Online Assessment in Higher Education: A Systematic Review

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Abstract
Online assessment is defined as a systematic method of gathering information about a learner and learning processes to draw inferences about the learner's dispositions. Online assessments provide opportunities for meaningful feedback and interactive support for learners as well as possible influences on the engagement of learners and learning outcomes. The purpose of this systematic literature review is to identify and synthesize original research studies focusing on online assessments in higher education. Out of an initial set of 4,290 publications, a final sample of 114 key publications was identified, according to predefined inclusion criteria. The synthesis yielded four main categories of online assessment modes: peer, teacher, automated, and self-assessment. The synthesis of findings supports the assumption that online assessments have promising potential in supporting and improving online learning processes and outcomes. A summary of success factors for implementing online assessments includes instructional support as well as clear-defined assessment criteria. Future research may focus on online assessments harnessing formative and summative data from stakeholders and learning environments to facilitate learning processes in real-time and help decision-makers to improve learning environments, i.e., analytics-driven assessment.

Keywords: online assessment, feedback, systematic review, formative assessment, summative assessment, learning analytics

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Tracing the history of educational assessment practice is challenging as several diverse concepts refer to the idea of assessment. Our recent search in scientific databases identified an increase in research publications focusing on assessment from the 1950s to the 2020s by over 380%. Despite an intense debate over the past seven decades, the distinction between formative and summative assessment has not resulted in a precise definition and the distinction between the two remains blurry (Newton, 2007). The nature of formative and summative assessment and the difficulties of characterizing their differences and interrelationships have been discussed extensively in the literature (Black & Wiliam, 2009). Further, other terms have been introduced such as learning-oriented assessment emphasizing the development of learning elements of assessment (Carless, 2007), sustainable assessment, proposing the support of student learning beyond the formal learning setting (Boud, 2000), or stealth assessment denoting assessments that take place in the background without the user noticing it (Shute et al., 2016). More recently, the use of online assessments has been increasing rapidly, as they offer the promise of cheaper ways of delivering and marking assessments as well as access to vast amounts of assessment data from which a wide range of judgments might be made about students, teachers, schools and education systems (Webb & Ifenthaler, 2018). However, the various opportunities of online-enabled assessment also resulted in conceptual inconsistencies concerning the formats, modes, and types of online assessment.

In this article, online assessment is defined as a systematic method of gathering information or artifacts about a learner and learning processes to draw inferences about the person's dispositions using information and communication technology (Baker et al., 2016). We argue that the future of assessment faces major challenges including, perhaps most importantly, the extent to which assessments, when realized in online environments, can serve simultaneously the needs of learners and those of teachers as well as the educational organization. Gikandi et al. (2011) emphasized the opportunities of online assessments for enabling meaningful feedback and providing interactive support for learners. Further empirical research concerning online assessment highlights possible influences on the engagement of learners and learning outcomes (Nguyen et al., 2017). With the increased usage of online learning environments, such as MOOCs (Massive Open Online Courses) (Bonk et al., 2015), and the stronger presence of distance education programs (Moore & Kearsley, 2011), empirical studies have focused on different implementations of online assessments: for instance, online formative assessments (Baleni, 2015), digital game-based assessments (Kim & Ifenthaler, 2019), or online peer- and self-assessments (Admiraal et al., 2014). Attention has also been paid to best practice examples of embedding assessments in online learning environments (Martin et al., 2019). Further, developments in data analytics increased the awareness of Machine Learning and related algorithms for (semi-)automated assessment approaches (Lee et al., 2021), or analytics-enhanced online assessment (Ifenthaler et al., 2018; Gašević et al., 2022). A promising line of research emphasizes the opportunities of learning analytics and online assessments for providing (near) real-time informative feedback to learners and teachers (Martin & Whitmer, 2016; Gašević et al., 2022; Ifenthaler & Greiff, 2021; Tempelaar et al., 2018).

Given the controversial findings and discussions on online assessment, especially the conceptual inconsistencies of online assessments, the purpose of this systematic literature review is to identify and synthesize original research studies focusing on online assessments in higher education. The systematic review follows the PRISMA guideline for reporting systematic reviews (Page et al., 2021). We provide a functional platform for the scientific community to better understand differences in the design of online assessments, highlight the affordances for

technological implementation of online assessments, and identify new research areas focusing on online assessments. Implications for pedagogical practice emphasize the requirement of a design framework for online assessments in higher education.

Online assessment in Higher Education

Black (1998) defined three main distinctions of assessment: (a) formative assessment to aid learning; (b) summative assessment for review, transfer, and certification; (c) summative assessment for accountability to the public. Pellegrino et al. (2001) extend this definition with three main purposes of assessment: (a) assessment to assist learning (formative assessment), (b) assessment of individual student achievement (summative assessment), and (c) assessment to evaluate programs (evaluative assessment). To facilitate learning through assessment, Carless (2007) emphasizes that assessment tasks should be learning tasks, that are related to the defined learning outcomes and distributed across the learning and course period.

Online Assessment

Online assessment describes the assessment of students learning with methods including information and communication technologies (Conrad & Openo, 2018). This does not restrict online assessment to fully online courses and can also be implemented in a blended learning format (Gikandi et al., 2011). Online assessments may take on different pedagogical functions as part of online learning environments (Webb & Ifenthaler, 2018), for example, scaffolding students to complete a task and measuring how much support they need (Ahmed & Pollitt, 2010), or providing students with semantic rich and personalized feedback, as well as adaptive prompts for reflection (Ifenthaler, 2012; Schumacher & Ifenthaler, 2021). Other examples of online assessments include a pedagogical agent acting like a virtual coach tutoring learners and providing feedback when needed (Johnson & Lester, 2016) as well as an analysis of a learner's decisions during a digital game or simulation (Bellotti et al., 2013). Other online assessments use multimedia-constructed response items for authentic learning experiences (Lenhard et al., 2007) or provide students with an emotionally engaging virtual world experience that unobtrusively documents the progression of a person's leadership and ethical development over time (Turkay & Tirthali, 2010). Thus, online assessments offer a broad range of pedagogical functions including a medium for communication, a learning assistant, a judge, a test administrator, a performance prompt, a practice arena, or a performance workspace (Webb et al., 2013). Online assessment can be performed formatively throughout the learning progress or in a summative way at the end of a learning segment (Gikandi et al., 2011).

Types, Modes, and Formats of Online Assessments

In the course of drawing inferences about students' learning process, online assessment can include different types of assessments, ranging from single- and multiple-choice quizzes, written exams or essays, and oral presentations to authentic assessments including project-based cases, games and simulations, or e-Portfolios (Conrad & Openo, 2018). (Audience Response Systems are not included in our definition of online assessment.)

The assessment process can be performed by different individuals or groups, i.e., different modes of assessment. Peers have the potential to take on the role of the assessor and provide each other with feedback (Admiraal et al., 2014). Learners might also self-assess by evaluating their learning process and outcome themselves or by reflecting on their learning

(Conrad & Openo, 2018). Furthermore, the possibilities in online assessment also allow for automated assessment providing automated feedback (Gamage et al., 2019).
In this systematic review, an online assessment format can either be formative or summative. An online assessment mode may be self-assessment, peer-assessment, teacher-assessment, or automated-assessment (system-based). An assessment type refers to the implemented task of the assessment. This might include for example quizzes, essays, e-Portfolios, project-based tasks, or others.

Previous Systematic Reviews

The above-noted increase in assessment-related publications also set forth several systematic reviews concerning the field of assessment. The work by Dochy et al. (1999) emphasized the relationship between learning and assessment. The review included N = 63 studies suggesting that different assessment forms, such as self-, peer, and co-assessment support learners in becoming more responsible and reflective. With the advent of online technologies, assessment-related research included new approaches, especially online assessments. Gikandi et al. (2011) provided the first comprehensive overview of online formative assessment. The findings of the N = 18 key studies suggested that effective online formative assessment can foster formative feedback and enhanced learner engagement. Furthermore, the field has undergone many developments in the last few years. In a more recent publication, Wei et al. (2021) reviewed N = 65 studies that focused on MOOCs and the different assessment types related to learning outcomes. Montenegro-Rueda et al. (2021) focused on the implementation of assessment with consideration of the impact of the COVID-19 pandemic on higher education. Therefore, this review of N = 13 articles did not provide a comprehensive overview of how online assessment is developed and used, irrespective of the necessity due to the worldwide exceptional situation. The rationale behind this review was to provide an updated, broad overview of variations of online assessment in higher education and to analyze how they are designed and implemented as well as their potential in supporting learning and teaching in emergency situations.

Purpose of the Study and Research Questions

Given the renewed awareness of online assessments (Gašević et al., 2022), the purpose of this systematic literature review is to identify and synthesize original research studies focusing on online assessments. Three main research questions guide the systematic review process: (1) Which modes (e.g., self-assessment, peer-assessment, teacher-assessment, automated-assessment) are used in online and blended learning and for each assessment mode, what formats (formative or summative), and types (e.g., quiz, essay) and feedback are implemented in higher education? (2) What are the objectives of online assessments in higher education? (3) What are the success factors for accepting and using online assessments in higher education?

Method

This systematic review followed the PRISMA guideline for reporting systematic reviews (Page et al., 2021).

Data Sources and Search Strategies

The research process is outlined in Figure 1 and involves a systematic search of international research databases including ScienceDirect, Web of Science, ACM Digital Library,

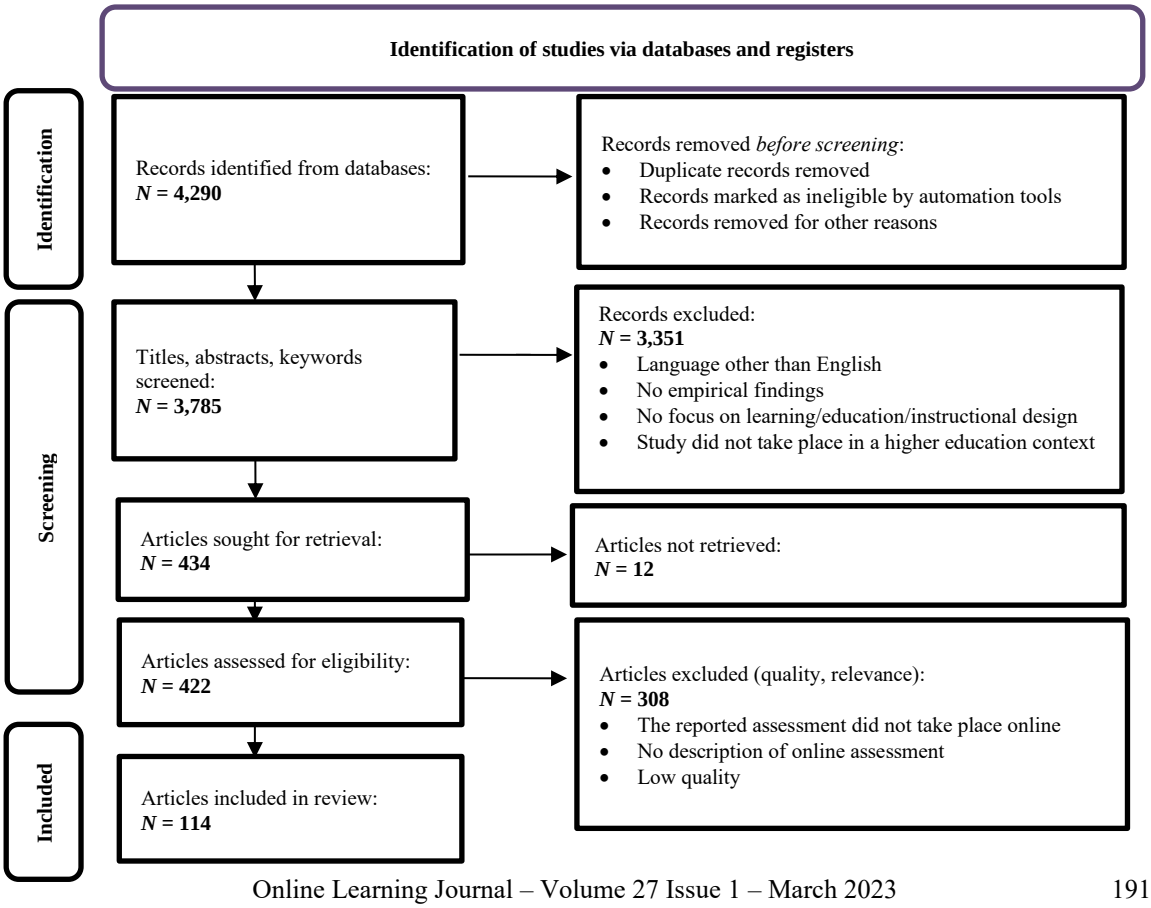
DBLP, Google Scholar, ERIC, etc. Additionally, relevant journals in the field of Learning Sciences and Educational Technology were used in the research process and are listed in the next section. The search includes articles published since January 2010 (marking the increased availability of empirical findings focusing on online environments such as MOOCs) until June 2022 to ensure that there were enough publications to capture different research trends. Keywords for the literature search in titles, abstracts, keywords, and full texts include combinations of "assessment," "online," "higher education," "learning outcomes," "MOOCs," plus additional keywords based on a first scan of results.

Identification and Screening Process

Initial screening of articles followed specific inclusion criteria: The study (1) presents empirical findings, (2) examines online assessments, (3) is in the field of higher education, (4) is published between 2010 and 2022, (5) is written in English, (6) is published in a peer-reviewed scientific journal, and (7) has an abstract available. The methodology strictly followed the use of a pre-defined research protocol and included a rigorous validation process involving human raters. The research protocol included a detailed description of the identification, screening, and inclusion criteria (see Figure 1 for a description of main criteria). For example, the screening process followed exclusion criteria such as the language of the article not being English, the articles not including empirical findings, or the research was not focused on higher education. The key insights from these publications were synthesized into the final findings reflecting the state of research on online assessments for supporting learning and teaching in higher education as well as highlighting implications for pedagogical practice.

Figure 1

Diagram of the Systematic Literature Review Process



The predefined identification and screening process included five major steps as follows: Identification of international databases: GoogleScholar, ACM Digital Library, Web of Science, Science Direct, ERIC, and DBLP.

Specific search in relevant peer-reviewed scientific journals, according to the top 20 journals on educational technology in Google Scholar to cover the most impactful contributions in the field. These are: *Australasian Journal of Educational Technology*, *British Journal of Educational Technology*, *Computer Assisted Language Learning*, *Computers & Education*, *Education & Information Technologies*, *Educational Technology Research & Development*, *IEEE Transactions on Learning Technologies*, *Interactive Learning Environments*, *International Journal of Artificial Intelligence in Education, International Journal of Educational Technology in Higher Education*, *International Journal of Emerging Technologies in Learning*, *International Journal of Instruction*, *Journal of Computer Assisted Learning*, Journal of Educational Computing Research, *Journal of Educational Technology & Society, Language Learning & Technology*, *TechTrends*, *The International Review of Research in Open and Distributed Learning*, *The Internet & Higher Education*.

The search was conducted using the terms: "assessment," "online," "higher education," "learning outcomes," and "MOOCs." Based on this search, N = 4,290 publications were found. After the removal of duplicates, the sample included N = 3,785 publications. A title search removing publications with irrelevant topics leads to N = 1,401 and an in-depth abstract search to a final N = 434 publications. After a full-text search, 114 publications were identified and included in this systematic review.

Data Coding

The selected publications were open-coded. The coded items included as descriptive information the authors and the year of publication. Concerning the reported assessment, formats, modes, types, and feedback were coded. Relating to the context of the assessment of the course, its type (blended vs. online) as well as the domain, country, and educational level were classified. Additionally, the objective of the study was analyzed and summarized.

Data Analysis

The data analysis was conducted in the form of qualitative content analysis. Based on the coded data, central concepts were identified, summarized, and synthesized in an inductive format. The data was then analyzed quantitatively as well as qualitatively.

Results

Summary of Publications

Out of the 114 publications, the majority came from the United States (N = 30; 26%) as well as from Australia (N = 18; 16%), the United Kingdom (N = 13; 11%), Spain (N = 10; 9%) and Germany (N = 6; 5%). Out of these studies, 42% (N = 48 researched online assessments in blended learning scenarios, while 33% (N = 38) investigated assessments in fully online courses. Five studies (4%) included blended and online scenarios, and 23 (20%) studies did not state the learning and assessment scenario. Eight publications investigated assessments that took part in Computer Science, Education Science, or Teacher education, as well as in Mathematics, seven in Business Education, five in English Second Language Learning, four in Psychology, and three in both Pharmacy and Statistics & Biology. Ten studies investigated multiple domains.

Most studies included participants from undergraduate courses (N = 65; 57%), ten from graduate, and one from postgraduate. A further 18 studies included participants from multiple educational levels, twelve studies researched MOOCs, in which the educational level of participants was not assessed and eight did not clearly state. Most publications included in the final sample were published in the year 2018 (N = 23); 13 were published in 2021 and in 2020, 12 in 2019, 11 in 2016, 10 in 2017 as well as in 2014, 6 in 2015, 2013, and 2012, 2 in 2022 and 1 in 2011 as well as in 2010.

Types of Online Assessment in Higher Education (RQ1)

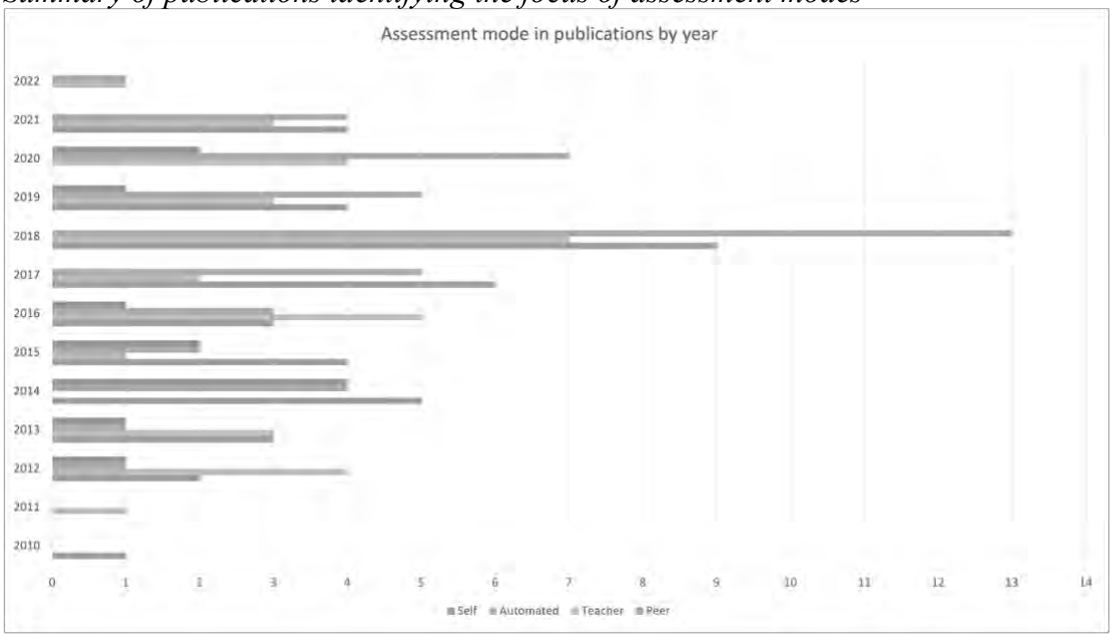
Assessment types are diverse and include a broad range of possible implementations. Additionally, many publications included multiple types. Some main categories of types could nonetheless be identified. N = 42 (37%) publications reported some type of quiz, N = 18 (16%) essays or other writing tasks, N = 15 (13%) ePortfolios, and equally N = 15 (13%) publications included in their work other tasks such as programming, calculations, translation etc. N = 12 (10%) cases described a type of project-based learning and N = 11 (9%) short- or open answer questions. N = 4 reported students working on a Wiki, N = 2 learner-generated questions and N = 2 journaling. N = 13 (11%) did not clearly state the actual type of assessment.

Modes of Online Assessment in Higher Education (RQ1)

The modes of online assessment were identified as peer-assessment, automated-assessment, teacher-assessment, and self-assessment. Concerning assessment formats, the publications included N = 49 (43%) studies that described solely formative assessment, N = 34 (30%) studies that examined formative as well as summative assessment, N = 26 (23%) only summative, and N = 4 did not clearly state the format of assessment. One publication focused on pre-class assessment. Figure 2 provides an overview of the included assessment modes by year of publication.

Figure 2

Summary of publications identifying the focus of assessment modes



Assessment Mode: Peer Assessment

Out of the 114 publications, N = 41 (36%) included some mode of peer assessment.

Implementation type: Peer assessment was frequently realized using essays (Admiraal et al., 2015; Chew et al., 2016; Formanek et al., 2017; Huisman et al., 2018; Luaces et al., 2017; Meek et al., 2017; Sullivan & Watson, 2015; Zong et al., 2021). But also other writing types were reported, such as creative writing (Ashton & Davies, 2015), scientific writing (Herzog & Katzlinger, 2017; Mao & Peck, 2013), creating entries in a shared wiki (Hickey & Rehak, 2013; Sampaio-Maia et al., 2014), translation tasks (Ortega-Arranz et al., 2019), or letter-writing (Liu et al., 2018). Peer assessment also included types such as e-Portfolios (Chew et al., 2016; Vaughan, 2014; Xiao & Hao, 2018), or e-Journals (Zhan, 2021). In addition, peer assessment was implemented in the context of project-based learning. For example in tasks of creating plans, such as business plans (Sekendiz, 2018) or teaching plans (Li et al., 2010; Li & Gao, 2016). Others focused on educational projects (Wadmany & Melamed, 2018), research projects (Liu & Lee, 2013; Wu et al., 2014), art (Tucker et al., 2014), or design projects (McCarthy, 2017). Peer assessment was also implemented as team projects (Tucker, 2014), or on shorter project tasks in linguistics (Rogerson-Revell, 2015). Other types of assignments that were assessed through peers included mathematical calculations (Kristanto, 2018), or statistical exercises (ArchMiller et al., 2017). Further, oral assignments in language learning (Chen et al., 2021), diagram exercises (Pinargote-Ortega et al., 2021), discussion entries (Wang, 2019), and question generation (Yeh & Lai, 2012) were implemented assessment types.

Assessment format: In N = 15 (13%) articles, peer assessment was implemented in the format of formative assessment (Chen et al., 2021; Elizondo-Garcia et al., 2019; Filius et al., 2018; Filius et al., 2019; Hickey & Rehak, 2013; Kristanto, 2018; Mao & Peck, 2013; McCarthy, 2017; Ogange et al., 2018; Rogerson-Revell, 2015; Sekendiz, 2018; Tucker et al., 2014; Vaughan, 2014; Xiao & Hao, 2018; Zong et al., 2021). In 14 cases, peer assessment was implemented for solely summative assessment format (ArchMiller et al., 2017; Ashton & Davies, 2015; Formanek et al., 2017; Li et al., 2010; Luaces et al., 2017; Pinargote-Ortega et al., 2021; Sampaio-Maia et al., 2014; Sullivan & Watson, 2015; Tenório et al., 2016, Tucker, 2014; Wadmany & Melamed, 2018; Wang, 2019; Wu et al., 2014; Zhan, 2021). A combination of formative as well as summative assessment formats was reported in 12 learning scenarios (Admiraal et al., 2015; Chew et al., 2016, Herzog & Katzlinger, 2017; Huisman et al., 2018, Li & Gao, 2016; Liu & Lee, 2013; Liu et al., 2018; McCracken et al., 2012; Meek et al., 2017; Nguyen et al., 2017; Ortega-Arranz et al., 2019; Yeh & Lai, 2012).

Feedback: In most cases, peer feedback was provided in a written format and if graded, included reasoning for a given grade. Grades and feedback were frequently based on some form of a pre-defined grid, such as a rubric, for students to align with when creating their feedback and giving grades to their fellow students (Admiraal et al., 2015; ArchMiller et al., 2017; Ashton & Davies, 2015; Chen et al., 2021; Chew et al., 2016; Elizondo-Garcia et al., 2019; Formanek et al., 2017; Herzog & Katzlinger, 2017; Huisman et al., 2018; Liu & Lee, 2013; Li & Gao, 2016; Liu et al., 2018; Luaces et al., 2017; Mao & Peck, 2013; McCarthy, 2017; Meek et al., 2017; Pinargote-Ortega et al., 2021; Tenório et al., 2016; Tucker et al., 2014; Tucker, 2014; Wadmany & Melamed, 2018; Wu et al., 2014; Xiao & Hao, 2018; Zhan, 2021; Zong et al., 2021). Other cases, in which written feedback was given without a rubric, included reviews (Sampaio-Maia et al., 2014), feedback in a narrative form (Sullivan & Watson, 2015), constructive criticism (Wang, 2019; Sekendiz, 2018; Rogerson-Revell, 2015, Kristanto, 2018), or comments on the

work of other students (Yeh & Lai, 2012; Ogange et al., 2018). Other modalities of peer feedback were examined in studies, such as dialogue peer feedback, including the responses of the assessed students on the feedback (Filius et al., 2018; Hickey & Rehak, 2013), providing peer feedback in an audio format (4/27/2012 9:34:00 AM; Herzog & Katzlinger, 2017) or with a gamified approach (Ortega-Arranz et al., 2019).

Assessment Mode: Automated Assessment

Some variation of automated assessment mode was included in N = 46 (40%) studies.

Implementation type: Automated assessment was mostly used on quizzes. Quizzes included all sorts of tasks that did not require students to write longer answer, such as multiple-choice questions, single-choice questions, blank-filling or crossword-type tests (Admiraal et al., 2015; Azevedo et al., 2022; Babo et al., 2020; Bacca-Acosta & Avila-Garzon, 2021; Bekmanova et al., 2021; Carpenter et al., 2017; Chaudy & Connolly, 2018; Davis et al., 2020; Dermo & Boyne, 2014; Förster et al., 2018; Gamage et al., 2019; Gámiz Sánchez et al., 2014: Guerrero-Roldán & Noguera, 2018; Hughes et al., 2020; Huisman et al., 2018; Kühbeck et al., 2019; López-Tocón, 2021; Mao & Peck, 2013; Meek et al., 2017; Mora et al., 2012; Ortega-Arranz et al., 2019; Reilly et al., 2016; Ross et al., 2018; Sancho-Vinuesa et al., 2018; Schaffer et al., 2017; Shaw et al., 2019; Stratling, 2017: Taghizadeh et al., 2014; Tempelaar, 2020; Thille et al., 2014; Wilkinson et al., 2020). Automated assessment, including Natural Language Processing, was also used on short-answer questions (Carnegie, 2015; Chen et al., 2018; Ellis & Barber, 2016), or tasks including longer texts (Reilly et al., 2016; Santamaría Lancho et al., 2018; Xian, 2020). Other implementation types included mathematical exercises (Acosta-Gonzaga & Walet, 2018; Yang et al., 2016), programming tasks (Polito & Temperini, 2021; Thille et al,, 2014), or interactive activities (MacKenzie, 2019; Turner & Briggs, 2018). Additional automated assessments included the assessment of language proficiency (Fratter & Marigo, 2018).

Assessment format: Automated assessment was mostly used for formative assessment and rarely for summative. In 23 cases, an automated assessment was used in the context of solely formative assessment (Acosta-Gonzaga & Walet, 2018; Bacca-Acosta & Avila-Garzon, 2021; Bekmanova et al., 2021; Carpenter et al., 2017; Chen et al., 2021; Förster et al., 2018; Gámiz Sánchez et al., 2014; Hughes et al., 2020; Kühbeck et al., 2019; López-Tocón, 2021; MacKenzie, 2019; Meek et al., 2017; Ogange et al., 2018; Polito & Temperini, 2021; Reilly et al., 2016; Sancho-Vinuesa et al., 2018; Santamaría Lancho et al., 2018; Scalise et al., 2018; Schaffer et al., 2017; Stratling, 2017; Tempelaar, 2020; Wilkinson et al., 2020; Xian, 2020). A total of 15 cases included formative as well as summative assessments (Admiraal et al., 2015; Azevedo et al., 2022; Babo et al., 2020; Carnegie, 2015; Davis et al., 2020; Dermo & Boyne, 2014; Gamage et al., 2019; Guerrero-Roldán & Noguera, 2018; Huisman et al., 2018; Mora et al., 2012; Nguyen et al., 2017; Ortega-Arranz et al., 2019, Wells et al., 2021; Yang et al., 2016, Turner & Briggs, 2018) and only six cases used automated assessment exclusively as summative assessment (Chaudy & Connolly, 2018; Ellis & Barber, 2016; Ross et al., 2018; Shaw et al., 2019; Taghizadeh et al., 2014; Mao & Peck, 2013). In one case it was used pre-class (Fratter & Marigo, 2018).

Feedback: Feedback provided through automated assessment mostly included some form of corrective feedback (Bacca-Acosta & Avila-Garzon, 2021; Carpenter et al., 2017; Chen et al., 2018; Förster et al., 2018; Gámiz Sánchez et al., 2014; López-Tocón, 2021; MacKenzie, 2019; Meek et al., 2017 , Ross et al., 2018; Sancho-Vinuesa et al., 2018; Stratling, 2017; Wilkinson et al., 2020; Davis et al., 2020). Other types of automated feedback included guidance in case of

wrong answers towards the correct solution (Acosta-Gonzaga & Walet, 2018; Carnegie, 2015; Guerrero-Roldán & Noguera, 2018), explanation for common mistakes (Gamage et al., 2019), retrieval cues (Shaw et al., 2019) or explanations & worked solution (Scalise et al., 2018). More elaborated, personalized feedback included tailored feedback on personal proficiencies (Hughes et al., 2020; Ellis & Barber, 2016; Thille et al., 2014; Stratling, 2017; Taghizadeh et al., 2014), and recommendations on topics to further study (Yang et al., 2016). Feedback was also provided to students as automatic comments on writing (Xian, 2020), or a report on the students' performance (Schaffer et al., 2017). The potential of automated feedback was also used to develop visual representation of the retrieved data, such as histogram about students' proficiencies (Fratter & Marigo, 2018), or graphical representations of accuracy of answers (Santamaría Lancho et al., 2018). One approach included feedback in alignment with the learning behavior (Tempelaar, 2020). In other cases, feedback was given by means of gamification, such as badges and rewards (Polito & Temperini, 2021; Ortega-Arranz et al., 2019).

Assessment Mode: Teacher Assessment

Assessment of students through a teacher was identified in N = 34 (30%) studies. Teacher assessment mode in this context includes tutors, graduate assistants, a teaching team, or the instructors of the classes.

Implementation type: The assessment by teachers was incorporated in a variety of cases. For instance, teacher assessment was frequently used on e-Portfolios (Birks et al., 2016; Farrelly & Kaplin, 2019; Jarrott & Gambrel, 2011; McNeill et al., 2012; Nicholson, 2018; Wang & Wang, 2012; Xiao & Hao, 2018), and in other cases on essay tasks (Law, 2019; Milne et al., 2020; Reilly et al., 2016; Sarcona et al., 2020; Turner & Briggs, 2018; Luaces et al., 2017; Chew et al., 2016), as well as on other forms of writing exercises, such as scientific writing (Herzog & Katzlinger, 2017; Mao & Peck, 2013), wiki entries (Hickey & Rehak, 2013), or writing exercises in language learning (Xian, 2020). Teacher assessment was also used for statistical programming tasks (ArchMiller et al., 2017) as well as in modeling exercises (Garcia-Peñalvo et al., 2021). Concerning more practical tasks, teacher assessment was also used for cases of skill demonstration in medicine (Hay et al., 2013). Shorter forms of assessments, such as quizzes (Guerrero-Roldán & Noguera, 2018; McNeill et al., 2012), or interactive activities (Gonzalez-Gomez et al., 2020; Turner & Briggs, 2018) were also assessed by teachers. Other implementation forms included exam questions in an essay format (Turner & Briggs, 2018; Senel & Senel, 2021), conceptual questions (Scalise et al., 2018), question generation by students (Yeh & Lai, 2012), and e-tivities including audio und written tasks (Rogerson-Revell, 2015).

Assessment format: Teacher assessment was used in seven cases in context of only summative assessment (ArchMiller et al., 2017; Birks et al., 2016; Chew et al., 2016; Luaces et al., 2017; Schultz et al., 2022; Tawafak et al., 2019; West & Turner, 2016), however, 16 times in a formative assessment format (Gonzalez-Gomez et al., 2020; Jarrott & Gambrel, 2011; Kim et al., 2021; Law, 2019; Mao & Peck, 2013; Milne et al., 2020; Nicholson, 2018; Ogange et al., 2018; Reilly et al., 2016; Rogerson-Revell, 2015; Sarcona et al., 2020; Scalise et al., 2018; Senel & Senel, 2021; Wang & Wang, 2012; Xian, 2020; Xiao & Hao, 2018). Additionally, ten cases included formative as well as summative assessments (Farrelly & Kaplin, 2019; Garcia-Peñalvo et al., 2021; Guerrero-Roldán & Noguera, 2018; Hay et al., 62013; Herzog & Katzlinger, 2018; Hickey & Rehak, 2013; McCracken et al., 2012; McNeill et al., 2012; Turner & Briggs, 2018; Yeh & Lai, 2012).

Feedback: Teacher assessment included corrective feedback (Yeh & Lai, 2012), classifying submissions as suitable or not suitable (Gonzalez-Gomez et al., 2020), or scores on draft (Mao & Peck, 2013). More elaborated feedback by teachers included feedback guiding students towards correct answers (Guerrero-Roldán & Noguera, 2018), or suggestions for the learning process (Garcia-Pealñvo et al., 2021). Similar to peer assessment, teacher feedback was frequently provided based on a rubric (ArchMiller et al., 2017; Chew et al., 2016; Herzog & Katzlinger, 2017; Law, 2019; Luaces et al., 2017; Milne et al., 2020; Reilly et al., 2016; Senel & Senel, 2021; West & Turner, 2016; Xiao & Hao, 2018). Other forms of written feedback included written reviews (Jarrott & Gambrel, 2011; Rogerson-Revell, 2015), comments on portfolios (Nicholson, 2018; Wang & Wang, 2012; Farrelly & Kaplin, 2019), or comments on writing (Xian, 2020). Sometimes other modalities of teacher feedback were investigated, such as the form of discussion (Hickey & Rehak, 2013), in a video format (Hay et al., 2013, West & Turner, 2016), or audio format (Sarcona et al., 2020).

Assessment Mode: Self-assessment

Some mode of self-assessment was reported in N = 12 (11%) studies. In these cases, a self-assessment mode is defined as assessing the proficiency of oneself not including automated assessment components.

Implementation type: Self-assessment was often implemented in the form of electronic portfolios (Amhag, 2020; Faulkner et al., 2013; Hains-Wesson et al., 2014; Hwang et al., 2015; Mason & Williams, 2016; Vaughan, 2014), on essays (Admiraal et al., 2015), or wiki entries (Vaughan, 2014). Self-assessment was also implemented in projects, such as technical and design group projects (Tucker, 2014) or research projects (Wu et al., 2014). In one case, students were asked to assess their own level of self-control (Bohndick et al., 2020).

Assessment format: Two cases used self-assessment for summative assessment (Tucker, 2014; Wu et al., 2014), five for formative assessment (Amhag, 2020; Bohndick et al., 2020; Hwang et al., 2015; Mason & Williams, 2016; Vaughan, 2014), and three for formative as well as summative assessment (Faulkner et al., 2013; McCracken et al., 2012; Admiraal et al., 2015).

Feedback: Self-assessment was used as a form of reflection (Amhag, 2020; Faulkner et al., 2013; Hains-Wesson et al., 2014; Hwang et al., 2015), or measuring the own performance by comparing it to a rubric or guideline (Admiraal et al., 2015; Mao & Peck, 2013; Tucker, 2014; Vaughan, 2014; Wu et al., 2014).

Summary of Results for RQ1

Concerning research question one, the results of this systematic review indicate that studies focused on online assessment in higher education used the modes self-assessment, peer assessment, automated assessment, as well as teacher assessment. Peer assessment was used on the assessment types of writing tasks, e-Portfolios, or projects and was frequently used in formative as well as in summative assessment, often in combination. Automated assessment on the other hand was used on quizzes, short text answers, or standardized exercises, such as programming tasks. It was used frequently in formative assessment form only and seldomly in summative assessment. Teacher assessment was used on a broad variety of types such as e-Portfolios, essays, or project-based tasks. Teachers assessed mostly in a formative format or formative and summative in combination. Self-assessment was realized through e-Portfolios, essays, wikis, or projects and mostly in a formative format as a reflection of the current learning

process. Overall, the formative format was used more often than summative and automated the most used mode, followed by peer and teacher assessment and ultimately self-assessment. Objectives of online assessment in higher education (RQ2).

The purposes of the publications in this systematic review can be divided into two categories: (1) the objective of the presented form of online assessment and (2) factors influencing the effectiveness of the online assessment.

First, regarding the objective of the presented form of online assessment, multiple studies of this review looked at the effect of feedback on latent factors of the learning process of students such as motivation, self-regulation, engagement, reflection, and others. Accordingly, the key publications investigated how aspects of formative feedback might influence the motivation of students. Approaches included effects of repeated questions on motivation (Stratling, 2017), adaptive quizzes improving motivation and engagement (Ross et al., 2018), positive or negative feedback on self-assessment influencing the motivation of students (Bohndick et al., 2020), the influence of formative peer essay grading on motivation (Formanek et al., 2017), and formative teacher assessments in a science context influencing the motivation of students (Gonzalez-Gomez et al., 2020). Other studies focused on the self-regulation of students. Methods for increasing self-regulation by assessing students formatively included question generating and giving students responsibility for their assessment (Caspari-Sadeghi et al., 2021), possible interaction of students with formative questions (Chen et al., 2018), as well as the influence of journaling, self-assessment, and peer-sharing on cognition regulation strategies of students (Hwang et al., 2015). Other key publications focused on the increase of students' engagement through formative assessment, including online assessment through formative quizzes (Holmes, 2018; Hughes et al., 2020), formative portfolio assessment (Nicholson, 2018), or peer assessment (Chen et al., 2021; Sullivan & Watson, 2015; Vaughan, 2014). Another group of studies focused on increasing engagement and satisfaction based on different forms of formative assessment (Nguyen et al., 2017) and influencing students' engagement through gamified formative assessment (Tenório et al., 2016; Polito & Temperini, 2021). Studies that included assessment through ePortfolios frequently focused on the positive impact that formative assessment could have on the ability of students to reflect their own learning process (Mason & Williams, 2016; Hains-Wesson et al., 2014; McWhorter et al., 2013; Jarrott & Gambrel, 2011; Amhag, 2020) or giving students the possibility to reflect themselves meeting possible professional requirements (Faulkner et al., 2013). Other factors which have been influenced by the usage of formative assessment, were the sense of community (Kim et al., 2021), collaborative learning (Sampaio-Maia et al., 2014), an attitudinal change (Watson et al., 2017), reading comprehension (Yeh & Lai, 2012), critical thinking (Zhan, 2021), and usage of educational technology (Acosta-Gonzaga & Walet, 2018).

Second, a great share of the key publications in this systematic review described the goal of the presented online assessment as to increase learning success using variations of formative assessment. Formative quizzes were used to improve the final learning outcome of students and the achievement of their learning goals (Carnegie, 2015; Carpenter et al., 2017; Kühbeck et al., 2019; Gamage et al., 2019; Gámiz Sánchez et al., 2014; Wilkinson et al., 2020) as well as supporting their learning process (Tempelaar, 2020). Formative feedback was also shown to improve accuracy in second-language writing (Xian, 2020). Additionally, not only formative but also summative assessment lead to increase of academic performance (Tawafak et al., 2019). E-Portfolios were used to foster higher-order thinking skills (Wang & Wang, 2012), to increase the creative thinking ability (Xiao & Hao, 2018), or to generally increase the final learning outcome

(Hickey & Rehak, 2013; Farrelly & Kaplin, 2019). In the context of providing formative feedback to improve the final learning outcome, peer feedback was often an essential part, such as formative peer feedback to improve on writing skills (Mao & Peck, 2013; Huisman et al., 2018), improve projects (Li & Gao, 2016; Li et al., 2010; Liu et al., 2018; Sekendiz, 2018), or to foster deep learning (Filius et al., 2018). Other publications focused on using online assessment to improve the educational process. One of the goals was to enable personalization and adaptivity of learning processes with means of online assessment, such as creating an adaptive learning path based on the results of formative assessment (Bekmanova et al., 2021; Hashim et al., 2020), or more personalized feedback (Thille et al., 2014). Another advantage that online assessment could bring to the learning scenarios is the possibility to assess larger groups of students at the same time through quizzes (Mora et al., 2012; Gleason, 2012), but also on longer answers through means of automated essay scoring (Reilly et al., 2016; Santamaría Lancho et al., 2018). Online assessment was also attributed as giving the opportunity to correctly place students in the foreign-language learning (Fratter & Marigo, 2018; Taghizadeh et al., 2014), assessing different levels of understanding (Küchemann et al., 2021) and peer feedback for enhancing assessment and feedback experience for international students (Chew et al., 2016). The transformation of face-to-face courses to online courses showed that online assessment created possibilities for peer assessment that went beyond paper-based peer methods (Wu et al., 2014). Last, in some cases, the objective of the assessments was to be used as part of an approach to analyzing students learning behavior and providing them feedback on their learning process. Analyzing behavior together with grade outcome such as assessing the behavior of students (Wells et al., 2021), using assessment data for diagnosing learning problems (Yang et al., 2016) or providing assessment feedback in combination with learning analytics feedback (Tempelaar, 2020) were methods used for this process. Other approaches focused on connecting assessment with the sentiment of discussion (Tucker et al., 2014) or a gamified analytics approach (Chaudy & Connolly, 2018).

Summary of Results for RQ2

Concerning research question two, the objectives of online assessment can be found in supporting learning as well as teaching processes in higher education. The impact of formative assessment was reported not only on the final learning outcome but also on factors influencing the learning process such as motivation, self-regulation, engagement, or reflection. Additionally, a goal of using online assessment can lie in enhancing the learning and assessment process such as assessing greater courses, providing learners more elaborate feedback, and creating adaptive learning paths.

Success factors of online assessment in higher education (RQ3)

Design principles for online assessment were extracted from the publications by examining the experienced acceptance of students and the reported success of online assessment scenarios. Authentic assessments, presenting students with tasks they would likely face in a real-world setting, were found to be central to successful online assessments (Martin et al., 2019; McCracken et al., 2012; Dermo & Boyne, 2014; Schultz et al., 2022). Additionally, online assessments are expected to be well-aligned with the course materials and competencies for the desired learning outcome as well as the prerequisites of the students (McCracken et al., 2012; Guerrero-Roldán & Noguera, 2018; McNeill et al., 2012). The online assessment criteria need to be made as transparent as possible (McCracken et al., 2012; Martin et al., 2019) and, from the teacher's side, availability and communication with the students were found to be essential

success factors (Martin et al., 2019). Additional factors from the student's perspective were perceived ease of use and perceived usefulness of online assessments (Bacca-Acosta & Avila-Garzon, 2021).

Concerning peer assessment in particular, multiple factors are identified in their influence on the quality of peer assessment. Findings support a discussion-based assessment training, leading to more accurate peer feedback (Liu et al., 2018). Additionally, factors of the respective courses' instructional design are seemingly supporting the quality of peer feedback, as aligning the guidance of the students and tasks with the amount of students (Herzog & Katzlinger, 2017) and increasing the level of guidance through providing the students a rubric as the base of their assessment process (Elizondo-Garcia et al., 2019; Ashton & Davies, 2015; ArchMiller et al., 2017). Other key publications recommended to provide guidelines (Wadmany & Melamed, 2018) as well as explaining to students the rationale of the online peer assessment (Meek et al., 2017). Concerning the format of peer feedback, longer, rather than many, comments and comments aiding for revision were preferred by students (Zong et al., 2021). Approaches including natural-language processing proposed using sentiment analysis on feedback to detect inaccuracies in peer feedback between the given feedback and the given score have been highlighted (Pinargote-Ortega et al., 2021). Other findings advocate for using peer assessment mostly for formative and not summative assessment (Admiraal et al., 2015).

Concerning the design of formative online assessment through quizzes, the key publications suggest that quizzes should not only include true or false questions but a mixture of types (López-Tocón, 2021). Other studies found that quizzes are a well-suited form of online assessment for theoretical knowledge, but not necessarily for practical knowledge and should therefore be combined with other forms of online assessment, such as project-based learning or further homework tasks (Babo et al., 2020). While a higher correlation between final exam performance and the performance on formative quizzes with limited time and attempts was found (MacKenzie, 2019), unlimited attempts in general lead to a higher performance in the final exam (Davis et al., 2020).

Concerning summative online assessment, the key publications emphasize that end-of-module assessments in the form of essays, practical reports and/or applied assessments, were preferred by students over exams and led to higher completion rates (Turner & Briggs, 2018). Timely feedback (Martin et al., 2019; McCracken et al., 2012) was considered an essential success factor for online assessment. The key publications also considered the effects of the modality of peer and teacher feedback, the support of video feedback, and the positive reception by students (West & Turner, 2016). Other studies found a preference by students for an audio format by peers (Filius et al., 2019) or a written format by teachers (Sarcona et al., 2020) In general, feedback in online assessment should be part of a broader approach and not only seen as part of one task (Milne et al., 2020).

Summary of results for RQ3

Concerning research question three, success factors for implementing online assessment include instructional support as well as transparent pre-defined grading criteria. Especially for peer assessment rubrics, guidelines and explaining the rationale to the learners are important for a successful implementation. Additionally, the overall design of the assessment should be chosen depending on the respective learning objective and potentially different modes, types, and formats combined.

Discussion

Online assessments enriched standard or paper-based assessment approaches, some of which hold much promise for supporting learning (Webb et al., 2013). A range of different online assessment scenarios have been the focus of educational research and development, however, often at small scale (Stödberg, 2012). Still, the complexity of designing and implementing online assessment and feedback systems has been discussed widely over the past few years (Sadler, 2010; Shute, 2008). Current research findings suggest that online assessment systems meet several specific requirements, such as (a) adaptability to different subject domains, (b) flexibility for experimental as well as learning and teaching settings, (c) management of huge amounts of data, (d) rapid analysis of complex and unstructured data, (e) immediate feedback for learners and educators, as well as (f) generation of automated reports of results for educational decision-making. This systematic review investigated the renewed awareness of online assessments (Gašević et al., 2022) by identifying and synthesizing original research studies focusing on online assessments in the context of higher education.

Summary of Key Findings

Modes and formats of online assessments. Regarding research question one (RQ1), the findings of this systematic review suggest that online assessment is widely implemented, varying in the design and intended goals of the respective learning scenario. The four main modes of assessment were identified as peer-, teacher-, automated-, and self-assessment (e.g., Hickey & Rehak, 2013; Law, 2019; Luaces et al., 2017; Xian, 2020; Xiao & Hao, 2018). Frequently, various assessment modes are combined in assessment design, especially peer- and teacher-assessment as well as a combination of automated-, peer-, and teacher-assessment. While peer- and teacher-assessments are mostly provided on longer texts or project tasks, automated-assessments mostly take place on shorter assignments and self-assessments on reflection tasks. Concerning the assessment format, automated- as well as self-assessments were mostly implemented formatively and rarely in summative format (e.g., Acosta-Gonzaga & Walet, 2018; Bacca-Acosta & Avila-Garzon, 2021; Bekmanova et al., 2021; Förster et al., 2018; Gámiz Sánchez et al., 2014; Scalise et al., 2018; Schaffer et al., 2017). Peer- and teacher-assessments frequently were applied for both formative and summative formats. The scope of the feedback also differs depending on the assessment mode. While peer and teacher feedback included transparency measurements such as rubrics and provided numeric as well as more elaborated feedback, automated feedback was provided as correction, albeit the results from this review also suggest that there are also advances to provide more detailed feedback aiding students (e.g., Acosta-Gonzaga & Walet, 2018; Carnegie, 2015; Guerrero-Roldán & Noguera, 2018).
Objectives of online assessments. Regarding research question two (RQ2), the findings of this systematic review suggest that online assessment has promising potential in supporting and improving online learning processes (e.g., Mason & Williams, 2016; Jarrott & Gambrel, 2011; Amhag, 2020). Formative assessment has the potential to support the student's learning process by either influencing learning success factors or leading to an increase in the final learning outcome. Furthermore, online assessment can also be used as an analytical approach to provide more advanced feedback to students and teachers on learning processes. Additionally, to improve the learning environment through means of new opportunities created through technological enhancement such as personalization, adaptivity, or gamification (e.g. Tempelaar, 2020; Wells et al., 2021).

Success factors of online assessments. Regarding research question three (RQ3), the findings of this systematic review suggest that a successful implementation of online assessment is based on instructional support as well as clear-defined assessment criteria (Martin et al., 2019; McCracken et al., 2012; Dermo & Boyne, 2014; Schultz et al., 2022). The main factors examined by the key studies were the alignment of the assessment format, mode, and type with the targeted learning outcomes. Another takeaway from this systematic review is the benefits of implementing authentic tasks in online assessment (Conrad & Openo, 2018). On the side of teaching staff, transparency, communication, and timely as well as detailed feedback were found as main contributors to success. Similarly, when implementing peer-assessment, guidelines, such as rubrics, communication, as well as providing feedback useful for revision, are essential factors.

Implications for Theory and Practice

The findings of this systematic literature review pose implications for theory as well as practice. A major takeaway is the broad opportunities created through online assessments and their influence on learning processes as well as outcomes. Instructional practice in higher education might consider the potential of formative online assessment for supporting students' learning. Additionally, online assessment, in general, creates new possibilities such as elaborated productive feedback, assessment of greater groups, or adaptive learning. For designing online assessment certain success factors should be considered such as clear communication of pre-defined guidelines, support of the teachers and learners as well as timely feedback. Additionally, a combination of different modes, formats, and types could be chosen depending on the targeted learning objectives.

Concerning theory in this field, it appears to be important to further research the differentiation between automated- and self-assessment as well as determine a clear distinction between formative and continuous assessment. Clear definitions regarding assessment formats, modes, and types seem to be key to a substantial scientific discussion. In the future, research should focus on leveraging the objectives and potentials of online assessment for supporting learning as well as teaching in higher education. Furthermore, designing a coherent framework for the interaction and design of online assessment modes, formats, and types would be beneficial for creating guidelines on the effective design, development, implementation, and evaluation of online assessments. Another factor will be how to further develop the online assessment techniques while addressing the identified challenges.

Limitations and Future Research

This systematic review is subject to limitations that provide implications for future research. First, even if keywords are applied, databases approached, and specific journals searched, some important research studies may still have been neglected in this systematic review. In addition, this systematic review only included articles published in the English language. Hence, important findings from articles published in other languages may have been overlooked. Second, the systematic review covers a limited time period. While writing this systematic review, further studies may have been published that could provide additional insights into the impact of online assessments on learning and teaching. Accordingly, a continuing meta-discussion of findings is required while the research area matures. Thus, additional research shall

cover a wider time period to consider more publications focusing on online assessments with a specific emphasis on the historical development of online assessments.

Future research may address the multiple challenges identified in this systematic review when implementing online assessments. For example, the increased risk for academic misconduct (Tsai, 2016) and challenges due to higher initial investment (Azevedo et al., 2022). To enable equal opportunities, challenges include implementing an ICT infrastructure and reliable connectivity (James, 2016), equal internet access of the students (Hains-Wesson et al., 2014), and new study habits that students need to develop (Azevedo et al., 2022). Other challenges in creating fair online assessment include the heterogeneous educational background of learners (McCarthy, 2017) as well as multiple possible graduate destinations (Schultz et al., 2022). Additional concerns were raised on the fairness of peer-assessment, especially in group tasks (ArchMiller et al., 2017) as well as technological and logistical challenges in the widespread implementation of e-Portfolios in higher education (Birks et al., 2016).

Looking forward, online assessment harnesses formative and summative data from stakeholders and learning environments to facilitate learning processes in real-time and help decision-makers to improve learning environments. Therefore, future research may focus on distinct features of online assessments, for instance providing semantic-rich feedback for written assignments in near real-time using natural-language processing (Bektik, 2019; Gottipati et al., 2018; Ifenthaler, 2023; Whitelock & Bektik, 2018), generating progress reports toward curricular required competences or learning outcomes including intra-individual and inter-individual comparisons (Ifenthaler at al., 2023; Lockyer et al., 2013), supporting peer-assessments focusing on specific learning outcomes or general study skills (e.g., learning strategies, time management) (Gašević et al., 2019; Gašević et al., 2017), or including pre- and reflective prompts highlighting persistence of strengths and weaknesses of specific learning events and assessment results (e.g., recurring errors, misconceptions, learning habits) (Schumacher & Ifenthaler, 2021).

Conclusion

Given the variety of online assessments documented in the 114 studies of this systematic review, the formative assessment format was used more often than the summative assessment. Implementations mainly used the automated-assessment mode, followed by peer- and teacher-assessment modes, while the self-assessment mode was used scarcely. Online assessments impact not only students' learning outcomes but also influence motivation, self-regulation, engagement, or reflection. The successful implementation of online assessments requires instructional support, transparent guidelines and regulations, as well as an alignment of possible assessment formats, modes, and types with expected learning outcomes.

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Declarations

The authors declare no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The data that support the findings of this study are available on request from the corresponding author. (joana.heil@uni-mannheim.de)

References

(*) indicates publications included in the systematic review.

*Abbakumov, D., Desmet, P., & Van den Noortgate, W. (2020). Rasch model extensions for enhanced formative assessments in MOOCs. *Applied Measurement in Education*, *33*(2), 113–123.

*Acosta-Gonzaga, E., & Walet, N. R. (2018). The role of attitudinal factors in mathematical online assessments: A study of undergraduate STEM students. *Assessment & Evaluation in Higher Education*, *43*(5), 710–726.

Admiraal, W., Huisman, B., & van de Ven, M. (2014). Self- and peer assessment in Massive Open Online Courses. *International Journal of Higher Education*, *3*(3), 119–128. https://doi.org/10.5430/ijhe.v3n3p119

*Admiraal, W., Huisman, B., & Pilli, O. (2015). Assessment in Massive Open Online Courses. *Electronic Journal of E-Learning*, *13*(4), 207–216.

Ahmed, A., & Pollitt, A. (2010). The support model for interactive assessment. *Assessment in Education: Principles, Policy & Practice, 17*(2), 133–167.

*Amhag, L. (2020). Student reflections and self-assessments in vocational training supported by a mobile learning hub. *International Journal of Mobile and Blended Learning*, *12*(1), 1–16.

*ArchMiller, A., Fieberg, J., Walker, J. D., & Holm, N. (2017). Group peer assessment for summative evaluation in a graduate-level statistics course for ecologists. *Assessment & Evaluation in Higher Education*, *42*(8), 1208–1220. http://dx.doi.org/10.1080/02602938.2016.1243219

*Ashton, S., & Davies, R. S. (2015). Using scaffolded rubrics to improve peer assessment in a MOOC writing course. *Distance Education*, *36*(3), 312–334. http://dx.doi.org/10.1080/01587919.2015.1081733

*Azevedo, B. F., Pereira, A. I., Fernandes, F. P., & Pacheco, M. F. (2022). Mathematics learning and assessment using MathE platform: A case study. *Education and Information Technologies*, *27*(2), 1747–1769. https://doi.org/10.1007/s10639-021-10669-y

*Babo, R., Babo, L., Suhonen, J., & Tukiainen, M. (2020). E-Assessment with multiple-choice questions: A 5-year study of students' opinions and experience. *Journal of Information Technology Education: Innovations in Practice*, *19*, 1–29. https://doi.org/10.28945/4491

*Bacca-Acosta, J., & Avila-Garzon, C. (2021). Student engagement with mobile-based assessment systems: A survival analysis. *Journal of Computer Assisted Learning*, *37*(1), 158–171. https://doi.org/10.1111/jcal.12475

Baker, E., Chung, G., & Cai, L. (2016). Assessment, gaze, refraction, and blur: The course of achievement testing in the past 100 years. *Review of Research in Education*, *40*, 94–142. https://doi.org/10.3102/0091732X16679806

Baleni, Z. (2015). Online formative assessment in higher education: Its pros and cons. *Electronic Journal of e-Learning*, *13*(4), 228–226.

*Bekmanova, G., Ongarbayev, Y., Somzhurek, B., & Mukatayev, N. (2021). Personalized training model for organizing blended and lifelong distance learning courses and its effectiveness in higher education. *Journal of Computing in Higher Education*, *33*(3), 668–683. https://doi.org/10.1007/s12528-021-09282-2

Bektik, D. (2019). Issues and challenges for implementing writing analytics at higher education. In D. Ifenthaler, J. Y.-K. Yau, & D.-K. Mah (Eds.), *Utilizing learning analytics to support study success* (pp. 143–155). Springer.

Bellotti, F., Kapralos, B., Lee, K., Moreno-Ger, P., & Berta, R. (2013). Assessment in and of serious games: An overview. *Advances in Human-Computer Interaction*, *2013*, 1:1. https://doi.org/10.1155/2013/136864

Bennett, R. E. (2015). The changing nature of educational assessment. *Review of Research in Education*, *39*(1), 370–407. https://doi.org/10.3102/0091732x14554179

*Birks, M., Hartin, P., Woods, C., Emmanuel, E., & Hitchins, M. (2016). Students' perceptions of the use of eportfolios in nursing and midwifery education. *Nurse Education in Practice*, *18*, 46–51. https://doi.org/10.1016/j.nepr.2016.03.003

Black, P. J. (1998). *Testing: friend or foe? The theory and practice of assessment and testing*. Falmer Press.

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, *21*, 5–31. https://doi.org/10.1007/s11092-008-9068-5

*Bohndick, C., Menne, C. M., Kohlmeyer, S., & Buhl, H. M. (2020). Feedback in Internet-based self-assessments and its effects on acceptance and motivation. *Journal of Further and Higher Education*, *44*(6), 717–728. https://doi.org/10.1080/0309877X.2019.1596233

Bonk, C. J., Lee, M. M., Reeves, T. C., & Reynolds, T. H. (Eds.). (2015). *MOOCs and open education around the world*. Routledge. https://doi.org/10.4324/9781315751108.

Boud, D. (2000). Sustainable assessment: rethinking assessment for the learning society. *Studies in Continuing Education*, *22*(2), 151–167. https://doi.org/10.1080/713695728

Carless, D. (2007). Learning-oriented assessment: conceptual bases and practical implications. *Innovations in Education and Teaching International*, *44*(1), 57–66. https://doi.org/10.1080/14703290601081332

*Carnegie, J. (2015). Use of feedback-oriented online exercises to help physiology students construct well-organized answers to short-answer questions. *CBE—Life Sciences Education*, *14*(3), ar25. https://doi.org/10.1187/cbe.14-08-0132

*Carpenter, S. K., Rahman, S., Lund, T. J. S., Armstrong, P. I., Lamm, M. H., Reason, R. D., & Coffman, C. R. (2017). Students' use of optional online reviews and its relationship to summative assessment outcomes in introductory biology. *CBE—Life Sciences Education*, *16*(2), ar23. https://doi.org/10.1187/cbe.16-06-0205

*Caspari-Sadeghi, S., Forster-Heinlein, B., Maegdefrau, J., & Bachl, L. (2021). Student-generated questions: developing mathematical competence through online assessment. *International Journal for the Scholarship of Teaching and Learning*, *15*(1), 8. https://doi.org/10.20429/ijsotl.2021.150108

*Chaudy, Y., & Connolly, T. (2018). Specification and evaluation of an assessment engine for educational games: Empowering educators with an assessment editor and a learning analytics dashboard. *Entertainment Computing*, *27*, 209–224. https://doi.org/10.1016/j.entcom.2018.07.003

*Chen, X., Breslow, L., & DeBoer, J. (2018). Analyzing productive learning behaviors for students using immediate corrective feedback in a blended learning environment. *Computers & Education*, *117*, 59–74. https://doi.org/10.1016/j.compedu.2017.09.013

*Chen, Z., Jiao, J., & Hu, K. (2021). Formative assessment as an online instruction intervention: Student engagement, outcomes, and perceptions. *International Journal of Distance Education Technologies*, *19*(1), 50–65. https://doi.org/10.4018/IJDET.20210101.oa1

*Chew, E., Snee, H., & Price, T. (2016). Enhancing international postgraduates' learning experience with online peer assessment and feedback innovation. *Innovations in Education and Teaching International*, *53*(3), 247–259. https://doi.org/10.1080/14703297.2014.937729

Conrad, D., & Openo, J. (2018). *Assessment strategies for online learning: engagement and authenticity*. Athabasca University Press. https://doi.org/10.15215/aupress/9781771992329.01

*Davis, M. C., Duryee, L. A., Schilling, A. H., Loar, E. A., & Hammond, H. G. (2020). Examining the impact of multiple practice quiz attempts on student exam performance. *Journal of Educators Online*, *17*(2).

*Dermo, J., & Boyne, J. (2014). Assessing understanding of complex learning outcomes and real-world skills using an authentic software tool: A study from biomedical sciences. *Practitioner Research in Higher Education*, *8*(1), 101–112.

Dochy, F. J. R. C., Segers, M., & Sluijsmans, D. (1999). The use of self-, peer and co-assessment in higher education: A review. *Studies in Higher Education*, *24*(3), 331–350.

*Elizondo-Garcia, J., Schunn, C., & Gallardo, K. (2019). Quality of peer feedback in relation to instructional design: a comparative study in energy and sustainability MOOCs. *International Journal of Instruction*, *12*(1), 1025–1040.

Ellis, C. (2013). Broadening the scope and increasing usefulness of learning analytics: the case for assessment analytics. *British Journal of Educational Technology*, *44*(4), 662–664. https://doi.org/10.1111/bjet.12028

*Ellis, S., & Barber, J. (2016). Expanding and personalising feedback in online assessment: a case study in a school of pharmacy. *Practitioner Research in Higher Education*, *10*(1), 121–129.

*Farrelly, D., & Kaplin, D. (2019). Using student feedback to inform change within a community college teacher education program's ePortfolio initiative. *Community College Enterprise*, *25*(2), 9–38.

*Faulkner, M., Mahfuzul Aziz, S., Waye, V., & Smith, E. (2013). Exploring ways that eportfolios can support the progressive development of graduate qualities and professional competencies. *Higher Education Research and Development*, *32*(6), 871–887.

*Filius, R. M., de Kleijn, R. A. M., Uijl, S. G., Prins, F. J., van Rijen, H. V. M., & Grobbee, D. E. (2019). Audio peer feedback to promote deep learning in online education. *Journal of Computer Assisted Learning*, *35*(5), 607–619. https://doi.org/10.1111/jcal.12363

*Filius, R. M., Kleijn, R. A. M. de, Uijl, S. G., Prins, F. J., Rijen, H. V. M. van, & Grobbee, D. E. (2018). Strengthening dialogic peer feedback aiming for deep learning in SPOCs. *Computers & Education*, *125*, 86–100. https://doi.org/10.1016/j.compedu.2018.06.004

*Formanek, M., Wenger, M. C., Buxner, S. R., Impey, C. D., & Sonam, T. (2017). Insights about large-scale online peer assessment from an analysis of an astronomy MOOC. *Computers & Education*, *113*, 243–262. https://doi.org/10.1016/j.compedu.2017.05.019

*Förster, M., Weiser, C., & Maur, A. (2018). How feedback provided by voluntary electronic quizzes affects learning outcomes of university students in large classes. *Computers & Education*, *121*, 100–114. https://doi.org/10.1016/j.compedu.2018.02.012

*Fratter, I., & Marigo, L. (2018). Integrated forms of self-assessment and placement testing for Italian L2 aimed at incoming foreign university exchange students at the University of

Padua. *Language Learning in Higher Education*, *8*(1), 91–114. https://doi.org/10.1515/cercles-2018-0005

*Gamage, S. H. P. W., Ayres, J. R., Behrend, M. B., & Smith, E. J. (2019). Optimising Moodle quizzes for online assessments. *International Journal of STEM Education*, *6*(1), 1–14. https://doi.org/10.1186/s40594-019-0181-4

*Gámiz Sánchez, V., Montes Soldado, R., & Pérez López, M. C. (2014). Self-assessment via a blended-learning strategy to improve performance in an accounting subject. *International Journal of Educational Technology in Higher Education*, *11*(2), 43–54. https://doi.org/10.7238/rusc.v11i2.2055

*Garcia-Peñalvo, F. J., Garcia-Holgado, A., Vazquez-Ingelmo, A., & Carlos Sanchez-Prieto, J. (2021). Planning, communication and active methodologies: online assessment of the software engineering subject during the COVID-19 crisis. *Ried-Revista Iberoamericana De Educacion A Distancia*, *24*(2), 41–66. https://doi.org/10.5944/ried.24.2.27689

Gašević, D., Greiff, S., & Shaffer, D. (2022). Towards strengthening links between learning analytics and assessment: Challenges and potentials of a promising new bond. *Computers in Human Behavior*, *134*, 107304. https://doi.org/10.1016/j.chb.2022.107304

Gašević, D., Joksimović, S., Eagan, B. R., & Shaffer, D. W. (2019). SENS: Network analytics to combine social and cognitive perspectives of collaborative learning. *Computers in Human Behavior*, *92*, 562–577. https://doi.org/10.1016/j.chb.2018.07.003

Gašević, D., Jovanović, J., Pardo, A., & Dawson, S. (2017). Detecting learning strategies with analytics: Links with self-reported measures and academic performance. J*ournal of Learning Analytics*, *4*(2), 113–128. https://doi.org/jla.2017.42.10

Gikandi, J. W., Morrow, D., & Davis, N. E. (2011). Online formative assessment in higher education: A review of the literature. *Computers & Education*, *57*(4), 2333–2351. https://doi.org/10.1016/j.compedu.2011.06.004

*Gleason, J. (2012). Using technology-assisted instruction and assessment to reduce the effect of class size on student outcomes in undergraduate mathematics courses. *College Teaching*, *60*(3), 87–94. https://doi.org/ 10.1080/87567555.2011.637249

*González-Gómez, D., Jeong, J. S., & Canada-Canada, F. (2020). Examining the effect of an online formative assessment tool (O Fat) of students' motivation and achievement for a university science education. *Journal of Baltic Science Education*, *19*(3), 401–414. https://doi.org/10.33225/jbse/20.19.401

Gottipati, S., Shankararaman, V., & Lin, J. R. (2018). Text analytics approach to extract course improvement suggestions from students' feedback. *Research and Practice in Technology Enhanced Learning*, *13*(6). https://doi.org/10.1186/s41039-018-0073-0

*Guerrero-Roldán, A.-E., & Noguera, I. (2018). A model for aligning assessment with competences and learning activities in online courses. *Internet And Higher Education*, *38*, 36–46. https://doi.org/10.1016/j.iheduc.2018.04.005

*Hains-Wesson, R., Wakeling, L., & Aldred, P. (2014). A university-wide ePortfolio initiative at Federation University Australia: Software analysis, test-to-production, and evaluation phases. *International Journal of EPortfolio*, *4*(2), 143–156.

* Hashim, H., Salam, S., Mohamad, S. N. M., & Sazali, N. S. S. (2018). The designing of adaptive self-assessment activities in second language learning using massive open online courses (MOOCs). *International Journal of Advanced Computer Science and Applications*, *9*(9), 276–282.

*Hay, P. J., Engstrom, C., Green, A., Friis, P., Dickens, S., & Macdonald, D. (2013). Promoting assessment efficacy through an integrated system for online clinical assessment of practical skills. *Assessment & Evaluation in Higher Education*, *38*(5), 520–535. https://doi.org/10.1080/02602938.2012.658019

*Herzog, M. A., & Katzlinger, E. (2017). The multiple faces of peer review in higher education. five learning scenarios developed for digital business. *EURASIA Journal of Mathematics, Science & Technology Education*, *13*(4), 1121–1143. https://doi.org/ 10.12973/eurasia.2017.00662a

*Hickey, D., & Rehak, A. (2013). Wikifolios and participatory assessment for engagement, understanding, and achievement in online courses. *Journal of Educational Multimedia and Hypermedia*, *22*(4), 407–441.

*Holmes, N. (2018). Engaging with assessment: increasing student engagement through continuous assessment. *Active Learning in Higher Education*, *19*(1), 23–34. https://doi.org/10.1177/1469787417723230

*Hughes, M., Salamonson, Y., & Metcalfe, L. (2020). Student engagement using multiple-attempt "Weekly Participation Task" quizzes with undergraduate nursing students. *Nurse Education in Practice*, *46*, 102803. https://doi.org/10.1016/j.nepr.2020.102803

*Huisman, B., Admiraal, W., Pilli, O., van de Ven, M., & Saab, N. (2018). Peer assessment in moocs: the relationship between peer reviewers' ability and authors' essay performance. *British Journal of Educational Technology*, *49*(1), 101–110. https://doi.org/ 10.1111/bjet.12520

*Hwang, W.-Y., Hsu, J.-L., Shadiev, R., Chang, C.-L., & Huang, Y.-M. (2015). Employing self-assessment, journaling, and peer sharing to enhance learning from an online course. *Journal of Computing in Higher Education*, *27*(2), 114–133.

Ifenthaler, D. (2012). Determining the effectiveness of prompts for self-regulated learning in problem-solving scenarios. *Journal of Educational Technology & Society*, *15*(1), 38–52.

Ifenthaler, D. (2023). Automated essay grading systems. In O. Zawacki-Richter & I. Jung (Eds.), *Hanboock of open, distance and digital education* (pp. 1057–1071). Springer. https://doi.org/10.1007/978-981-19-2080-6_59

Ifenthaler, D., & Greiff, S. (2021). Leveraging learning analytics for assessment and feedback. In J. Liebowitz (Ed.), *Online learning analytics* (pp. 1–18). Auerbach Publications. https://doi.org/10.1201/9781003194620

Ifenthaler, D., Greiff, S., & Gibson, D. C. (2018). Making use of data for assessments: harnessing analytics and data science. In J. Voogt, G. Knezek, R. Christensen, & K.-W. Lai (Eds.), *International Handbook of IT in Primary and Secondary Education* (2nd ed., pp. 649–663). Springer. https://doi.org/10.1007/978-3-319-71054-9_41

Ifenthaler, D., Schumacher, C., & Kuzilek, J. (2023). Investigating students' use of self-assessments in higher education using learning analytics. *Journal of Computer Assisted Learning*, *39*(1), 255–268. https://doi.org/10.1111/jcal.12744

*James, R. (2016). Tertiary student attitudes to invigilated, online summative examinations. *International Journal of Educational Technology in Higher Education*, *13*(1), 19. https://doi.org/10.1186/s41239-016-0015-0

*Jarrott, S., & Gambrel, L. E. (2011). The bottomless file box: electronic portfolios for learning and evaluation purposes. *International Journal of EPortfolio*, *1*(1), 85–94.

Johnson, W. L., & Lester, J. C. (2016). Face-to-Face interaction with pedagogical agents, twenty years later. International Journal of Artificial Intelligence in Education, 26(1), 25–36. https://doi.org/10.1007/s40593-015-0065-9

*Kim, Y. A., Rezende, L., Eadie, E., Maximillian, J., Southard, K., Elfring, L., Blowers, P., & Talanquer, V. (2021). Responsive teaching in online learning environments: using an instructional team to promote formative assessment and sense of community. *Journal of College Science Teaching*, *50*(4), 17–24.

Kim, Y. J., & Ifenthaler, D. (2019). Game-based assessment: The past ten years and moving forward. In D. Ifenthaler & Y. J. Kim (Eds.), *Game-based assessment revisted* (pp. 3–12). Springer. https://doi.org/10.1007/978-3-030-15569-8_1

*Kristanto, Y. D. (2018). Technology-enhanced pre-instructional peer assessment: Exploring students' perceptions in a statistical methods course. *Online Submission*, *4*(2), 105–116.

*Küchemann, S., Malone, S., Edelsbrunner, P., Lichtenberger, A., Stern, E., Schumacher, R., Brünken, R., Vaterlaus, A., & Kuhn, J. (2021). Inventory for the assessment of representational competence of vector fields. *Physical Review Physics Education Research*, *17*(2), 20126. https://doi.org/10.1103/PhysRevPhysEducRes.17.020126

*Kühbeck, F., Berberat, P. O., Engelhardt, S., & Sarikas, A. (2019). Correlation of online assessment parameters with summative exam performance in undergraduate medical education of pharmacology: A prospective cohort study. *BMC Medical Education*, *19*(1), 412. https://doi.org/10.1186/s12909-019-1814-5

*Law, S. (2019). Using digital tools to assess and improve college student writing. *Higher Education Studies*, *9*(2), 117–123.

Lee, H.-S., Gweon, G.-H., Lord, T., Paessel, N., Pallant, A., & Pryputniewicz, S. (2021). Machine learning-enabled automated feedback: Supporting students' revision of scientific arguments based on data drawn from simulation. *Journal of Science Education and Technology*, *30*(2), 168–192. https://doi.org/10.1007/s10956-020-09889-7

Lenhard, W., Baier, H., Hoffmann, J., & Schneider, W. (2007). Automatische Bewertung offener Antworten mittels Latenter Semantischer Analyse [Automatic scoring of constructed-response items with latent semantic analysis]. Diagnostica, 53(3), 155–165. https://doi.org/10.1026/0012-1924.53.3.155

*Li, L., & Gao, F. (2016). The effect of peer assessment on project performance of students at different learning levels. *Assessment & Evaluation in Higher Education*, *41*(6), 885–900.

*Li, L., Liu, X., & Steckelberg, A. L. (2010). Assessor or assessee: How student learning improves by giving and receiving peer feedback. *British Journal of Educational Technology*, *41*(3), 525–536. https://doi.org/ 10.1111/j.1467-8535.2009.00968.x

*Liu, E. Z.-F., & Lee, C.-Y. (2013). Using peer feedback to improve learning via online peer assessment. *Turkish Online Journal of Educational Technology—TOJET*, *12*(1), 187–199.

*Liu, X., Li, L., & Zhang, Z. (2018). Small group discussion as a key component in online assessment training for enhanced student learning in web-based peer assessment. *Assessment & Evaluation in Higher Education*, *43*(2), 207–222. https://doi.org/10.1080/02602938.2017.1324018

Lockyer, L., Heathcote, E., & Dawson, S. (2013). Informing pedagogical action: Aligning learning analytics with learning design. *American Behavioral Scientist*, *57*(10), 1439–1459. https://doi.org/10.1177/0002764213479367

*López-Tocón, I. (2021). Moodle quizzes as a continuous assessment in higher education: An exploratory approach in physical chemistry. *Education Sciences*, *11*(9), 500. https://doi.org/10.3390/educsci11090500

*Luaces, O., Díez, J., Alonso-Betanzos, A., Troncoso, A., & Bahamonde, A. (2017). Content-based methods in peer assessment of open-response questions to grade students as authors and as graders. *Knowledge-Based Systems*, *117*, 79–87. https://doi.org/10.1016/j.knosys.2016.06.024

*MacKenzie, L. M. (2019). Improving learning outcomes: Unlimited vs. limited attempts and time for supplemental interactive online learning activities. *Journal of Curriculum and Teaching*, *8*(4), 36–45. https://doi.org/10.5430/jct.v8n4p36

*Mao, J., & Peck, K. (2013). Assessment strategies, self-regulated learning skills, and perceptions of assessment in online learning. *Quarterly Review of Distance Education*, *14*(2), 75–95.

*Martin, F., Ritzhaupt, A., Kumar, S., & Budhrani, K. (2019). Award-winning faculty online teaching practices: Course design, assessment and evaluation, and facilitation. *The Internet and Higher Education*, *42*, 34–43. https://doi.org/10.1016/j.iheduc.2019.04.001

Martin, F., & Whitmer, J. C. (2016). Applying learning analytics to investigate timed release in online learning. *Technology, Knowledge and Learning*, *21*(1), 59–74. https://doi.org/10.1007/s10758-015-9261-9

*Mason, R., & Williams, B. (2016). Using ePortfolio's to assess undergraduate paramedic students: a proof of concept evaluation. *International Journal of Higher Education*, *5*(3), 146–154. https://doi.org/ 10.5430/ijhe.v5n3p146

*McCarthy, J. (2017). Enhancing feedback in higher education: Students' attitudes towards online and in-class formative assessment feedback models. *Active Learning in Higher Education*, *18*(2), 127–141. https://doi.org/10.1177/146978741770761

*McCracken, J., Cho, S., Sharif, A., Wilson, B., & Miller, J. (2012). Principled assessment strategy design for online courses and programs. *Electronic Journal of E-Learning*, *10*(1), 107–119.

*McNeill, M., Gosper, M., & Xu, J. (2012). Assessment choices to target higher order learning outcomes: the power of academic empowerment. *Research in Learning Technology*, *20*(3), 283–296.

*McWhorter, R. R., Delello, J. A., Roberts, P. B., Raisor, C. M., & Fowler, D. A. (2013). A cross-case analysis of the use of web-based eportfolios in higher education. *Journal of Information Technology Education: Innovations in Practice*, *12*, 253–286.

*Meek, S. E. M., Blakemore, L., & Marks, L. (2017). Is peer review an appropriate form of assessment in a MOOC? Student participation and performance in formative peer review. *Assessment & Evaluation in Higher Education*, *42*(6), 1000–1013.

*Milne, L., McCann, J., Bolton, K., Savage, J., & Spence, A. (2020). Student satisfaction with feedback in a third year Nutrition unit: A strategic approach. *Journal of University Teaching and Learning Practice*, *17*(5), 67–83. https://doi.org/10.53761/1.17.5.5

Montenegro-Rueda, M., Luque-de la Rosa, A., Sarasola Sánchez-Serrano, J. L., & Fernández-Cerero, J. (2021). Assessment in higher education during the COVID-19 pandemic: A systematic review. *Sustainability*, *13*(19), 10509.

Moore, M. G., & Kearsley, G. (2011). *Distance education: a systems view of online learning*. Wadsworth Cengage Learning.

*Mora, M. C., Sancho-Bru, J. L., Iserte, J. L., & Sanchez, F. T. (2012). An e-assessment approach for evaluation in engineering overcrowded groups. *Computers & Education*, *59*(2), 732–740. https://doi.org/10.1016/j.compedu.2012.03.011

Newton, P. E. (2007). Clarifying the purposes of educational assessment. *Assessment in Education: Principles, Policy & Practice*, *14*(2), 149–170. https://doi.org/10.1080/09695940701478321

*Nguyen, Q., Rienties, B., Toetenel, L., Ferguson, R., & Whitelock, D. (2017). Examining the designs of computer-based assessment and its impact on student engagement, satisfaction, and pass rates. *Computers in Human Behavior*, *76*, 703–714. https://doi.org/10.1016/j.chb.2017.03.028

*Nicholson, D. T. (2018). Enhancing student engagement through online portfolio assessment. *Practitioner Research in Higher Education*, *11*(1), 15–31.

*Ogange, B. O., Agak, J. O., Okelo, K. O., & Kiprotich, P. (2018). Student perceptions of the effectiveness of formative assessment in an online learning environment. *Open Praxis*, *10*(1), 29–39.

*Ortega-Arranz, A., Bote-Lorenzo, M. L., Asensio-Pérez, J. I., Martínez-Monés, A., Gómez-Sánchez, E., & Dimitriadis, Y. (2019). To reward and beyond: Analyzing the effect of reward-based strategies in a MOOC. *Computers & Education*, *142*, 103639. https://doi.org/10.1016/j.compedu.2019.103639

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., . . . Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71

Pellegrino, J. W., Chudowsky, N., & Glaser, R. (Eds.). (2001). *Knowing what students know: The science and design of educational assessment*. National Academy Press.

*Pinargote-Ortega, M., Bowen-Mendoza, L., Meza, J., & Ventura, S. (2021). Peer assessment using soft computing techniques. *Journal of Computing in Higher Education*, *33*(3), 684–726. https://doi.org/10.1007/s12528-021-09296-w

*Polito, G., & Temperini, M. (2021). A gamified web based system for computer programming learning. *Computers and Education: Artificial Intelligence*, *2*, 100029. https://doi.org/10.1016/j.caeai.2021.100029

*Reilly, E. D., Williams, K. M., Stafford, R. E., Corliss, S. B., Walkow, J. C., & Kidwell, D. K. (2016). Global times call for global measures: investigating automated essay scoring in linguistically-diverse MOOCs. *Online Learning*, *20*(2), 217–229.

*Rogerson-Revell, P. (2015). Constructively aligning technologies with learning and assessment in a distance education master's programme. *Distance Education*, *36*(1), 129–147.

*Ross, B., Chase, A.-M., Robbie, D., Oates, G., & Absalom, Y. (2018). Adaptive quizzes to increase motivation, Mark engagement and learning outcomes in a first year accounting unit. *International Journal Of Educational Technology In Higher Education*, *15*(1), 1–14. https://doi.org/10.1186/s41239-018-0113-2

*Sampaio-Maia, B., Maia, J. S., Leitao, S., Amaral, M., & Vieira-Marques, P. (2014). Wiki as a tool for Microbiology teaching, learning and assessment. *European Journal of Dental Education*, *18*(2), 91–97. https://doi.org/10.1111/eje.12061

*Sancho-Vinuesa, T., Masià, R., Fuertes-Alpiste, M., & Molas-Castells, N. (2018). Exploring the effectiveness of continuous activity with automatic feedback in online calculus. *Computer Applications in Engineering Education*, *26*(1), 62–74. https://doi.org/10.1002/cae.21861

*Santamaría Lancho, M., Hernández, M., Sánchez-Elvira Paniagua, Á., Luzón Encabo, J. M., & de Jorge-Botana, G. (2018). Using semantic technologies for formative assessment and scoring in large courses and MOOCs. *Journal of Interactive Media in Education*, *2018*(1), 1–10. https://doi.org/10.5334/jime.468.

*Sarcona, A., Dirhan, D., & Davidson, P. (2020). An overview of audio and written feedback from students' and instructors' perspective. *Educational Media International*, *57*(1), 47–60. https://doi.org/10.1080/09523987.2020.1744853

*Scalise, K., Douskey, M., & Stacy, A. (2018). Measuring learning gains and examining implications for student success in STEM. *Higher Education Pedagogies*, *3*(1), 183–195. https://doi.org/10.1080/23752696.2018.1425096

*Schaffer, H. E., Young, K. R., Ligon, E. W., & Chapman, D. D. (2017). Automating individualized formative feedback in large classes based on a directed concept graph. *Frontiers in Psychology*, *8*, 260. https://doi.org/10.1080/23752696.2018.1425096

Schumacher, C., & Ifenthaler, D. (2021). Investigating prompts for supporting students' self-regulation—A remaining challenge for learning analytics approaches? *The Internet and Higher Education*, *49*, 100791. https://doi.org/10.1016/j.iheduc.2020.100791

*Schultz, M., Young, K., K. Gunning, T., & Harvey, M. L. (2022). Defining and measuring authentic assessment: a case study in the context of tertiary science. *Assessment & Evaluation in Higher Education*, *47*(1), 77–94. https://doi.org/10.1080/02602938.2021.1887811

*Sekendiz, B. (2018). Utilisation of formative peer-assessment in distance online education: A case study of a multi-model sport management unit. *Interactive Learning Environments*, *26*(5), 682–694. https://doi.org/10.1080/10494820.2017.1396229

*Senel, S., & Senel, H. C. (2021). Remote assessment in higher education during COVID-19 pandemic. *International Journal of Assessment Tools in Education*, *8*(2), 181–199.

*Shaw, L., MacIsaac, J., & Singleton-Jackson, J. (2019). The efficacy of an online cognitive assessment tool for enhancing and improving student academic outcomes. *Online Learning Journal*, *23*(2), 124–144. https://doi.org/ 10.24059/olj.v23i2.1490

Shute, V. J., Wang, L., Greiff, S., Zhao, W., & Moore, G. (2016). Measuring problem solving skills via stealth assessment in an engaging video game. *Computers in Human Behavior*, *63*, 106–117. https://doi.org/10.1016/j.chb.2016.05.047

Stödberg, U. (2012). A research review of e-assessment. *Assessment & Evaluation in Higher Education*, *37*(5), 591–604. https://doi.org/10.1080/02602938.2011.557496

*Stratling, R. (2017). The complementary use of audience response systems and online tests to implement repeat testing: a case study. *British Journal of Educational Technology*, *48*(2), 370–384. https://doi.org/ 10.1111/bjet.12362

*Sullivan, D., & Watson, S. (2015). Peer assessment within hybrid and online courses: Students' view of its potential and performance. *Journal of Educational Issues*, *1*(1), 1–18. https://doi.org/10.5296/jei.v1i1.7255

*Taghizadeh, M., Alavi, S. M., & Rezaee, A. A. (2014). Diagnosing L2 learners' language skills based on the use of a web-based assessment tool called DIALANG. *International Journal of E-Learning & Distance Education*, *29*(2), n2.

*Tawafak, R. M., Romli, A. M., & Alsinani, M. J. (2019). Student assessment feedback effectiveness model for enhancing teaching method and developing academic performance. *International Journal of Information and Communication Technology Education*, *15*(3), 75–88. https://doi.org/10.4018/IJICTE.2019070106

*Tempelaar, D. (2020). Supporting the less-adaptive student: The role of learning analytics, formative assessment and blended learning. *Assessment & Evaluation in Higher Education*, *45*(4), 579–593.

Tempelaar, D. T., Rienties, B., Mittelmeier, J., & Nguyen, Q. (2018). Student profiling in a dispositional learning analytics application using formative assessment. *Computers in Human Behavior*, *78*, 408–420. https://doi.org/10.1016/j.chb.2017.08.010

*Tenório, T., Bittencourt, I. I., Isotani, S., Pedro, A., & Ospina, P. (2016). A gamified peer assessment model for on-line learning environments in a competitive context. *Computers in Human Behavior*, *64*, 247–263. https://doi.org/10.1016/j.chb.2016.06.049

*Thille, C., Schneider, E., Kizilcec, R. F., Piech, C., Halawa, S. A., & Greene, D. K. (2014). The future of data-enriched assessment. *Research & Practice in Assessment*, *9*, 5–16.

*Tsai, N. W. (2016). Assessment of students' learning behavior and academic misconduct in a student-pulled online learning and student-governed testing environment: A case study. *Journal of Education for Business*, *91*(7), 387–392. https://dx.doi.org/10.1080/08832323.2016.1238808

*Tucker, C., Pursel, B. K., & Divinsky, A. (2014). Mining student-generated textual data in MOOCs and quantifying their effects on student performance and learning outcomes. *Computers in Education Journal*, *5*(4), 84–95.

*Tucker, R. (2014). Sex does not matter: Gender bias and gender differences in peer assessments of contributions to group work. *Assessment & Evaluation in Higher Education*, *39*(3), 293–309. http://dx.doi.org/10.1080/02602938.2013.830282

Turkay, S., & Tirthali, D. (2010). Youth leadership development in virtual worlds: A case study. *Procedia - Social and Behavioral Sciences*, *2*(2), 3175–3179. https://doi.org/10.1016/j.sbspro.2010.03.485

*Turner, J., & Briggs, G. (2018). To see or not to see? Comparing the effectiveness of examinations and end of module assessments in online distance learning. *Assessment & Evaluation in Higher Education*, *43*(7), 1048–1060. https://doi.org/10.1080/02602938.2018.1428730

*Vaughan, N. (2014). Student engagement and blended learning: Making the assessment connection. *Education Sciences*, *4*(4), 247–264. https://doi.org/10.3390/educsci4040247

*Wadmany, R., & Melamed, O. (2018). "New Media in Education" MOOC: Improving peer assessments of students' plans and their innovativeness. *Journal of Education and E-Learning Research*, *5*(2), 122–130. https://doi.org/10.20448/journal.509.2018.52.122.130

*Wang, S., & Wang, H. (2012). Organizational schemata of e-portfolios for fostering higher-order thinking. *Information Systems Frontiers*, *14*(2), 395–407. https://doi.org/10.1007/s10796-010-9262-0

*Wang, Y.-M. (2019). Enhancing the quality of online discussion—assessment matters. *Journal of Educational Technology Systems*, *48*(1), 112–129. https://doi.org/10.1177/0047239519861

*Watson, S. L., Watson, W. R., & Kim, W. (2017). Primary assessment activity and learner perceptions of attitude change in four MOOCs. *Educational Media International*, *54*(3), 245–260. https://doi.org/10.1080/09523987.2017.1384165

Webb, M., Gibson, D. C., & Forkosh-Baruch, A. (2013). Challenges for information technology supporting educational assessment. *Journal of Computer Assisted Learning*, *29*(5), 451–462. https://doi.org/10.1111/jcal.12033

Webb, M., & Ifenthaler, D. (2018). Assessment as, for and of 21st century learning using information technology: An overview. In J. Voogt, G. Knezek, R. Christensen, & K.-W. Lai (Eds.), *International Handbook of IT in Primary and Secondary Education* (2nd ed., pp. 1–20). Springer.

Wei, X., Saab, N., & Admiraal, W. (2021). Assessment of cognitive, behavioral, and affective learning outcomes in massive open online courses: A systematic literature review. *Computers & Education*, *163*, 104097.

*Wells, J., Spence, A., & McKenzie, S. (2021). Student participation in computing studies to understand engagement and grade outcome. *Journal of Information Technology Education*, *20,* 385–403. https://doi.org/10.28945/4817

*West, J., & Turner, W. (2016). Enhancing the assessment experience: Improving student perceptions, engagement and understanding using online video feedback. *Innovations in Education and Teaching International*, *53*(4), 400–410. http://dx.doi.org/10.1080/14703297.2014.1003954

Whitelock, D., & Bektik, D. (2018). Progress and challenges for automated scoring and feedback systems for large-scale assessments. In J. Voogt, G. Knezek, R. Christensen, & K.-W. Lai (Eds.), *International Handbook of IT in Primary and Secondary Education* (2nd ed., pp. 617–634). Springer.

*Wilkinson, K., Dafoulas, G., Garelick, H., & Huyck, C. (2020). Are quiz-games an effective revision tool in anatomical sciences for higher education and what do students think of them? *British Journal of Educational Technology*, *51*(3), 761–777. https://doi.org/10.1111/bjet.12883

*Wu, C., Chanda, E., & Willison, J. (2014). Implementation and outcomes of online self and peer assessment on group based honours research projects. *Assessment & Evaluation in Higher Education*, *39*(1), 21–37. http://dx.doi.org/10.1080/02602938.2013.779634

*Xian, L. (2020). The effectiveness of dynamic assessment in linguistic accuracy in efl writing: an investigation assisted by online scoring systems. *Language Teaching Research Quarterly*, *18*, 98–114.

*Xiao, Y. A. N. G., & Hao, G. A. O. (2018). Teaching business english course: Incorporating portfolio assessment-based blended learning and MOOC. *Journal of Literature and Art Studies*, *8*(9), 1364–1369. https://doi.org/10.17265/2159-5836/2018.09.008

*Yang, T. C., Chen, S. Y., & Chen, M. C. (2016). An investigation of a two-tier test strategy in a university calculus course: Causes versus consequences. *IEEE Transactions on Learning Technologies*, *9*(2), 146–156.

*Yeh, H.-C., & Lai, P.-Y. (2012). Implementing online question generation to foster reading comprehension. *Australasian Journal of Educational Technology*, *28*(7), 1152–1175.

*Zhan, Y. (2021). What matters in design? Cultivating undergraduates' critical thinking through online peer assessment in a confucian heritage context. *Assessment & Evaluation in Higher Education*, *46*(4), 615–630. https://doi.org/10.1080/02602938.2020.1804826

*Zong, Z., Schunn, C. D., & Wang, Y. (2021). What aspects of online peer feedback robustly predict growth in students' task performance? *Computers in Human Behavior*, *124*, 106924. https://doi.org/10.1016/j.chb.2021.106924