opportunity for the students to check their answers, and thus, could encourage 'laziness' in the students. The teachers also expressed the view that the assessment process should not be over-dependent on technology. However, the majority affirmed that online assessment was time-saving and lessened the burden associated with examination processing.

Bloom et al. (2018) reported that faculty members had difficulties with computers when an ExamSoft® assessment program was implemented at the Campbell University College of Pharmacy and Health Sciences. Of the 35 faculty members who responded to the survey, 68% reported they had trouble at least once while creating an online examination, and 59% reported having had at least one problem during the administration of an examination. The faculty members did not perceive an impact on examination performance due to the adoption of ExamSoft®, and the analysis of examination grades indicated no significant performance differences across paper-based and ExamSoft® examinations. Despite the difficulties encountered, educators in this study saw the benefits of ExamSoft®, and indicated preferring it to paper-based examinations.

Amante et al. (2019) conducted a survey with 130 teachers and 424 students from Public Universities and Polytechnic Institutes of Portugal on the factors influencing digital assessment. Findings showed that approximately 70% of the teachers felt that there was a lack of knowledge on the use of technology in the teaching subject area (68%), as well as how online activities were assessed (67%). Other difficulties cited were the extra time commitments needed by teachers to implement the approach (38%), the additional effort needed to learn on the part of teachers (35%) and fears related to potential technical problems (35%). The researchers concluded that teachers' perceptions of digital assessment were not directly related to the teachers' age groups. Similar results were reported by Rolim and Isaias (2018), in which 168 higher education teachers in Portugal were surveyed on their views about using e-assessment approaches. The majority reported considering digital assessment as a beneficial alternative to paper-based assessments, but also cited "insufficient knowledge" as a potentially influential factor in whether online assessment would be accepted by colleagues and students.

Although the studies reviewed revealed that teachers had responded well to the transition to online assessment, implementation issues and challenges were also uncovered. For instance, additional workload and efforts to learn were required to use online assessment systems effectively (Amante et al., 2019; Rolim & Isaias, 2018). Like in the studies on students' acceptance, the trust of online assessment process also casted a shadow on teachers' confidence in the online assessment system and its automatic grading processes (Bloom et al., 2018; Hamsatu et al., 2016).

Need for an integrated model to direct research on users' acceptance of online assessment approaches

To ensure that the advantages of online assessment for higher education are fully realised, the approach must ultimately be accepted favourably by its end-users. Most studies on the acceptance of online assessment to date have focused on students, with research on teachers' acceptance of online assessment being comparatively limited (Chien et al., 2014; Imtiaz & Maarop, 2014). This is surprising, given that it is the teachers who design, administer and deliver the online assessments, and thus, will be the primary decision-makers in terms of whether the approach is adopted, the extent to which it is used, and the success with which it is integrated into ongoing teaching and learning processes (Amante et al., 2019).

Many disparate studies on the factors that can impact teachers' intentions to use technology-based pedagogical and assessment tools have appeared within the literature (Amante et al., 2019; Bloom et al., 2018; Fageeh, 2015; Hamsatu et al., 2016; Jamil et al., 2012). For example, various authors have suggested that administrators should implement online assessment systems that are user-centric in their designs, providing simple, clearly explained and consistent navigations that allow both teachers and students to navigate through assessment items with ease (Webb et al., 2013). This remains, however, an area in which much progress could still potentially be made. In the authors' views, progress within this field has been hampered by the absence of an integrating theoretical framework. Many papers published thus far, therefore, have focused on a range of factors that may be quite idiosyncratic to their specific contexts. We argue that a more general, systematic approach, drawing upon sound theoretical frameworks, is needed for the field to move along.

Among the many technology acceptance models that have appeared to date, the United Theory of Acceptance and Use of Technology (UTAUT) is a sound candidate for addressing such a need. In developing the UTAUT, Venkatesh et al. (2003) consolidated various previous Technology Acceptance Model (TAM) theories (Davis, 1989, Taylor & Todd, 1995) and related models of behaviour (Ajzen, 1991; Compeau et al., 1999; Fishbein & Ajzen, 1975; Moore & Benbasat, 1991; Thompson et al., 1991). In the UTAUT, four constructs play a significant role as direct determinants of user acceptance and use behaviour: (1) performance expectancy, or the degree to which an individual believes that using the system helps him or her to attain gains in his or her job performance; (2) effort expectancy, or the degree of ease with which the user can

deploy the system; (3) social influence, or the extent to which an individual perceives that important others believe he or she should use the system; and (4) facilitating conditions, or the degree to which an individual believes that there is an existing organisational and technical infrastructure to support the use of the system (See Figure 5). In the original UTAUT, attitude toward using technology, self-efficacy and anxiety are not direct determinants of behavioural intentions to use technology, though the exclusion of these elements has been contested by other researchers (Dulle & Minishi-Majanja, 2011; El-Gayar & Moran, 2006; El-Gayar et al., 2011; Khechine & Augier, 2019; Moran et al., 2010).

Figure 5. Unified Theory of Acceptance and Use of Technology. Note: Adapted from Venkatesh et al. (2003).

We propose that an extended model that draws upon the strong theoretical foundations of the original UTAUT model could provide a systematic basis for further research into teachers' intentions to use online assessment methods. This proposed extended model is depicted in Figure 6.

Figure 6. Extended UTAUT Model. Note: Adapted from Venkatesh et al. (2003).

In the proposed extended model, attitude has been introduced as a construct. The rationale for including attitude into the proposed extended model is that many previous UTAUT extension studies have found that attitude significantly influences users' behavioural intentions (Botero et al., 2018; El-Gayar & Moran, 2006; El-Gayar et al., 2011;

Jairak et al., 2009; Khechine & Augier, 2019; Moran et al., 2010; Nassuora, 2012; Shuhaiber, 2015; Thomas et al., 2013). The proposed extended model also includes two new constructs: usability and learnability. Usability is the degree of ease with which users can adopt the system to achieve their objectives with effectiveness, efficiency and satisfaction (Bevan et al., 2015; Jokela et al., 2003; Shackel, 2009). Learnability refers to the extent to which users can quickly become familiar with the application and make use of all relevant features and capabilities, which will depend heavily on the quality of the system interfaces (Jeng, 2005; Nielsen, 1994). These additional constructs have been incorporated into the extended model based on findings that both usability and learnability have a significant impact on user's acceptance of technology in different contexts (Jeng, 2005; Joo et al., 2011; Zbick et al., 2015).
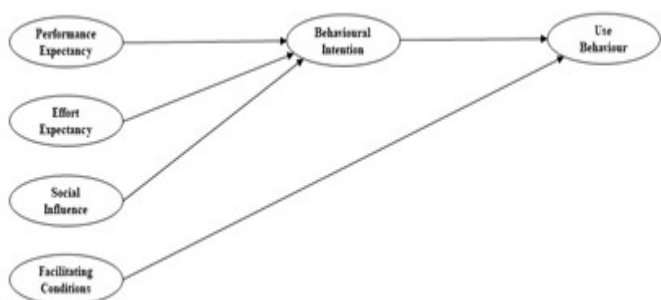
Conclusions and recommendations

To ensure that the advantages of online assessment for higher education are fully realised, the implementation must be accepted favourably by its end-users. Most studies on the acceptance of online assessment to date have focused on students, with research on teachers' acceptance of online assessment being comparatively limited (Chien et al., 2014; Imtiaz & Maarop, 2014). This can make it difficult for administrators who wish to introduce online assessment systems to determine how this can best be done.

In this paper, we have argued that an extended UTAUT can be used to better integrate research into enhancing the adoption of online assessment within universities by teaching staff members. In the extended UTUAT, users' responses to technology still depend on factors such as performance expectancy (PE), facilitating conditions (FC) and social influence (SI), as in the original UTAUT. However, users' attitudes, and the perceived usability and learnability of systems are also proposed to have a significant impact on users' intentions to adopt the system (BI). The extended UTAUT is proposed here as a model that may increase the power with which teaching staff's acceptance of online assessment systems can be predicted.
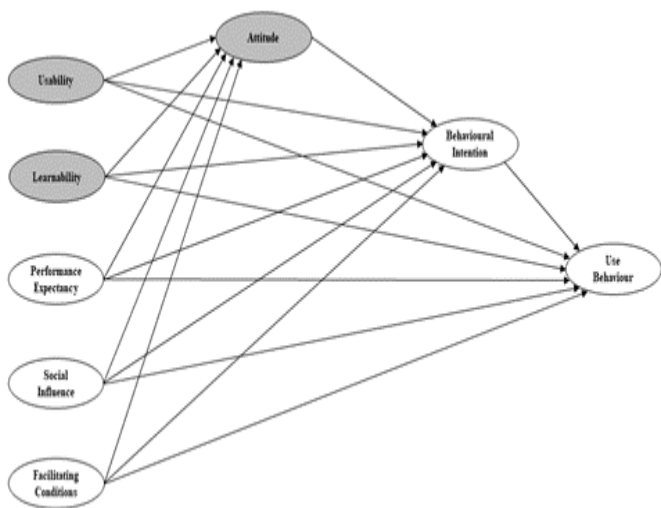
Moving beyond questions of design, the context in which online assessment approaches are introduced is also likely to be an essential factor in users' acceptance of the approaches. The success of any shift to online assessment will require 'buy-in' from both the students and the teachers. The level of buy-in seen from teachers is likely to be a product of myriad factors, including the nature of the technology, the organisational context, and the model used to manage the change process (Legris et al., 2003; Orlikowski & Hoffman, 1997). Hence, faculties need to consider carefully how they should enact the change process when introducing new online assessment systems. The following strategies may help to ensure that teachers respond more favourably to shifts from paper-based to online assessment systems.

(i) Ensure that proper scaffolding is applied in introducing teachers to the online assessment systems. This strategy will be important regardless of how useable and learnable a system is. Yuen and Ma (2008) commented that this step is crucial to build up teachers' confidence in using technology in general. Increased confidence will, in turn, increase willingness to use other forms of instructional technology in the future. Intuitively, more straight-forward user interfaces are likely to appeal to teachers with little prior experience in online assessment systems. However, with increased experience, these teachers may also be willing to use more sophisticated systems.

(ii) Provide effective ongoing professional development to assist teachers in the adoption of online assessment tools. Studies have shown that the most effective professional development programmes that improve teaching practices are those with activities that are ongoing and sustained over time (Tournaki et al., 2011). Besides providing professional development programmes, ongoing institutional support provision will also be essential. Buchan and Swann (2007) suggested a three-level support approach which includes real-time training and professional development, helpdesk troubleshooting, and self-help resources. High-quality technical support structures for different staff groups must also be readily available and accessible throughout the assessment periods.

(iii) Ensure that the additional initial learning requirements are factored into teachers' workloads. The extent to which this must be considered will vary in part with how well the system is designed (i.e., systems that are more 'learnable' will entail a lower workload commitment than those less so). However, this factor is likely to be a significant moderator of responses to the introduction of online assessment or any other technology-based tool. In the study by Amante et al. (2019), teachers cited reasons such as "extra time spent by teachers" and "additional effort to learn by teachers" for not using online assessment tools. Results of this kind underscore the importance of considering the impact on workload as a potential barrier to the introduction of online assessment systems.

(iv) Offer different levels of induction that can be tailored to the needs of individuals. As cited previously, some studies have highlighted significant relationships between age, experience and teachers' attitudes towards online assessment. These results suggest that different levels of support in the introduction of online assessment may be needed for different teacher cohorts. Again, the extent to which this factor needs to be considered may be a product of the learnability of the system.

(v) Include proctoring tools to improve examination integrity when implementing online assessment. Many educational institutions that implemented online assessment require the physical presence of the students in the examination process for supervisory reasons. There are already proctoring tools that allow online assessments to be carried out remotely, without requiring that physical presence of students (González et al., 2020; Selwyn et al., 2021). In the study by Hylton et al. (2016) on using webcam-based proctoring to deter misconduct in online examinations, it was revealed that candidates who were not monitored by a proctoring tool perceived to have experienced greater levels of opportunity to engage in examination misconduct than those who were monitored by a proctoring tool. As such, proctoring tools can be employed to add a layer of deterrence against the misuse of online assessment systems and counter deception and dishonesty during examinations. Milone et al. (2017) posited that from an instructor's perspective, there were benefits in using proctoring as compared to in-person testing. The physical space and invigilators needed for in-person testing are eliminated and the cost of the online proctoring is passed on to students. Hall et al., (2021) recommended that for educational institutions considering implementation of online proctoring, orientation should be conducted for both lecturers and students. This could take place as a mock examination to acquaint lecturers and students before their first remotely proctored examination. It was also recommended that technical support should be made available if any issue arose during the proctored examinations.

Universities need to manage the paradigm shift from paper-based to online assessment well for such implementations to succeed (Amante et al., 2019). At present, however, only a limited body of evidence exists to guide higher education institutions on the best approaches to achieve this goal, and in particular, on how teachers are likely to respond to these shifts. Further research into teachers' responses to online assessment, and into ways to overcome perceived barriers to its use in real settings, will be critical to ensure that its benefits are seen in improved teaching and learning outcomes. The extended UTAUT model proposed here may assist in integrating research within this important field, to ensure that the benefits of online assessment methods are harnessed fully within the higher education sector.

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