



## Digital Learning Technology Blend in Assessment Activities of Higher Education: A Systematic Review

Chowdhury, Sabbir Ahmed; Khalid, Md Saifuddin; Arefin, A. S. M. Shamsul

*Published in:*  
Blended Learning in Higher Education

*Publication date:*  
2021

*Document Version*  
Peer reviewed version

[Link back to DTU Orbit](#)

*Citation (APA):*  
Chowdhury, S. A., Khalid, M. S., & Arefin, A. S. M. S. (2021). Digital Learning Technology Blend in Assessment Activities of Higher Education: A Systematic Review. In M. A. Impedovo, M. S. Khalid, K. Kinley, & M. C. K. Yok (Eds.), *Blended Learning in Higher Education* (pp. 102–11). Aalborg Universitetsforlag.

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# Digital Learning Technology Blend in Assessment Activities of Higher Education: A Systematic Review

**Sabbir Ahmed Chowdhury**

University of the West of Scotland, UK

**Md Saifuddin Khalid**

Technical University of Denmark, Denmark

**A S M Shamsul Arefin**

University of Dhaka, Bangladesh

Online teaching and assessment in higher educational institutions have become the new normal due to the COVID-19 pandemic. This chapter presents a systematic literature review on various digital assessment activities as the diversity of student assessment and feedback technologies cannot be identified from existing literature. Applying Creswell's five steps and PRISMA guidelines, 40 peer-reviewed articles are reviewed. The synthesis of the digital learning technologies for student assessment and feedback are classified into three categories: regular online examinations, alternative online assessment strategies, and ethical assessment. The authors focus on the recent digital technologies for student assessment as well as feedback and recommend empirical investigation on the functionalities and pedagogical designs.

*Keywords:* Digital Learning Technology, Blended Learning, Assessment, Higher Education, Online Examination, Feedback, E-learning.

## 1. Introduction

The digital systems categorized as digital learning technologies or e-learning applications for teaching-learning activities and assessment or exam-related activities in education are receiving greater attention during the COVID-19 social distancing. Amidst the new normal, educational institutions are trying to remain operational and uphold the quality, with particular emphasis on teaching-learning and assessment activities. Existing literature lacks an overview of the digital technologies integrated for conducting the formative and summative evaluation. Thus, this systematic review includes peer-reviewed articles and applications on digital assessment. Due to the didactic differences in different age groups and teaching-learning activities in the pre-school, elementary school and tertiary educational institutions, this chapter primarily focuses on the assessment practices in higher education. Despite technological advancement, the policies, procedures, and norms in the national and educational contexts play a significant role in the adoption and integration of educational technologies. While the techniques and technologies for assessment and exams are being developed and integrated with the technologically and economically advantaged contexts, the disadvantaged contexts are putting up greater effort as well. This systematic literature review addresses the following questions:

1. *What digital learning technologies are blended in the examination and feedback activities of the courses in higher education?*
2. *How are the digital systems blended in higher education for examination and feedback?*

The different sections of this chapter unfold the research questions. First, a brief presentation of the background shows the preliminary knowledge and expectations with which the authors began to write the chapter. Second, the methods section elaborates the systematic approach to the literature review. Third, the analysis and synthesis summarize and discusses the main themes identified in the articles on assessment and feedback of students' learning in digital platforms.

## 2. Background

COVID-19 pandemic has forced higher educational institutions to conduct examinations and feedback online, which involve various kinds of systems, functionalities, and perceptions. The scope, functionalities, and perceived affordances of the digital learning technologies depend on the differences among People (i.e., individual

differences of mental model, size, etc.), Activities (i.e., formative or summative, multimodal digital, oral), Context (i.e. local culture, indoor/outdoor/lab etc.), and Technologies (i.e., systems, media, and functionalities) (Benyon, 2019). Studies have shown that the use of digital technologies either do not affect the students' scores (Khalid et al., 2011; Stack, 2015) or have a positive effect due to strategic use of formative assessment and feedback (Johnson & Kiviniemi, 2009).

In the entirely digital technology-mediated courses, interpersonal communications are mediated by computer interfaces rather than face-to-face instructor-student interactions. The lack of visual cues, absence of synchronous conversations, and incorporation of technical issues suggest that assessment in an online learning context varies from the traditional face-to-face classroom (Reeves, 2000).

The structured activity students are engaged with after their instructor has graded and returned an exam, is defined as an *exam wrapper*, which “is designed to promote self-reflection and improve study practices (Stephenson et al., 2017). A study conducted in two Canadian universities shows that exam wrappers do not have a significant effect on final exam scores or on course drop rates. However, the use of wrappers are “associated with improved rates of test pickup and increased scores on a course evaluation question regarding the fairness of evaluation methods” (Stephenson et al., 2017).

To facilitate the increased number of computer science students, an introductory computer programming course's traditional pen-and-paper exam was replaced with multiple take-home exams (Hellas et al., 2017). Belli et al. (2020) used Turnitin and Urkund on 2,390 students' written works to promote honesty and trust in students, grow self-confidence, learn not to plagiarize, and save time for the teachers. Migut et al. (2018) present preliminary results of automated video proctoring as part of bring-your-own-device (BYOD) assessment at the University of Amsterdam. The study investigates how to partially automate the proctoring process by using the recordings of the screen and automatic video analysis.

Bloomfield and Groves (2008) present the design and implementation of a system that allows a standard paper-based exam to be graded via tablet computer. As part of a course, with a special footer to automatically recognize the examination page, a high-speed scanner scans the pages, graded by one or more people using tablet computers, and returned electronically to the students. Khalid et al. (2011) generated multiple sets of quiz questions using a plugin of Moodle learning management system, which was answered by sending an SMS string and returned an SMS containing score with right answer string and by attending the quizzed on Moodle in a computer lab. Balta and Tzafilkou (2019) used Socrative software in a physics course for instant formative feedback on quizzes and noted the improvement of student engagement and attitudes towards the subject matter.

Technology-mediated text-based corrective feedback for second-language learning to writing skills, in general, are supported by the software KungFu writing, LangCorr, Grademark, Markin, and EasyCorrect (Kjaergaard, 2017). For instance, the company EasyCorrect developed Edword.com with plugins to Google Docs and Microsoft Word for giving feedback to students using comments, voice, references, and other features along with reusing comments to save time and providing insights through analytics on both teacher's activities and students' actions.

The authors were exposed to the above-mentioned digital learning technologies designed for or integrated into the assessment and feedback activities of higher education and identified the scope of a broad categorization. Thus, the scope of this book chapter is ‘what’ digital technologies and ‘how’ the functionalities are integrated for assessment and feedback part of online teaching-learning activities.

### 3. Methods

This study applies Creswell's five major steps for systematic literature review. These are identifying key terms, locating literature in the databases, critically evaluating and selecting the literature, organizing the selection of literature by abstracting or taking notes and writing a literature review reporting summaries of the literature for inclusion (Creswell, 2012). Accordingly, two databases were selected: ACM Digital Library and ERIC. Search criteria were restricted to peer-reviewed full-text of the last 5 years and written in English. Using different combinations of the keywords shown in Table 1, experimental searches and an iterative approach to searching were conducted.

Table 1: Keywords for Systematic Literature Review.

Assessment	Technology	Higher	Strategy
Evaluation	Digital	Tertiary	Activity
Feedback	Blended	University	Technique
Examination	E-Learning	Graduate	Process

First, ERIC returned 48 papers and ACM digital library returned 120 papers. Furthermore, additional relevant and related 31 resources including online materials, journals and conference proceedings, written in English and dated back to the year 2000, were considered for this review. During the eligibility phase, papers on the theoretical framework, models, techniques and efficacy of online learning were excluded. The review process included identification, screening, eligibility, and included stages as proposed by the PRISMA guidelines (Moher *et al.*, 2009). Figure 1 shows an overview of the review methodology by illustrating the PRISMA steps and procedures.

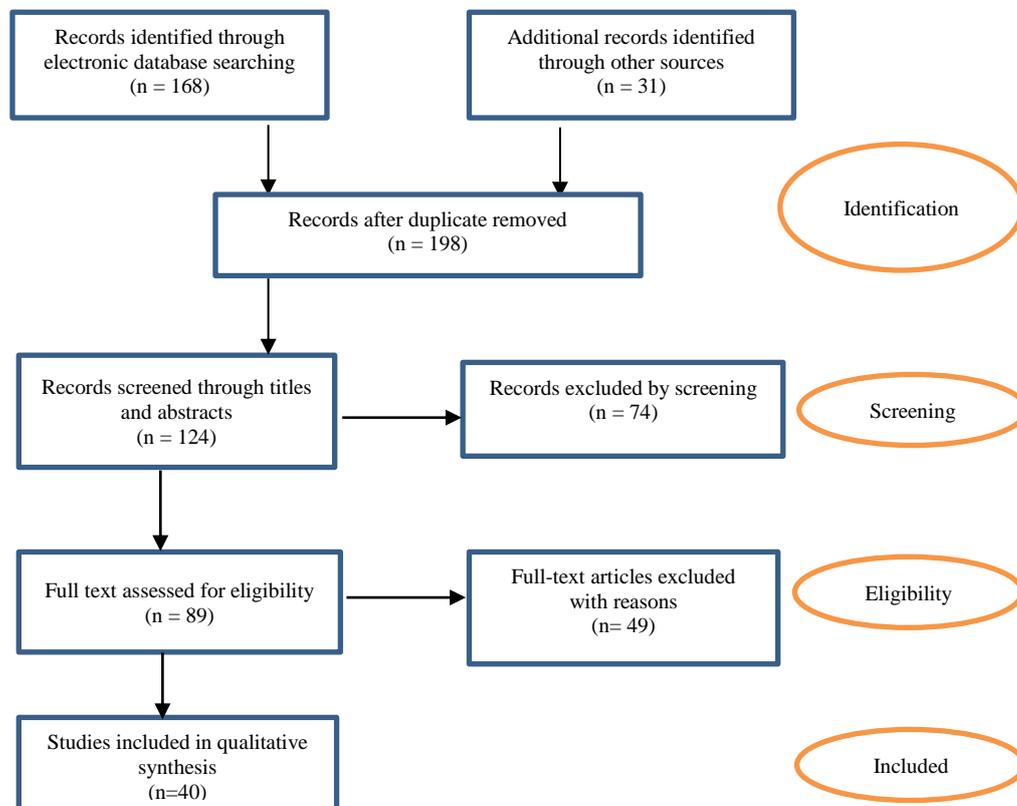


Figure 1: PRISMA Flow Diagram of the study.

Finally, 40 papers were included for qualitative synthesis. The constant comparative method (Hewitt-Taylor, 2001) was applied to qualitatively analyze and synthesize these articles.

#### 4. Synthesis: Technology Blended Assessment Activities in Higher Education

The summary of 40 research materials is shown in Table 2, which shows the six categories emerging from the literature. They are regular online assessments or examinations, adaptive assessment, automated assessments, digital badges, Recognition of Prior Learning (RPL), and ethical assessments.

Table 2: Overview of the Digital Technology blended Assessment

Sl.	Article Authors	Categories					
		Online Assessment/ Examinations	Adaptive Assessment	Automated Assessments	Digital Badges	Recognition of Prior Learning	Ethical Assessments
1	Ahadi <i>et al.</i> , 2015			x			
2	Alston, 2017	x					
3	Armellini & Aiyegbayo, 2010	x	x	x	x	x	
4	Baird, 2013				x		
5	Balfour, 2013			x			
6	Baylari & Montazer, 2009		x				
7	Beebe <i>et al.</i> , 2010	x					
8	Boboc <i>et al.</i> , 2006	x					
9	Boud & Soler, 2016			x			
10	Bradley, 2016						x
11	Butcher, 2015					x	
12	Cao and Porter, 2017	x					
13	Challis, 2005		x				
14	Chauhan, 2014		x	x			
15	Chen <i>et al.</i> , 2005		x				
16	Chen, 2018	x					
17	Conrad <i>et al.</i> , 2013					x	
18	CPR, 2020			x			
19	DiCarlo and Cooper, 2014	x					
20	Heintz, 2017						x
21	Hellas <i>et al.</i> , 2017						x
22	Hickey & Kelley, 2013				x		
23	Khan <i>et al.</i> , 2017	x					
24	Kolowich, 2013			x			
25	Meyer & Zhu, 2013		x				
26	Murphy, 2017	x					
27	Mwiya <i>et al.</i> , 2017	x					
28	Nguyen <i>et al.</i> , 2017	x	x	x	x	x	
29	Pereira <i>et al.</i> , 2009	x	x				
30	Qing and Akins, 2005	x					
31	Quansah, 2018	x					
32	Reeves, 2000,	x	x				
33	Shermis <i>et al.</i> , 2010			x			
34	Speck, 2002	x					
35	Tally, 2012				x		
36	Van Gog <i>et al.</i> 2010			x			
37	Vonderwell <i>et al.</i> , 2007	x					

Sl.	Article Authors	Categories					
		Online Assessment/ Examinations	Adaptive Assessment	Automated Assessments	Digital Badges	Recognition of Prior Learning	Ethical Assessments
38	Vonderwell and Boboc, 2013	x					
39	Weleschuk <i>et al.</i> , 2019	x					
40	Yudelson <i>et al.</i> , 2014			x			

The six categories are grouped under three broad concepts: regular online examinations, alternative online assessment strategies, and ethical assessments. The following subsections discuss these concepts or themes.

#### 4.1 Regular Online Examinations

In differentiating online pedagogy and traditional pedagogy, Qing & Akins (2005) reported, “face-to-face pedagogy can and should be used to inform online pedagogy. But face-to-face pedagogy in itself cannot be the driving force to designing online courses; one must consider e-pedagogy to create a successful and meaningful course”. Speck (2002) suggested that trainers should design assignments that finds a good balance between summative and formative assessment. Regarding online pedagogical assessment strategies, Vonderwell *et al.* (2007) opined that online learning assessment should encompass personal and peer group assessment, learner autonomy as well as regulatory mechanisms. The literature thus suggests that traditional assessment strategies need to be revisited for a balanced online learning assessment. Besides, exploring various effective assessment strategies and activities can help to identify and develop improved formative and summative evaluative tools for online environments.

Online examinations are regularly carried out in many higher educational institutes globally that provide online education. Online examinations are also practised as independent assessment tools in traditional education assessment practices in order to avoid subjective bias (DiCarlo & Cooper, 2014). In online examinations, initially, a question repository is built by teachers and test sheets are automatically formulated based on examination system’s predefined strategy. Students receive invitations or links for the examination from the concerned teacher, sign up and complete the examinations remotely. Once the examination is over, answers are automatically checked by the examination system and students can have the feedback immediately or after a prescheduled time interval. Thus, online examinations can help complete the assessment without human monitoring, without subjective bias and minimal man-hour involvement (Chen, 2018). A typical online examination system block diagram is shown in Figure 2.

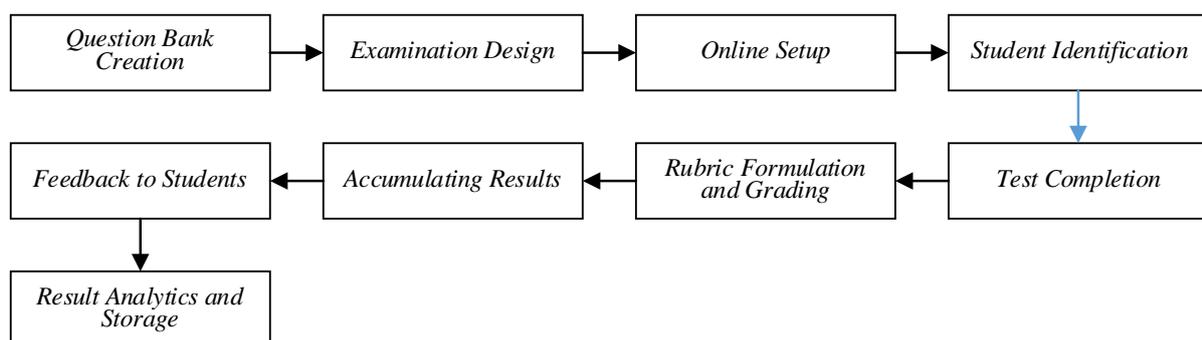


Figure 2: A typical online examination system block diagram

Initially, a question bank is created and the examination for an individual is designed. After that, online setup is prepared for test paper uploading and dispatching to an individual student. Students identify through authenticating themselves via predefined security protocols and complete the test. Then grading rubrics is designed by the examiners and the test papers are graded. Afterwards, the results of all the tests are accumulated and students are notified to view their scripts and results. Last but not the least, different analytics on the final results are deployed for reporting to the concerned stakeholders and the results along with all the reports are stored in a database or cloud (Cao & Porter, 2017).

The question repository or bank for conducting online examinations usually contain questions of various modes, like true/false questions, single answer questions, multiple-choice questions etc. that try to evaluate the grasps of students on the fundamental concepts of a subject and the capacity of students to apply the knowledge in problem-solving. Questions are put up in the repository and arranged according to difficulty levels, starting from easy to highly difficult. Different examination papers are prepared for individual students with questions from all the difficulty levels maintaining a similar difficulty level for every individual test (Murphy, 2017).

The online examination system has superiority over the traditional examination system. The online examination system automatically summarizes, analyzes the test results and ready to interpret with a click depending on the requirements of the user. Analysis regarding question-answer patterns, individual and overall performance can be readily available for monitoring and future development.

### ***I. Formative Assessment***

Vonderwell, Liang, and Alderman (2007) summarized methods for “promoting formative assessment in online teaching and learning” (p. 22). The methods are reflection paper, the minute paper, role play, hook questions, things to keep in mind, questions wall, and checking in with students. Nguyen *et al.* (2017) examined the design of computer-based assessment in 74 undergraduate modules and its impact on 72,377 students’ engagement, satisfaction, and pass rates. Their analysis using fixed effect models suggests that educators implement very different learning designs, which is the adaptivity dimension of content and activities. The formative assessment activities strongly influence students’ time spent on the virtual learning environment and arguably will be similar in the case of time of time spent on the adaptive learning platforms. The definition of learning design included the following activities: assessment, assimilation (attending to information), finding and handling information, communication (discussing module related content with another person), productivity (constructing an artefact), experiential (applying learning in real-world settings), and interactive/adaptive (applying learning in a simulated setting). The learning design variables were able to explain 69% of the variability in time spent on the VLE per visit. Only one of the models implied that the increase of an average one hour assessment time is associated with only 0.48 min average increase in time spent on site. With different assessment strategies across modules, the students adapt their learning strategies.

### ***II. Summative Evaluation***

Challis (2005) reviewed that the design of online summative examinations is likely to require more time and effort compared to the traditional exams, bring complex scenarios of possible ways of setting questions (image, sound, simulation), and integrating adaptivity will require considerably enhanced skills. Furthermore, while computer-based testing are considered inappropriate in some disciplines, it was envisioned that consortia will be employing experts to prepare banks of tests for national and international use, contributing to reliability of assessments and comparability of standards. Nguyen *et al.* (2017) reflected that “Whether students were actually learning and to what extent good pass rates and high satisfaction scores are actually an accurate reflection of appropriate learning designs and [computer-based assessment] CBA can be debated.” (p. 712) The reflection raises the need for defining teaching and learning quality dimensions and the desired impact and interpretation of summative assessment.

## **4.2 Alternative Online Assessment Strategies**

### ***I. Adaptive Assessment***

Automated assessments are almost mandatory for providing the learner grading and feedback anywhere and anytime enrolled in Massive Open Online Courses (MOOCs) as learner-trainer interaction is nearly impossible (Reeves, 2000, Chauhan, 2014). Researches have shown that assessments based on Item Response Theory (IRT) can be an effective online assessment strategy (Chen *et al.*, 2005, Baylari & Montazer, 2009). According to IRT, tests are designed to automatically adapt according to learner’s progress, learner performance and learner’s achievement of learning outcomes. The tests include different difficulty levels and automatically adjusts the difficulty levels based on the response of the learner to each test item (Meyer & Zhu, 2013). The final score is based on the correct answers with weighted difficulty levels with each answer (Challis, 2005). Thus, adaptive assessment is advantageous in tailoring the course content to accommodate individual learner needs and a meaningful strategy to assess and help diverse participants enrolled in a MOOC (Baylari & Montazer, 2009).

## ***II. Automated Assessments***

Automated assessment is in effect since the inception of MOOCs and helps to provide prompt feedback to participants. Researches have demonstrated positive results, reliability and satisfaction in MOOC faculties regarding the usage of automated assessment techniques (Chauhan, 2014, Kolowich, 2013).

Automated Essay Scoring (AES) and UCLA's Calibrated Peer Review (CPR) have been the two most favourite choices of MOOC automated assessment techniques (Shermis *et al.*, 2010). AES evaluates student writing assignments for multiple factors like grammar, style, complexity, vocabulary usage and content alignment with the overall theme of the essay. Whereas, CPR is a web-based tool that evaluates peer-reviewed discipline-based writing in classes of any size (CPR, 2020). CPR is more suitable than AES for large sections and able to provide personalized feedback to students. However, the preference of the two depends on a number of factors like learning outcomes, course structure, pedagogy, and student expectations etc. An initial start with AES followed by CPR in the later stages of a MOOC is preferred by some researchers (Chauhan, 2014, Balfour, 2013). Even though controversies regarding the accuracy and effectiveness of AES and CPR remains, MOOC platforms like EdX and Coursera have successfully incorporated automated assessment strategies for writing skills assessment (Balfour, 2013).

Ahadi *et al.* (2015) applied machine learning on programming process data of introductory programming course for early detection of students in need of assistance. The benefits are: providing early feedback to struggling students and increase the difficulty level for the students, early detection of students who do not ask for feedback, and matching high-performing and low-performing students for peer-group learning.

## ***III. Digital Badges***

A digital badge is a process of assessing one's accomplishments that can be integrated with online platforms. A trainer can measure the required skillset and knowledge base of a trainee and can issue a badge once he or she has completed certain landmarks. The badge showcases the trainee or learner's achievements. Thus digital badges can be a measure of student learning and achievement in digital classrooms. The badge earning landmarks or learning outcomes may incorporate accumulation of knowledge and skills, completion of teaching-learning activities like assignments and presentations, and the extent of learner's engagement with the course content. Many professional and educational institutes utilize the digital badge strategy to recognize learning and achievement. LinkedIn users' additions of MOOC completion certificates over Coursera and similar platforms are widely recognized in professional communities globally (Baird, 2013). In a similar manner, universities like Indiana University and Purdue University use four different types of badges for the Big Open Online Course (BOOC) participants and a local badge system called "Passport" on the successful accomplishment of course objectives respectively (Hickey & Kelley, 2013, Tally, 2012).

## ***IV. Recognition of Prior Learning (RPL)***

RPL is one of the most popular choices for assessment techniques in Open Education Resources (OER). Participants in OER programs submit portfolios and a summative assessment of their learning in succession for achieving certification in RPL (Butcher, 2015, Conrad *et al.*, 2013). Students participating in MOOCs, offered by various well-reputed institutions, for a credit or certification may find this assessment strategy rewarding in pursuing their learning goals. Institutes can enjoy leverage by utilizing RPL for both formative and summative assessments as well as assess students' prior learning and skills to provide them with a better opportunity in their upcoming endeavour.

### **4.3 Ethical Assessments**

Plagiarism is a well-recognized problem in all education programs and the central concerns are the unnoticed or unidentified plagiarism that make the assessment unreliable. Where there lies an opportunity for students to take unethical means, the assessment becomes questionable. Bradley (2016) randomized the programming assignments that are set for students so that it becomes unlikely that any two students will be working on the same problem set. The study analyzed the "natural similarity i.e. the level of similarity that could reasonably occur without plagiarism (p. 21).

Assessment of writing exercises, articles and other write-ups are in practice for a long time in academia and are checked for plagiarism through paid and free software like Turnitin, iThenticate, Urkund, Grammarly, etc. However, digital ethical assessments demand modifications due to the nature of examination platforms and the

environment. The matter gets worse regarding examinations on a computer as computers provide the opportunity of cheating in digital examinations and examinations performed at home (Heintz, 2017).

Hellas *et al.* (2017) reported that potential cheaters tend to show behaviour patterns, like help-seeking, systemic cheating and collaboration with peers and/ or outsiders etc. Linear solution processes that can detect copy-paste plagiarisms, detection of alignments of processes in programming exercises, use of plagiarism checkers in written assignments etc. can be deployed to countermeasure the cheatings in digital examinations (Hellas *et al.*, 2017). However, detecting plagiarism and ensuring ethical standards of examinations constitute a big area of concern for instructors and researchers that is out of the scope of this chapter.

## 5. Discussion

The findings of this study are far from an exhaustive or sufficiently comprehensive overview of digital assessment methods and tools in the contexts of higher education. This chapter may help educators identify ways to improve their assessment practices in an online environment. Factors that influence the design and implementation of online assessment strategies should be analyzed in such a way that they can enlighten subsequent progress of formative and summative assessment activities as well as tools. One particularly difficult issue to address in online education is an invisible distance setting. Rather than developing a diversified, responsive and participation-oriented assessment process, the majority of assessment practices follow informal feedback strategies suggesting digital product as an outcome than the improvement of the learning experience. For example, implementing online asynchronous discussions, typically participants are measured quantitatively (i.e., as the assessment *of* learning) rather than qualitatively (i.e., as assessment *for* learning). Hence, assessment procedures, especially in the online settings, need to be balanced between formative (process) and summative (product) outcomes that demand increased online interaction among instructors and students. Online formative assessment is appreciated by the researchers as it helps participants to review their scores along with the evaluation of gained knowledge, thus, assists in improving performance (Van Gog *et al.* 2010; Boud & Soler, 2016). Formative classroom assessment methods should follow straightforward design methods to ensure significant positive differences in learning outcomes; though there exists diversity among competencies being assessed in online courses (Pereira *et al.*, 2009; Mwiya *et al.*, 2017). Although instructors' course design as well as feedback between students and teachers is more individualized in the online environment, online learning and technologies have the potential to be collaborative and constructive. Hence, it is vital to design and implement assessment practices to encourage and enhance interdependent learning activities in the online environment.

Moreover, features that influence effective assessment practices in the online environment are not exclusively technological, but also supervisory and pedagogical. Since online learning is facilitated through a computer interface, there may be a distinction made between the delivery of online learning and mediation and the expedition of online learning. Developing a responsive and responsible online pedagogy generates sets of interrelated characteristics that persuade effective assessment strategies and tools (Boboc *et al.*, 2006, Alston, 2017). Hence, online pedagogy needs to consider those factors which facilitate a more constructivist interaction across the computer interface of the virtual classroom (Quansah, 2018). Subsequently, reforming the organizational educational system as well as a better understanding of learning experiences for online students, web 2.0 tools can be employed as a new design for involving students and exploiting the benefits of formative assessments in the online classroom (Armellini & Aiyegbayo, 2010; Nguyen *et al.*, 2017).

Furthermore, generating an assessment plan for the period of the thorough online class evidently help instructors to map out their pedagogical strategies considering students' technological tools as well as connectivity to avoid the digital divide (Vonderwell & Boboc, 2013; Khan *et al.*, 2017). Five major themes including time management, student responsibility and initiative, the structure of the online medium, complexity of content, and informal assessment are mimicked in the online setting directed towards the contributory better outcome (Beebe *et al.*, 2010; Weleschuk *et al.*, 2019). As recent technological advances are outpouring, it is projected that more learning technologies will have emerged and the more varied applications of the online settings will be needed for better understanding. As such, it is vital to identify the factors that maximize student participation and performance, as well as teacher effectiveness and overall instructional satisfaction through online platform. Last but not the least, integration of plagiarism related rubrics in assessment models (Yudelson *et al.*, 2014) can be beneficial regarding the standardized assessment practices (Ahadi *et al.*, 2015).

## 6. Future Research Directions

There is a need to evaluate an appropriate pedagogy for assessment within the environment of the online settings, especially for teaching at scale or large classrooms. Future research should provide educators with tools and

approaches in developing online-specific, pedagogically sound learning opportunities to concentrate on both summative and formative assessment systems. Hence, stakeholders need to emphasize on creating and maintaining a sustainable online learning community to support assessment for learning as well as to promote high-level thinking skills. The diversity of assessment practices including written essays, multiple-choice tests, take-home exams, oral exams individually and in groups, and the individual differences in the application of assessment rubrics encompass a sufficiently large domain that need further study from the perspective of digitalization and automation. The explainability of numerical and computation methods along with the ability of individuals to understand the methods applied for digitalized assessment also pose some dilemmas.

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