



Online formative assessment in higher education: A review of the literature

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ABSTRACT

As online and blended learning has become common place educational strategy in higher education, educators need to reconceptualise fundamental issues of teaching, learning and assessment in non traditional spaces. These issues include concepts such as validity and reliability of assessment in online environments in relation to serving the intended purposes, as well as understanding how formative assessment functions within online and blended learning. This article provides a systematic qualitative review of the research literature on online formative assessment in higher education. As an integrative narrative review, the method applied in this review entailed systematic searching, reviewing, and writing this review of the literature to bring together key themes and findings of research in this field. The authors applied qualitative thematic criteria in selecting and reviewing the available literature from which they focused on identifying and analyzing the core themes that are central to the concept of formative assessment with a key focus on application of formative assessment within blended and online contexts. Various techniques were identified for formative assessment by the individual, peers and the teacher, many of which were linked with online tools such as self-test quiz tools, discussion forums and e-portfolios. The benefits identified include improvement of learner engagement and centrality in the process as key actors, including the development of a learning community. The key findings are that effective online formative assessment can foster a learner and assessment centered focus through formative feedback and enhanced learner engagement with valuable learning experiences. Ongoing authentic assessment activities and interactive formative feedback were identified as important characteristics that can address threats to validity and reliability within the context of online formative assessment.

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1. Introduction

Online and blended learning have become common place in 21st century higher education. Larreamendy-Joerns and Leinhardt (2006) review of the literature “observed two complementary movements in the educational landscape: the merging of online teaching and learning into the stream of everyday practices at universities, and the increasingly salient role of distance programs in institutions of higher education” (p. 572). Talent-Runnels et al (2006) reviewed course environment, learners’ outcomes, learners’ characteristics, and institutional and administrative factors. In critiquing the available literature, they identified that “asynchronous communication seemed to facilitate in-depth communication (but not more than in traditional classes), students liked to move at their own pace, learning outcomes appeared to be the same as in traditional courses, and students with prior training in computers were more satisfied with online courses” (p. 93). A meta-analysis of online learning reported by the US Department of Education (2009) suggests that online instruction, in general, can be more beneficial than traditional face-to-face (f2f) instruction for both K-12 and older learners. In addition, second order meta-analysis of the impact of any application technology on learning over 40 years by Tamin, Bernard, Borokhovski, Abrami, and Schmid (2011) indicates a mean effect size of 0.33. However, none of these relatively recent literature reviews and further analyses directly addressed assessment, which is of interest because online and web enhanced courses provide many additional opportunities to dynamically interact with and assess learners, opportunities which are enhanced through formative assessment (Oosterhof, Conrad, & Ely, 2008).

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Assessment is at the heart of formal higher education. As identified by Bransford, Brown, and Cocking (2000, pp. 1–28), assessment is a core component for effective learning. The authors indicate that teaching and learning processes need to be assessment-centered to provide learners with opportunities to demonstrate their developing abilities and receive support to enhance their learning. It is important to note that, although formative assessment (assessment to support learning) and summative assessment (for validation and accreditation) are not separate or fixed processes, tensions exist between them (William & Black, 1996). Assessment can also be deeply embedded in pedagogy. For example, research of problem-based learning emphasizes embedded assessment and indicates that the levels of the knowledge structure being developed have implications for assessment strategies (Gijbels, Dochy, Bossche, & Segers, 2005). The literature reviewed by Hattie and Timperly (2007), and Nicol and Macfarlane (2006), which did not include research in online learning, indicated that feedback is most effective when highly related to clearly identified learning goals so that effective formative feedback is not only based on monitoring progress toward the specific goals but also promotes students to develop effective learning strategies. These processes characterize formative assessment and are aimed at supporting learning.

As Vonderwell, Liang, and Alderman (2007) indicated, assessment (whether formative or summative) in online learning contexts encompasses distinct characteristics as compared to f2f contexts particularly due to the asynchronous nature of interactivity among the online participants (the teacher and learners). Therefore, it requires educators to rethink online pedagogy in order to achieve effective formative assessment strategies that can support meaningful (higher-order or deep) learning and its assessment. Meaningful interactions within an effective learning community are antecedent to interactive collaboration which is a critical sociocognitive process in online settings necessary to facilitate critical thinking, a desirable marker for higher-order learning particularly in informal higher education (Akyol, Garrison, & Ozden, 2009; Kehrwald, 2010). However, as Akyol et al. (2009) identified, it is not an easy process to develop effective learning communities that will facilitate meaningful interactions particularly in online and blended settings because this requires well-structured strategies that are not always obvious among online educators. Effective integration of formative assessment in online learning environments has the potential to offer an appropriate structure for sustained meaningful interactions among learners and the teacher, and foster development of effective learning communities to facilitate meaningful learning and its assessment (Sorensen & Takle, 2005). Moreover, this can provide a systematic structure for effective learner support through ongoing monitoring of learning and provision of adequate formative feedback. Ongoing support for scaffolding learning is critical in online learning, and can be essentially facilitated through sustained interactive collaboration among the teacher and learners (Ludwig-Hardman & Dunclap, 2003). This is because it supports learners to engage productively, and assists them in the development of self-regulated learning dispositions. This in turn supports them to take primary responsibility for their learning which is an important requirement for success in online learning. Agreeing with these authors, our viewpoint is that sustained meaningful interactions and collaboration among the individual learner, peers and the teacher as learning community with a shared purpose can enhance opportunities for ongoing and adequate learner support. This can ultimately foster meaningful engagement and deep learning in online higher education. Following this viewpoint, we propose that effective application of formative assessment in online learning environments can offer an innovative pedagogical strategy to facilitate such opportunities.

In online higher education, however, emphasis continues to be placed on summative assessment with formative assessment receiving little attention despite its crucial role in promoting learning (Pachler, Daly, Mor, & Mellar, 2010; Wang, Wang, & Huang, 2008). For this reason, Pachler et al. (2010) and Wang, Wang, and Huang (2008) recommended a refocused emphasis on online formative assessment in order to create learner and assessment centered learning environments. However, a search of the literature did not reveal any review of online formative assessment. This paper aims to fill that gap with a focus on how formative assessment support learners in developing domain content knowledge and professional skills in an online environment. We also aim to enhance understanding of the core assessment concepts of validity and reliability as they occur in online contexts.

2. Methodology

The design of this review qualifies as a systematic qualitative review (Green, Johnson, & Adams, 2006; Pan, 2008, pp. 1–5). That is, the review employed systematic criteria to allow rigorous analysis, critique and synthesis of related literature and is thus integrative in nature (Torraco, 2005). The review process followed the three main steps of literature review as articulated in Galvan (2006), which are searching, reviewing and writing the literature review.

2.1. Searching the literature

Search terms and phrases were identified which included *online assessment*, *online formative assessment*, *innovative assessment*, *assessing online learning*, *assessment in higher education*, *online formative assessment in higher education* and *alternative assessment*. Authoritative electronic databases were searched including ERIC, Education Research Complete, ProQuest, Science Direct and Google Scholar. The search was bound within the higher education context and within the last two decades in which advancement and widespread use of educational digital technologies has grown rapidly. Only peer-reviewed sources were considered to ensure quality of the review. Further searches were accomplished through backward referencing, hand searching and consulting with experts in the field. Ninety one peer reviewed articles were considered as relevant although the extent of their relevance varied in relation to the themes they captured. A number of books authored by renowned authors in the field were also considered as secondary sources. The search process continued until the search did not reveal any new relevant articles. Retrieved articles were clustered to enable a systematic review. EndNote software was used to manage the references.

2.2. Reviewing the literature

This stage involved scanning through the selected articles, organizing them according to their date of publication (2010-backwards), and the extent of relevance to research themes. Selected articles were further categorized as primary (empirical) studies and secondary sources, giving preference to peer reviewed empirical studies. The authors reviewed the 91 articles that had been selected as relevant from the literature search. This reviewing process was guided by the previously noted purpose of this review, where themes emerging from each

article were noted in order to identify those articles whose focus coincided with the themes the authors had identified as central to the concept of formative assessment. These core themes included key features of formative assessment such as: embedding of assessment activities within teaching and learning processes, variety of ongoing and authentic assessment activities, ongoing formative feedback, and clarity of expected outcomes through the assessment rubrics. The other key criterion was that the authors' key focus was specifically on application of formative assessment in online and blended higher education contexts, thus online formative assessment (as defined in Section 3). During the review process, the three authors also identified and reached a consensus that among the 91 reviewed articles, 18 of them were more central to this review based on the following: they had a substantial focus on the identified core themes, they were empirical studies, and they specifically focused on application of formative assessment within online and blended higher education contexts. Therefore, these 18 empirical studies were considered as central to this review (see Table 1). These key empirical studies were bound within the period, between 2000 and 2010. To exhaustively explore our key focus, each of these key empirical studies was revisited and reviewed in more depth, and the authors took notes on how formative assessment was integrated in the studied context in relation to the specific techniques applied, what were the key findings and the underlying theoretical perspectives, and within which discipline the study was conducted.

2.3. Writing the literature review

This step entailed revisiting the drafted short notes and then referring back to the selected key empirical studies in order to write a detailed review. The first step was to critically analyze the methodological approaches, strengths and weaknesses, key findings, implications and conclusions of each empirical study. These aspects have been recognized as effective criteria for determining the quality of literature (Galvan, 2006, pp. 63–79; Pan, 2008, pp. 127–136). Appendix A (Table A.1) illustrates the criteria applied in analyzing the literature with a summary of two key studies included. The appendix captures the key focus, methodological and theoretical approach, strengths and weaknesses, and summarizes major findings of these studies. In addition, the relevant themes and implications for practice emerging from the other reviewed articles including the secondary sources were carefully considered, critiqued and integrated within the central themes derived from the key empirical studies. These ideas were systematically developed to inform the central themes and implications presented in this review.

2.3.1. The key studies

Based on the above selection criteria, the key studies included studies of online and blended contexts: 9 were of online contexts, 8 were of blended contexts, and the remaining study (Pachler et al., 2010) had participants from both blended and online contexts. The selected literature was drawn from a wide range of higher education disciplines. As shown in Appendix B (Table B.1), half of the selected studies were teacher education courses; and an additional five were multidisciplinary studies and included teacher education students. The remaining four studies focused on specific disciplines including engineering (2) and sciences (2). This was surprising given the US Department of Education (2009) recent meta-analysis of evidence-based practices in online learning found that the majority of studies came from medical fields and previous reviews of the literature of online learning also covered a wider range of disciplines (Larreamendy-Joerns & Leinhardt, 2006; Tallent-Runnels et al., 2006). The preponderance of studies in teacher education that we reviewed may be linked to teacher expertise and beliefs, which will be discussed later.

The key studies were drawn from a wide range of publications in Europe, Australasia and North America and had a great variety of purposes (or central focus), as may be seen in Table B.1 (Appendix B). In most cases it was not possible to identify the online tools and technologies in detail, although a learning management system was frequently adopted. Two studies included electronic portfolio software.

Table 1

Theory and methodology across the 18 key studies included in this review (in alphabetical order of first author).

Authors and Year	Mode of study	Theories explicitly cited	Other theoretical perspectives emerging	Methodology
Chung et al. (2006)	Blended	None	Problem-based learning, active learning	Case study: practitioner-based research
Crisp and Ward (2008)	Online	Scenario-based learning	Authentic learning	Survey
Dopper and Sjoer (2004)	Blended	None	Collaborative learning	Experimental: Practitioner-based research
Feldman and Capobianco (2008)	Blended	Collaborative learning	Authentic learning	Case study
Gaytan and McEwen (2007)	Online	None	Authentic learning	Survey
Herrington et al. (2006)	Online	Authentic learning	None	Case study
Lin (2008)	Blended	None	Collaborative learning	Case study
Mackey (2009)	Online	Communities of Practice (COP) (Wenger, 1998)	Authentic learning	Case study: practitioner-based research
Mackey and Evans (2011)	Online	COP (Wenger, 1998)	Authentic learning	Case study: practitioner-based research
Pachler et al. (2010)	Online and blended	Moments of contingency (Leahy, Lyon, Thompson, & William, 2005) and Conversational framework (Laurillard, 2002; 2007)	None	Case study
Smith (2007)	Blended	None	Bloom's taxonomy	Case study: practitioner-based research
Sorensen (2005)	Online	Collaborative learning	COP (Wenger, 1998), authentic learning	Case study: practitioner-based research
Sorensen and Takle (2005)	Online	Collaborative learning	Authentic learning	Case study: practitioner-based research
Van der Pol et al. (2008)	Blended	None	Collaborative learning	Case study
Vonderwell et al. (2007)	Online	Collaborative learning	Authentic learning	Case study
Wang (2009)	Blended	Collaborative learning	Authentic learning	Case study
Wang, et al (2008)	Blended	None	Authentic learning	Case study
Wolsey (2008)	Online	None	Collaborative learning	Case study

Table 1 lists the selected key studies with the theories explicitly cited along with other theoretical perspectives and/or emerging pedagogical viewpoints, as well as the methodology adopted. A number of the reviewed studies offered theory-based recommendations about what characterizes effective online pedagogical designs. For instance, Sorensen and Takle (2005) take the theoretical viewpoint of collaborative learning communities to provide a case study of an approach that supports learner-centered designs, which actively engage learners as co-facilitators and participants. They also suggested criteria that support ongoing assessment for both processes and products of learning. Vonderwell et al. (2007) described a theoretical viewpoint of collaborative and assessment learning that places emphasis on learners and the design of their learning environment rather than on the teacher. That study also suggested an approach that equally values the processes as well as the products of learning. Herrington, Reeves, and Oliver (2006) described design principles from the viewpoint of authentic learning and emphasized the integration of authentic assessment activities. Mackey (2009); Mackey and Evans (2011) theoretical perspective was linked to communities of practice (Wenger, 1998) to inform a course and programme design that blended authentic online learning and assessment activities with their applications in real-life contexts. Other studies had no explicit theory but some underlying conceptual viewpoints and assumptions were revealed within the article. For example, Chung, Shel, and Kaiser (2006), Gaytan and McEwen (2007) and Wang et al. (2008) described the provision of meaningful formative assessment activities in order to create online learning and assessment centered designs. Given the complexity and range of these theories and the early stage of research into this topic, it is not surprising to find that most researchers chose case study methodology (16 out of 18 key studies) and many researchers were also involved in the course, most often as the teacher and/or course developer.

3. Key terminologies

It is necessary to clarify the key terminologies at this point. Various terminologies have been used synonymously with other terms or varyingly defined by different authors in addressing aspects in education. Guri-Rosenelt (2009) has extensively discussed the importance of terminology clarification especially in educational domains.

Some of the key terms to distinguish include *e-learning*, *online* and *blended learning*. In describing the varying terms that are used to refer to applications of digital technologies in education, Guri-Rosenelt (2009) noted that more than twenty terms are synonymously used with the term *e-learning*. In particular, she noted that the term *e-learning* is widely used synonymously with the term *online learning* among other terms. While many definitions of *e-learning* appear in the literature, it can be broadly and sufficiently defined as any learning and/or teaching delivered or conducted through Information Communication Technology (ICT) of any kind, thus encompassing such various digital technologies including CD-ROM, television, interactive multimedia, mobile phones, and the Internet (Andrews & Haythornthwaite, 2007; Brenton, 2009; Guri-Rosenelt, 2009; Mellar, 2008). Based on these authors, e-learning covers a range of practices including online learning, blended learning, ICT mediated f2f, and distance learning. These terms are of relevance to this field; thus, it is necessary to draw a clear distinction among them. According to Guri-Rosenelt (2009, pp. 5–7), *distance learning* refers to any form of learning where teaching and learning activities are distributed across time and space and does not require the teacher and the student to be gathered in the same place and time. *Online learning* refers to a form of distance education primarily conducted through web-based ICT (Guri-Rosenelt, 2009, p. 5). Dabbagh and Bannan-Ritland (2005) define *online learning* as “distance learning environments that use Internet and/or web-based technologies to support the teaching and learning process” (p. 15). Consistent with these definitions, Allen, Seaman, and Garret (2007) defined online learning as a form of e-learning that is enabled by web-based technologies, does not require the teacher and the learner to be available at the same time and place, and constitutes 80% or more learning/teaching activities conducted through web-based ICT. These authors also defined *blended learning* as learning environments where 30–80% of learning/teaching activities are conducted through web-based ICT.

It is also necessary to define the term *assessment*. Assessment is defined as measurement of the learner’s achievement and progress in a learning process (Keeves, 1994; Reeves & Hedberg, 2009). Often, the term *assessment* is used synonymously with the term *evaluation*, which at times leads to ambiguity. It is thus necessary to draw a clear distinction between these concepts and related terms in this review. Although both terms have a component of measurement, it is desirable to reserve the term *evaluation* for operations associated with measuring worthiness/value of non-person entities (such as curricula, programmes, courses, instructional strategies among others) in relation to identified goals, while the term *assessment* is used to refer to operations associated with measuring achievements of persons in relation to desirable outcomes (Keeves, 1994). Wellington (2008) defines evaluation as “systematic investigation of worth of an innovation, initiative, policy or a programme. It is used to measure the effectiveness or impact of an intervention or initiative” (p. 236). In this review, the term *assessment* is purposefully used to refer to measurement of learner’s achievement and progress in a learning process. Two major forms of assessment exist: formative and summative assessments (Challis, 2005; Oosterhof et al., 2008, p. 7).

Summative assessment measures what students have learned at the end of an instructional unit, end of a course, or after some defined period (Hargreaves, 2008). It can also refer to ascertaining that the desired goals of learning have been met or certifying that the required levels of competence have been achieved (Challis, 2005). In general, summative assessment includes scoring for the purposes of awarding a grade or other forms of accreditation. Summative assessment has been the conventional form of assessment. It is commonly characterized by objective tests, pre-specified objectives and contents leading to uniformity of approaches, which mainly entail assessing general/broader content domains (Oosterhof et al., 2008, pp. 76–77). According to their analysis of online assessment literature (Oosterhof et al., 2008) these characteristics allow summative assessment to be considered suitable for certifying a learner’s final achievements.

Summative assessment has been associated with undesirable learning approaches that may encourage surface learning and low order thinking because in most cases, it assesses declarative knowledge and basic application with no evidence of personal reflection and deep understanding (Smith, 2007; Tshibalo, 2007). These limitations have necessitated integration of formative assessment into teaching and learning in order to support learners to develop deep and robust knowledge. This is not to suggest that summative assessment has no potential to assess higher-order cognitive skills such as analysis, synthesis and evaluation. Instead, as Smith (2007) and Gijbels et al. (2005) identified, summative assessment depends on the nature of the underlying knowledge structures being assessed.

Formative assessment is commonly applied in the classroom as a source of ongoing feedback with the aim to improve teaching and learning (Hargreaves, 2008). It can also be referred to as assessment for learning that occurs during the course of instruction with the aim to support learning (Oosterhof et al., 2008, pp. 76–77; Vonderwell et al., 2007). Formative assessment activities are embedded within

instructions to monitor learning and assess learners understanding for the purposes of modifying instruction and informing further learning through ongoing and timely feedback until the desired level of knowledge has been achieved. In their most recent and comprehensive review, Black and Wiliam (2009) attempted to provide a unifying basis for diverse practices of formative assessment. In describing formative assessment, Black and Wiliam noted that:

Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited. (p. 9)

Among the various definitions of formative assessment in the literature, the Black and Wiliam's definition aligns with our view of formative assessment. However, their focus was general and did not specifically address online contexts. We expand this definition by using the term *instruction* to refer to both teaching and learning activities/processes intended to create learning opportunities. Black and Wiliam also articulate the difference between intended use and actual results. This implies that formative assessment may fail to promote learning depending on how data obtained are used. As such, it is necessary to ensure that the evidence obtained is used in a way that fits formative purposes. Our definition also recognizes the shared responsibility and control to foster active learning by involving the teacher, individual learner, and peers as key actors in the learning process.

Formative assessment may also inform other stakeholders such as host institutions, parents, employers and the wider community about learner's progress (Smith, 2007). In this way, formative assessment serves summative purposes. On the other hand, summative assessment may also serve a formative role where data obtained are used to inform learning in subsequent units in the course. Smith noted that, "students and instructors may use exam results to adjust studying and teaching respectively, later in the course, so even exams can have a formative component; the line between formative and summative assessments is not sharp" (p. 30). This implies that any assessment could be formative or summative depending on how data obtained are used. However, we suggest that teacher care is necessary when undertaking such actions to ensure that the formative role of the assessment is not compromised. In addition, the teacher needs to explicitly share with the learners how assessment data will be used.

As Oosterhof et al. (2008, pp. 70–82) suggested, it is important to recognize that these two forms of assessment have a core role in higher education. While formative assessment is considered instructionally paramount because it promotes learning, the role of summative assessment in higher education, which is concerned with accountability and certification, remains crucial. As such, summative assessments are essential in certifying learner's achievements and establishing what is typical and reasonable. Formative assessment is needed within teaching and learning processes in order to support optimal learning.

Informed by these ideas, we define *formative assessment* as the iterative processes of establishing what, how much and how well students are learning in relation to the learning goals and expected outcomes in order to inform tailored formative feedback and support further learning, a pedagogical strategy that is more productive when role is shared among the teacher, peers and the individual learner. The convergence of formative assessment with technological perspectives brings to life the concept of online formative assessment. In describing this convergence, Pachler et al. (2010) used the term *formative e-assessment* which they defined as "the use of ICT to support the iterative process of gathering and analyzing information about student learning by teachers as well as learners and of evaluating it in relation to prior achievement and attainment of intended, as well as unintended learning outcomes" (p. 716). The Pachler et al.'s definition encompasses application of formative assessment in all forms of e-learning environments including the complementary role of ICT in f2f settings as well as in blended and online learning settings. In the same vein, we define *online formative assessment* as the application of formative assessment within learning online and blended settings where the teacher and learners are separated by time and/or space and where a substantial proportion of learning/teaching activities are conducted through web-based ICT. Therefore, this review specifically focuses on application of formative assessment in online and blended learning environments thus our use of the term online formative assessment. Having clarified our terminology, we present our review findings in the following section.

4. Findings: the nature of online formative assessment

Online formative assessment is characterized by diversity of approaches that can enhance learning experiences and outcomes. Based on our in-depth analysis of the literature, we first examine the fundamental issues of assessment within the online context, including validity, reliability and dishonesty. Next we discuss the functionality of online formative assessment.

4.1. Fundamental issues of assessment: validity, reliability and dishonesty

Similar to traditional f2f learning environments, fundamental issues of assessment in online settings need to be addressed in order to realize desirable outcomes (Oosterhof et al., 2008, pp. 1–12). These issues include validity, reliability and dishonesty. In online settings, these issues take on new dimensions in various ways due to the nature of interactivity in online environments among students and the teacher (Oosterhof et al., 2008, pp. 76–77; Wolsey, 2008). Wolsey illustrated the need for careful considerations during the design and embedding of formative assessment in online settings in order to address these issues effectively and overcome threats associated with them. Hargreaves (2007) also identified the need to recognize the distinction between validity and reliability within the context of assessment *for* learning (formative assessment) and assessment *of* learning (summative assessment). Although the study by Hargreaves did not specifically focus on online settings, we argue that his ideas are relevant in both f2f and online contexts. We affirm that it is necessary to reconceptualise and redefine validity and reliability within the context of formative assessment because the typical definitions applied in summative assessment are limited to quantitative conceptualizations, which is not sufficient to establish validity and reliability within the context of formative assessment. The nature of evidence in formative assessment encompasses multifaceted contexts (Blair & Monske, 2009; Rickards et al., 2008), and entails both processes and products of learning (Sorensen & Takle, 2005; Vonderwell et al., 2007), which calls for an alternative approach to issues of validity and reliability within the context of online formative assessment. Therefore, a qualitative or mixed methods approach is often required to establish the degree of validity and reliability in formative assessment. The following sections

identify characteristics of validity, reliability and dishonesty in formative assessment within the contexts of online learning in higher education.

4.1.1. Validity

It is important to start by reviewing the contemporary definition of validity as conceptualized in summative assessment. This will provide the basis to shift to a conception that meets our endeavors in this review. According to Messick (1989), validity is “an integrated evaluative judgment of the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of inferences and actions based on test scores” (p. 13). According to Messick’s (1989) conception of validity, one important principle of validity is the inferences we want to make from the test results; that is, the intended interpretation or the purpose of the test results. By implication, validation requires an explicit statement of the intended interpretations and uses (Shaw & Crisp, 2011). In describing validity as a concept that has evolved over time, Shaw and Crisp (2011) further noted that “contemporary validity theory generally sees validity as about the appropriateness of the inferences and uses made from assessment outcomes, including some considerations of the consequences of test score use” (p.14). Therefore, validity does not apply to the test (or assessment) itself but it focuses on the inferences made from the test results (or the assessment outcomes) and the decisions resulting from those inferences. Based on this viewpoint, assessment cannot be termed as valid or invalid. Instead, what is measured is the degree or extent of validity; for instance, in terms of the assessment being either more or less valid.

Within the unified conception of validity as articulated by Shaw and Crisp (2011), “validation activity requires sufficient evidence that the test actually measures what it claims to measure; the test scores demonstrate reliability; and that the test scores manifest associations with other variables in a way that is compatible with its predicted properties” (p. 18). Following this unified conception; reliability is fundamentally a component of validity in that validation emphasizes the need to consider multiple measures and multiple sources of evidence over a continued period of time when validating assessment inferences. However, these two concepts are presented separately in this review just for clarity purposes.

Drawing from this contemporary background, validity within the context of online formative assessment may be defined as the degree to which the assessment activities and processes promote further learning. This conception is based on the fundamental idea that the purpose of formative assessment is to support learning. In defining validity of formative assessment, Hargreaves (2007) stated, “validity of an assessment for learning depends on how far the interpretation and use of the assessment actually leads to further learning” (p. 186). This implies that by just designing assessments intended to serve formative purposes does not make it more valid; instead, formative assessment must stimulate a high level of the desired learning. As noted earlier, Black and William (2009, pp. 9–10) reinforced this by articulating the difference between intended use and results in relation to realizing the purpose of assessment (formative or summative). As such, it is necessary to ensure that the evidence obtained is used in a way that fits the intended purpose of assessment thus enhancing validity of assessment. Consistent with this are ideas by various authors within blended and online settings. For instance, Feldman and Capobianco (2008) in illustrating that what may seem to be formative may turn out to be formatively less valid, they noted, “... even when teachers ... use a series of assessments during the course of instruction, they tend to be short-term ways of obtaining summative information for the purposes of assigning grades rather than formative information for the improvement of teaching and learning” (p. 83). Similarly, use of online assessment techniques with the intention to promote learning does not necessarily make the assessment formatively more valid; instead, the key issue is whether these techniques are being used formatively (Pachler et al., 2010). To enhance the validity of online formative assessment, the teacher and the student need to appreciate that the learning it promotes is valuable. Teachers need to model and sustain effective formative assessment practices in order to achieve the potential benefits of online formative assessment.

Following analysis of the literature, we identified that validity of online formative assessment relates to the following characteristics: (1) authenticity of assessment activities, (2) effective formative feedback, (3) multidimensional perspectives, and (4) learner support. These characteristics are discussed in the following paragraphs.

Firstly, validity of online formative assessments may be threatened if the assessment activities and processes are not authentic and encourage the envisioned outcome; opportunities to apply knowledge, skills and judgments in diverse ill-structured contexts that characterize real world domains. This implies assessment activities should be authentic to the domain being studied. For instance, a study by Crisp and Ward (2008) demonstrated authentic contexts through realistic classroom situations, which provided teachers as learners with opportunities to develop and practice skills relevant in the teaching profession such as observation, analysis and decision-making, reflection and personal professional development.

Other studies (e.g. Lin, 2008; Mackey, 2009; Wang et al., 2008) demonstrated the need to offer complex and authentic assessment activities that engage the learner in decision-making and problem solving that is relevant to their real world situations. That way, learners engage themselves in meaningful ways that enable them to reflect deeply on both their learning processes and outcomes, which subsequently drive them towards metacognitive thinking and self-learning. Metacognitive thinking is associated with enhanced ability to transfer knowledge to new situations (Crisp & Ward, 2008). We contend that online formative assessment needs to encourage and promote the student learning experiences through a variety of authentic tasks thus promoting engagement and transferability.

As Herrington et al. (2006) demonstrated, the activities do not necessarily have to be in real world practice to be authentic; instead, authenticity may arise from engaging students with tools and/or tasks that are authentic to the domain being studied. This is particularly useful in facilitating contextual settings in order to enhance transferability.

Secondly, for online formative assessment to be considered as adequately valid, feedback should be timely, ongoing, formatively useful and easy to understand (Gaytan & McEwen, 2007; Koh, 2008; Wang et al., 2008; Wolsey, 2008). Wolsey’s study examined importance of formative feedback and assessment in online settings. Findings from that study illustrated that formative feedback requires to be characterized by promptness and having a provision for the students to repeat and/or revise the unsatisfactorily submitted task. In describing the importance of prompt feedback, Wolsey noted that, “the most effective feedback is that which is given at the time the learning is constructed (or as close to it as practical). When feedback is not provided in a timely way or is not related to knowledge that is familiar to the students, they tend to ignore that feedback...” (p. 323). Similarly, Tallent-Runnels et al. (2006) review of online courses emphasized the immediacy of teacher’s feedback in asynchronous learning environments for sustained engagement. Online settings offer various tools that can enhance immediacy and clarity of feedback, which is important in promoting satisfaction and active participation.

In providing feedback, unfamiliar vocabulary or phrases need to be avoided in order to promote higher levels of thinking and understanding as well as motivate students to pay attention to feedback (Wolsey, 2008). According to Wolsey (2008), clear, timely, ongoing and adequately detailed feedback is important in online environments due to physical interaction barriers among online participants, which may discourage or limit some learners to seek clarity. Wolsey also illustrated that indirect feedback, such as offering references and hints, as well as asking leading questions, facilitates student's development and achievement by encouraging the student to self-correct and to engage in reflective inquiry. These aspects manifest effective formative feedback that promotes student motivation towards self regulatory processes and confidence to demonstrate their capabilities (Nicol & Macfarlane, 2006). According to the findings of Van der Pol, Van den Berg, Admiraal, and Simons (2008), the nature of feedback in terms of content, style and presentation influences its use by students. This is to say, the more the students appreciate feedback (perceive it to be useful), the more they are likely to utilize the feedback in revising their work.

Effectiveness of feedback also relates to opportunities for frequent and meaningful interactions to enable shared purpose and meaning of learning goals and expected outcomes (Gaytan & McEwen, 2007; Wolsey, 2008). As Wolsey indicated, it is essential that the teacher share the rubrics with the learners, provide exemplars where applicable to achieve openness and transparency of rubrics, and support the feedback process. Wolsey further observed that online environments offer flexible opportunities to share and review rubrics thus promoting rubrics' openness and flexibility. Koh (2008) also identified that use of exemplars where applicable is crucial in making feedback easily understandable and clarifying rubrics and expected outcomes. Gaytan and McEwen (2007) in reporting the value and ways to foster opportunities for interaction and formative feedback noted:

Feedback is also a critical component in online assessment. It must be meaningful, timely, and should be supported by a well-designed rubric... The assessment value of e-mail messages, chat room conversations, and discussion board postings should not be ignored as they provide opportunities for the instructor to learn whether the students understand the instruction and are correctly interpreting the assessments. (p. 129)

Consistent with these findings of Gaytan and McEwen is a study by Van der Pol et al. (2008) which demonstrated that the level and quality of interactivity among online participants influence the effectiveness and efficiency of formative feedback.

Thirdly, validity of online formative assessment requires multidimensional approaches especially through incorporation of alternative activities. This approach can foster autonomy and flexibility thus enabling diverse opportunities for learners to demonstrate their capabilities and enhance their learning outcomes (Crisp & Ward, 2008; Gaytan & McEwen, 2007). In illustrating the need and means to enable multidimensional approaches, Gaytan and McEwen reported that, "effective online assessments should include a wide variety of clearly explained assignments on a regular basis" (p. 129). This in turn, may lead to mastery (deep) learning and equitable education through assessment activities that provide equal opportunity to learners with diverse needs, skills and abilities, giving them diverse opportunities to demonstrate their capabilities and voice their needs. As demonstrated by Vonderwell et al. (2007) and Mackey (2009), providing flexible assessment tasks can support learner autonomy and motivate learners, for instance, by providing a variety of choices or open-ended tasks. This in turn, makes learners accept responsibility for their learning. Online settings enhance multidimensional perspectives by affording learners various technological resources that support them to utilize variety of approaches as they develop and demonstrate their competences. However, we argue that it is necessary for the teacher to consider the nature of knowledge domain being assessed in order to determine the appropriate levels of flexibility to extend to the students. Practically, students' autonomy may be limited in cases where single or limited processes and/or approaches need to be closely followed. This may be associated with the aspects of authenticity within a particular domain, which may require that specific processes and/or tools are used and products meet specific standards.

Lastly, adequate learner support is critical to the validity within the context of formative assessment particularly in online settings. Sorensen and Takle (2005) demonstrated the usefulness of learner support in online settings. They showed that the teacher should be responsive to the diversity and needs of individual learners by supporting and mentoring learners as they learn and gain confidence on how to engage meaningfully in asynchronous environments. Tallent-Runnels et al. (2006) have also underscored the role of the teacher in mentoring and guiding learners in online learning. Mentoring as used in the current context refers to going beyond assisting learners to attain domain content knowledge and empowering learners (at least those experiencing learning difficulties) to develop positive dispositions as capable learners and encourage them to develop a habit of critical inquiry by persistently asking and/or answering questions correctly. This subsequently, enhances their personal and professional development, especially metacognitive skills, which is important in the field of higher education.

Other studies (Lin, 2008; Rickards et al., 2008; Wang, 2009) have demonstrated the value of learner support where both the teacher and peers are actors in facilitating or modeling this support. Findings by these studies indicate that students benefited from peer interactions, collaboration and feedback as they constructed their learning e-portfolios. According to these authors, asynchronous collaboration among peers in online settings offered effective ways to support learners in their varying learning needs. For instance, Lin identifies the need to support students in technological needs while Rickards et al. recognize the need to model learner engagement with meaningful reflection. Thus, there is need for the teacher to model and encourage collaboration and peer feedback among students within the learning processes.

4.1.2. Reliability

A study by Driessen, Vleuten, Schuwirth, Tartwijk, and Vermunt (2005), though not specific to online learning contexts, attempted to reconceptualize reliability within the context of formative assessment. Based on their ideas, reliability of online formative assessment is the degree to which what is assessed is dependable or sufficient to measure the level of knowledge structure being developed (the desired learning outcomes). Based on this conception, we identified the following characteristics in relation to reliability within the context of online formative assessment: (1) opportunities for documenting and monitoring evidence of learning, (2) multiple sources of evidence of learning and (3) explicit clarity of learning goals and shared meaning of rubrics. As it emerges through the ensuing paragraphs, characteristics of reliability tightly intertwine with validity aspects articulated in the previous sub-section.

Firstly, reliability within the context of online formative assessment relates to providing learners with an opportunity to demonstrate their progress and achievements by documenting evidence of their learning. Evidently, this would enable opportunities for monitoring the learning process and identify individual learners' progress, strengths and weaknesses in order to take remedial action until desired levels of knowledge are achieved (Chung et al., 2006; Gaytan & McEwen, 2007; Vonderwell et al., 2007). Therefore, online formative assessment should provide the

teacher with opportunities to continuously monitor the learning that is taking place. As well, this can provide room for learners to monitor their own progress and achievements. This in turn, motivates them to regulate their learning (Chung et al., 2006; Wang et al., 2008).

Secondly, reliability within online formative assessment relates to multidimensional approaches in order to provide opportunities for alternative approaches and solutions leading to multiple sources of evidence, thus enhancing reliability. As noted earlier, various studies in online formative assessment confirm the need and value of enabling multiple perspectives as evidence of learning. For instance, Gaytan and McEwen (2007) showed the need to incorporate a variety of assessment techniques and tasks to give learners multiple opportunities to demonstrate their learning. However, Smith (2007) observed that flexibility and autonomy require guiding the learners in choosing manageable tasks to avoid frustrations.

Thirdly, it is essential to realize that reliability within online formative assessment will be compromised unless rubrics are clearly defined, interpreted and shared. As Vonderwell et al. (2007) demonstrated, analytical rubrics allow students to assess their learning and guide them on expected level of performances. Our view is that, while innovative approaches help to foster good work, rubrics help to define good work. According to Crisp and Ward (2008), and Vonderwell et al. (2007), opportunities to negotiate meaning and apply rubrics enhance learners' decision-making skills and encourage them to become active participants in assessment. More importantly, this shared understanding and responsibility support the students to clearly understand the expected outcomes and become responsible for their learning. It also allows the teachers to reflect on their practice as well as on how to support students' development (Sorensen & Takle, 2005).

Instead of assigning scores based on overall perception of a student's work, the scoring should be analytical to make it more reliable; that is, points assigned should be based on predetermined qualities clearly spelled out in the rubrics (Gaytan & McEwen, 2007). As illustrated in Smith (2007), scoring formative assessment activities can play an important role in ensuring consistency, fairness and motivation but it should not be used as the only source of evidence for assessing students' level of competence. Instead, it should be used along with other information that may be available in relation to students' ability to provide insights about their understanding. Sharing rubrics and exemplars can promote the accuracy and consistency in scoring. We contend that effective online formative assessment will depend on openness and transparency of rubrics. Reliability may be threatened if online formative assessment does not offer multiple opportunities for students to demonstrate their learning.

4.1.3. Dishonesty

The issue of dishonesty in online formative assessment is closely related to the issues of validity and reliability. This implies that within the context of online formative assessment, aspects of dishonesty can be addressed by enhancing validity and reliability. Various aspects of dishonesty are discussed in the ensuing paragraphs.

Dishonesty relates to verifying the real identity of the learner and work ownership by establishing whether the learner is the designated one, as well as ensuring that the student is using learning resources within stipulated boundaries (Khare & Lam, 2008). Oosterhof et al. (2008, pp. 146–147) suggested that this issue may not pose a great threat and it is less prevalent in online formative assessment. This is contingent on the teacher being explicit in sharing the purpose of assessment (Gaytan & McEwen, 2007). According to Oosterhof et al. (2008, pp. 146–147), when the purpose of assessment has been explained and expected performances have been clearly understood through analytical rubrics and exemplars, dishonesty is minimized. In analyzing related literature, Kirkwood and Price (2008), and Gijbels, Segers, and Struyf (2008) supported this by observing that learners' approaches to learning could be influenced by instructional strategies and assessments activities utilized by the teachers.

Teachers need to reflect on student needs and reconstruct their classroom practices to motivate a positive disposition towards learning and assessment in order to counter undesirable habits and discourage surface approaches to learning that are a threat to honesty (Oosterhof et al., 2008, pp. 146–147). This may involve fending off distorting and de-motivating effects of prior learning and assessment experiences. Various authors indicate that prior assessment experiences may influence learner perceptions of formative assessment either positively or negatively. For instance, Smith (2007) indicated that students pay more attention to formative assessment if they know they will gain a grade in return. Duers and Brown (2009) also demonstrated that some students indicated positive experiences from prior summative assessment acted as a motivator in formative assessment where they were motivated by competition. However, findings by Wolsey (2008) indicated that extrinsic motivators can lead to surface learning if they take precedence over deep learning. According to Gijbels et al. (2008), surface approaches to learning refer to where "students learn by memorizing and reproducing the factual contents of the study materials without seeking for further connections, meaning, or the implications of what is learned" (p. 432). Effective online formative assessment requires the teachers and student alike to reconsider what they value in assessment and how achievement of expected outcomes is demonstrated.

Oosterhof et al. (2008) observed that authentic formative assessment activities can greatly reduce the chances of dishonesty because learners are provided with scoring rubrics and model products alongside the assessment task to guide them in their work. Duers and Brown (2009) also demonstrated that the authentic nature of performance tasks greatly increases students' commitment thus minimizing dishonesty. With authentic tasks, it is possible to assess the same concept while slightly varying the question or the problem thus defeating the usefulness of rote learning of answers among learners, and thus subsequently reducing the chances of cheating. Additionally, where the assessment activity is meaningful and holistic in elements of knowledge being assessed, cheating could be reduced.

Khare and Lam (2008) in reviewing the benefits and issues of online assessment associate the level of dishonesty with learners' academic level and suggest that postgraduate students exhibit low levels of dishonesty as compared to undergraduate counterparts. This can be explained by the fact that postgraduate students (at least in ideal situations) are mainly motivated by their commitment to master their subject of specialization and to apply it in meaningful contexts. In supporting this idea, Khare and Lam observed that adult learners usually choose to further their education on their own initiative and they are likely to engage in deep learning approaches thus minimizing cheating. They further recommend that online assessment, whether formative or summative, is more appropriate for learners who are deemed to have dispositions of autonomy and self regulation.

4.1.4. Summary of fundamentals of assessment: validity, reliability and dishonesty

In summary, validity within the context of online assessment relates to ensuring a variety of meaningful assessment activities that foster contextual, inquiry-based learning and multidimensional perspectives. Validity also relates to effectiveness of formative feedback in relation

to adequacy, immediacy, stimulating meaningful interactions, and offering adequate learner support. Reliability within the context of online formative assessment entails opportunities for ongoing documentation and monitoring learning, which informs the feedback process. Reliability also relates to enabling adequate opportunities for multiple sources of evidence of learning. Another way of enhancing reliability is through ensuring adequate opportunities to foster shared meaning of learning goals and assessment rubrics. The issue of dishonesty in online formative assessment, which relates to students truly owning their work, depends on the degree of inherent validity and reliability. This implies that dishonesty can be minimized through enhancing the identified aspects of validity and reliability.

Through this section, various studies demonstrate the need for embedded authentic assessment activities (Mackey, 2009; Mackey & Evans, 2011) and adequate learner support (Sorensen, 2005; Sorensen & Takle, 2005) in online learning to support learners' meaningful interaction and confidence to creatively explore new possibilities. This review also identified that issues of validity and reliability, and dishonesty take new dimensions in online settings as compared to f2f settings. One such distinctive characteristic relates to the nature of interactivity in online as compared to f2f settings. Thus, careful considerations are necessary during the design and integration of formative assessment in online environments in order to facilitate desirable characteristics and overcome associated threats. For instance, Wolsey (2008) demonstrated how clear, timely, ongoing and adequately detailed feedback is crucial to meaningful communication due to physical interaction barriers among learners and the teacher. Another distinctive characteristic is that in online settings, feedback needs to go beyond details to being interactive in a way that stimulates further dialog between the learner and the teacher or among the learners. In other words, feedback should not be an end in itself; it should create further opportunities for shared meaning, ongoing learner support, and scaffolding learning.

In addition, it is crucial to sustain immediacy of feedback in online settings as well as balancing this immediacy with reasonable amount of time for the students to respond. Vonderwell et al. (2007) exemplified this distinction in their study that utilized asynchronous threaded discussions to facilitate online learning and formative assessment. This balance is necessary for promoting deep inquiry, as learners need sufficient time to compose their thoughts and assess their understanding of content/issues before they respond or question other online participants. Furthermore, in online learning, individual learning styles and study plans are best taken into account.

Integrating online formative assessment while ensuring the identified characteristics will inevitably shift conceptions of validity and reliability and support functionality of online formative assessment as an innovative pedagogical strategy.

Having explored the fundamental issues, we now examine the functionality of formative assessment in online environments.

4.2. *The functionality of online formative assessment*

By addressing the fundamental issues discussed in the preceding section, online formative assessment can function as an innovative pedagogical strategy through facilitating the following opportunities: (1) formative and immediate feedback, (2) engagement with critical learning processes, and (3) promoting equitable education.

4.2.1. *Formative and immediate feedback*

Online environments can enhance opportunities for immediate and ongoing formative feedback. As Wolsey (2008) demonstrated in a study within an online context, formative feedback supports students to identify their strengths and weaknesses, revise their work, and continuously refine their understanding by reviewing feedback, which supports them towards engaged and self-regulated learning. It is evident that formative feedback can foster student engagement, improved achievement and enhance motivation to learn (Crisp & Ward, 2008). In reviewing the literature about formative assessment and its pedagogical implications in higher education, Koh (2008) identified deep learning, motivation and self-esteem, self-regulated and transferable learning as main benefits of formative feedback. Koh's review included studies in both online and f2f settings.

Effectiveness of feedback in relation to achieving interactive, adequate and timely formative feedback in online settings has a number of distinct characteristics as compared to f2f settings. Based on the findings of Sorensen and Takle (2005), and Vonderwell et al. (2007), embedding of formative assessment within online courses fostered a sense of an interactive and collaborative online learning communities, which provided learners with diverse opportunities for dynamic and meaningful interactions with other participants (particularly the teacher and peers). This in turn, enhanced opportunities for ongoing and interactive formative feedback. The Vonderwell et al.'s study was based on collaborative learning as a strategy for facilitating online learning, and its formative peer and self assessment. The Vonderwell et al.'s findings also indicated that online environments provided enhanced opportunities for students to respond or question the views of their peers, hence formative peer feedback. According to Vonderwell et al., one way in which online environments enable such opportunities is through asynchronous threaded discussions, which allow students to have adequate time to compose and reflect on their thoughts about their understanding of content and/or views before they share their thinking with other online participants. In illustrating this, Vonderwell et al. (2007) noted that:

Asynchronous discussions allowed students to rethink and assess their own understanding of content before they posted their responses...[this] facilitated reflective and self-assessment processes...gave the students enough time to share a composed thought or question... and be able to reword messages before posting them online. Time for reflection and being able to revisit the discussion messages posted allowed the students to assess their own contribution. (p. 319)

Consistent with Vonderwell et al. (2007), Van der Pol et al. (2008) in a study within online environments associated effectiveness of online formative feedback with opportunities for meaningful interactions. Their findings indicate that the level and quality of interactivity among online participants influence the effectiveness and efficiency of formative feedback. We argue that dynamic social relations between the student and the teacher are essential to provide effective feedback because it enhances motivation and satisfaction, which may encourage student's active engagement. Van der Pol et al. showed that online learning environments can allow more interactivity and can surpass interactions in f2f environments and provide enhanced opportunities for providing and reviewing peer feedback. Wolsey (2008) went further to illustrate how effectiveness of feedback can be enhanced in online settings through use of computer applications/software that offer opportunities to provide more detailed and clearly written feedback that is integrated within student work. These are critical aspects in online settings in relation to enhancing adequate and meaningful dialog between the teacher and the learner.

However, [Wolsey \(2008\)](#) and [Oosterhof et al. \(2008, pp. 76–77\)](#) cautioned that, although integration of formative assessment in online environments can potentially offer enhanced interactivity, the design of these environments is critical because formative assessment requires additional design considerations from the outset in order to provide facilities that can foster its effective integration. Therefore, a better understanding of online formative assessment offers a means to enhance the design of online courses and expand opportunities for dynamic interactions and informal assessments. This is operationalized through systematic utilization of a variety of online tools such as online discussions, group interactions, emails and online chats to overcome limited opportunities for informal observations and questions in online contexts that are typically available in f2f environments, where teachers often assess understanding informally by interpreting students' body language and using oral questions to probe learners' understanding.

For online discussions to be formatively useful, the teacher needs to structure them in a way that they offer alternative forums/topics in order to enhance participation and foster learner autonomy ([Vonderwell et al., 2007](#)). Documentation (archiving) of learning and assessment processes and products (reified artefacts) afforded in online settings also gives learners an opportunity to revisit their own and others' previous contributions as they compose responses and new ideas. These enable learners to progressively enhance their understanding of content and build knowledge collaboratively. It also fosters reflective dialog, peer and self assessment among learners.

[Chung et al. \(2006\)](#) also illustrated how online formative feedback provided opportunities for scaffolding learning towards higher levels of achievement. Learner's achievements were assessed based on pre-defined learning goals, and feedback was offered by knowledgeable others in relation to the identified learning needs with the aim to enhance learner understanding. According to the [Chung et al.'s](#) findings, tailored feedback can promote the disposition of self-regulated learning and encourage the learners to reflect upon their work in the effort to develop further understanding. This is an important factor in higher education and particularly for 21st century learners, who need to develop the disposition of lifelong self-improvement in order to meet their changing professional needs. [Wolsey \(2008\)](#) also demonstrated feedback as an essential feature of scaffolding learning by supporting learners to adjust their subsequent learning to close their performance gaps. We suggest that online and blended settings offer the teacher more ongoing opportunities to monitor and identify patterns of students' areas of weaknesses and provide feedback as concurrent scaffolded interventions (by being visible to all) that can meet the identified needs. Through ongoing monitoring of evidence of learning, the teacher can observe and identify patterns in students' progress and achievements, interpret them, and make inferences about students' progress, which in turn informs the appropriate formative feedback to serve common needs. This could be of benefit in providing adequate formative feedback often constrained by time availability, which is pertinent in online settings. However, this should never replace the need for individualized feedback where necessary. [Martens and Hermans \(2000\)](#) in a study within online contexts demonstrated that identifying learner knowledge, skills and experiences can be beneficial to providing adequate feedback. This is because the online environment enables the teacher to allocate appropriate time for tailored feedback to individual learners based on identified needs. Thus, online settings can be designed so as to enhance opportunities for formative feedback and ongoing learner support. Such opportunities can facilitate learning processes that enhance learner engagement.

4.2.2. Engagement with critical learning processes

Another theme emerging from the analysis of the key articles is that online formative assessment can engage learners in meaningful learning experiences through the creation of learning environments that support active engagement of learners. Engagement is instrumental to meaningful learning. According to [Garrison and Akyol \(2009\)](#) engaged learning provides the learners with opportunities to be active, creative and critical as well as being creators of their own perspective and identity, thus promoting their learning experiences. [Herrington, Oliver and Reeves' \(2003\)](#) review of studies within online contexts examined how authentic learning environments can influence learner engagement. They defined engagement as "what happens when we are able to give ourselves over to a representational action, comfortably and unambiguously" (p. 5).

[Oosterhof et al. \(2008, pp. 204–205\)](#) noted that interaction and engagement are at opposite ends of a continuum in which interaction involves the exchange of ideas and information among participants. When such exchanges continue and participants become intrinsically motivated to deepen the interactions accompanied by in-depth thoughts and critical analysis, the learner moves up the continuum and becomes engaged with the learning process. [Garrison and Akyol \(2009\)](#) further supported this observation by suggesting that engaged learning occurs when learners move beyond simple interactions to purposeful and meaningful discourse essential to construct and validate meaning. Confirming this are findings by various researchers (e.g. [Angus & Watson, 2009](#); [Chung et al., 2006](#); [Feldman & Capobianco, 2008](#); [Lin, 2008](#); [Wang et al., 2008](#)) within blended learning environments which illustrated enhanced engagement resulting from meaningful interactions with content, others and/or self afforded by online formative assessment.

Similarly, [LeBaron and Bennett \(2009\)](#) articulate how innovative instructional technologies can support self and peer assessment in online learning environments through three forms of interactions (learner-content/activities, learner-others and learner-self). Through these interactions, online formative assessment not only enhances engagement but also provides opportunities for shared understanding of learning goals and expected outcomes. We now examine how various studies exemplified these three forms of interactions in order to articulate how these relate to formative assessment within online settings and in which ways it enhances learner engagement.

Meaningful interactions with content occur when online formative assessment is within an authentic context that provides students opportunities with diverse challenging and engaging activities and materials and/or tools that are relevant to real-life situations. Such contextual opportunities may entail a variety of authentic learning and assessment tasks/projects that require learners to use online tools that support collaborative inquiry, computer-based simulation tools (avatars), tools for finding and presenting knowledge, and/or rich databases for information and exemplar scenarios. Various authors have provided case studies of authentic contexts that motivated, and broadened the learner's autonomy and involvement leading to prolonged engagement and meaningful learning experiences that enhanced learner ability to transfer knowledge to new contexts (e.g. [Correia & Davis, 2008](#); [Crisp & Ward, 2008](#); [Herrington et al., 2006](#); [Lin, 2008](#); [Mackey, 2009](#)). [Crisp and Ward \(2008\)](#) examined the role of online formative assessment in promoting deep learning and student motivation. Their findings demonstrate how scenario-based learning as a means of facilitating authentic learning context can enhance deep, collaborative, reflective and self-regulated learning. [Herrington et al. \(2006\)](#) examined how learner engagement could be enhanced through authentic learning environments to support meaningful interactions among learner, tasks and technological resources. They demonstrated that authentic tasks can promote deep understanding, enhance the learner's ability to transfer knowledge to real-life contexts and motivate them to become lifelong learners. [Lin \(2008\)](#) and [Wang \(2009\)](#) demonstrated how students' engagement with the process-oriented

e-portfolios created an authentic learning context that supported collaborative learning and assessment. The processes included developing, documenting, sharing and reflecting on learning processes and products. The e-portfolio processes provided opportunities for collaboration to achieve shared understandings of expected performances, ongoing documentation and monitoring of learning processes and products. In this way, they offered an authentic way of developing and assessing student knowledge. Subsequently, this enabled students to own and value their learning.

Mackey (2009); Mackey and Evans (2011) also demonstrated how authentic contexts can be created by engaging learners with learning and assessment activities that require and motivate them to interact with varying contexts that blend online learning with their own professional settings. The studies focused on professional development for teachers in ICT-related skills and were framed within the theoretical perspective of communities of practice (Wenger, 1998) as a way of enhancing transfer of learning into the student's practice. Through embedding authentic assessment activities within learning processes, Mackey (2009) demonstrated a form of engagement that crossed online boundaries to provide learners with opportunities to blend online learning and work contexts within their professional communities of practice in their workplaces (schools). As Mackey illustrated, this approach created an authentic learning environment that sustained engagement and autonomy of the learner beyond accomplishment of assessment requirements to self-learning and regulation, which, in turn, motivated them to integrate ICT in their professional practice. Mackey findings also provide evidence that this form of engagement transformed learners' identities as leaders and knowledgeable others who influenced other members of their communities of practice. These studies confirm that online formative assessment can foster learner engagement with critical learning processes that enable opportunities for active, contextualized, collaborative and reflective learning. As well, it provides room for dynamic interactions, and shared understanding of learning goals and expected outcomes. These, in turn, foster valuable learning experiences including active, contextual, collaborative, interactive, reflective, multiple perspectives orientation, and self regulated aspects of learning. Hakkarainen, Saarelainen, and Ruokamo (2007) identified these experiences as instrumental to meaningful teaching and learning.

Mackey (2009) also demonstrated that authentic online environments can provide teachers in a professional development programme with a variety of resources, particularly web 2.0 tools, to creatively try out and rediscover new ways/possibilities on how these learners could integrate ICT in their own practice. The diverse and interactive nature of these online tools supported learners to build confidence, demonstrate their capability in various ways and share it with other members of the online and f2f communities. Through these opportunities, learners were motivated to identify their learning needs, strengths, to network and collaborate with like-minded others. This supported progressive development of skills that were relevant and transferable to varying contexts, thus enhancing authenticity (Mackey & Evans 2011). Within these networks, learners also interacted with peers or colleagues who had varying views that challenged their thinking prompting them to reflect on alternative possibilities. In these ways, online formative assessment supported the growth of community online and enhanced learning also blended with the community of practice in the students' own school.

Chung et al. (2006) also adopted a problem-based learning approach within blended learning with an interactive online discussion as a strategy for online formative assessment that enhanced learners engagement both cognitively (through opportunities for feedback, ongoing monitoring and assessment, scaffolding learning, enhanced interactions) and affectively (other non-cognitive outcomes such as increased motivation and positive feelings).

Online formative assessment fosters interaction with others by providing opportunities for learners to interact meaningfully with other online participants, particularly their teacher and peers. This creates engaging learning environments, which enable learners to develop, share and compare understandings and experiences through asynchronous collaboration. These in turn, foster critical thinking, deep understanding and make the learning process self-scaffolding. Vonderwell et al. (2007) demonstrated how use of asynchronous online discussion as a strategy for self and peer formative assessment. This promoted reflective inquiry through enabling opportunities for dynamic and meaningful interactions, multiple perspectives, collaborative learning, shared understanding of learning goals and expected outcomes, and process-oriented and ongoing assessment. Vonderwell et al. also aimed to create learner and assessment centered learning through seamlessly integrating assessment into teaching and learning processes as well as enabling opportunities for shared responsibility where a teacher collaborates with the learner in negotiating meaning and applying rubrics.

Sorensen (2005) study within an online context and framed within collaborative learning communities demonstrated engagement as a mutual process among all the online participants (teacher and learners). Sorensen focused on professional development for teachers in ICT-related skills. She illustrated the need to go beyond individual involvement to incorporate mutual ability to develop and negotiate meaning with others within a social context. Consistent with Wolsey (2008) and Vonderwell et al. (2007) as noted earlier, Sorensen also demonstrated that online environments can provide dynamic opportunities for social interactions among learners and teachers as learners share their work, views and experiences. These forms of interactions provide opportunities for ongoing monitoring and assessment as learners engage in various learning and assessment activities. It also provides expanded opportunities to identify learners' needs and provide ongoing support, hence formative assessment. According to Sorensen, mutual engagement within social contexts resonates with culture of real professional practices, thus enhancing learners' ability to develop skills that are relevant and transferable to their real world situations.

Sorensen and Takle (2005) designed and facilitated collaborative interactions and reflective online dialog within threaded discussion forums where they and their meteorology students shared understanding of learning goals and content, self-reflections and ongoing assessment. Sorensen and Takle (2005) thus demonstrated a structure for learner and assessment centered design that was formatively evaluated by the educational technology students. For the two studied classes, the online structure provided "an open process in which knowledge resources enter dynamically from outside via the *participants* [students] as well as through the teacher" (Sorensen & Takle, 2005, p. 54). Their structure illustrates how the teacher and learners are knowledge resources through shared roles of facilitating collaborative learning and ongoing assessment. It also offers a way to facilitate collaborative assessment of both processes and products of learning within the design of an online course. Through these processes, student participation, motivation and ownership of learning were enhanced. This in turn, fostered engaged learning and deep understandings in relation to desirable learning outcomes. While Sorensen and Takle illustrated ways of engaging learners with processes that reflect relevant professional practices in meteorology and educational technology, they did not go further to illuminate the nature of learning and assessment activities that could facilitate these processes.

Pachler et al. (2010) also illustrated how shared roles can enhance formative processes. Pachler et al.'s study demonstrated convergence of theoretical perspectives and online formative assessment as a pedagogical practice. Their view of online formative assessment was

framed within moments of contingency theoretical perspectives and conversational theoretical framework as articulated in Pachler et al. (2010). In illustrating that both the teacher and students are key players in enabling of effective online formative assessment, Pachler et al. noted that,

Learner's response to a potential learning opportunity (provided for example, by teacher questioning, stimulus material, automated scoring of performance or peer comment) is part of their unique engagement in the learning process and is autobiographical. Responsiveness (on the part of the learner, teacher and/or peers) is key to contingency, and is necessary to 'moments', which have formative effects on learning (p. 716)... It is the learners and teachers as human actors who ultimately determine the formative effects of engaging with technologies, but technologies can shape the potential for this to happen. It is only when it is located in wider [shared] understandings of effective learning that the potentials of electronic tools to contribute to formative assessment can be understood and optimized. (p. 721)

As these authors demonstrated, through shared roles, authentic contexts were created to engage learners in collaborative and reflective discourse within an online learning community. Mackey (2009) also showed how blending students' professional work and online class contexts enabled opportunities for learners to engage with others during the learning process. Formative assessment by peers was evident in that learners engaged with peers who had varying or similar views (within online and real contexts) to reciprocate or question others' views that emerged during the learning process. These studies confirm that online formative assessment can provide learners with authentic, collaborative, and reflective learning environments to share learning experiences and dissonance of practice. These experiences emulate real professional communities of practice; thus, promoting learner ability to apply knowledge to their own practice.

Formative assessment enhances online environments by providing opportunities for interaction with self. This is afforded through expanded and flexible opportunities to document and annotate evidence of student growth and performance that allow ongoing monitoring of student progress and achievement by the teacher as well as the students themselves. As we identified earlier, this is evident through the findings of Mackey (2009), Mackey and Evans (2011), Sorensen and Takle (2005) and Vonderwell et al. (2007). Their findings demonstrate that learners were engaged with self as they reflected on their thinking in the process of accomplishing the learning and assessment activities, hence self assessment. These in turn, allow students to reflect on, assess, own and value their work and enable the teacher to reflect on students' needs. In addition, Lin (2008) reported that engagement with formative-oriented e-portfolio processes enabled students to reflect and assess their own and peers' work, which facilitated subsequent learning and enabled them to improve their work.

Another way that can enhance interactions with self in online settings is through online self-assessment quizzes. Smith (2007) case study found that students appreciated and benefited from immediate feedback from the self-test quizzes by enabling them to self-assess, reflect and revise their learning. These findings further revealed that students who frequently reviewed feedback performed better in summative assessment compared to those who did not or made limited reference to feedback. This implies that formative assessment may not benefit those students who do not fulfill their responsibility and sustain commitment. A limitation that Smith also acknowledges is that in his study, assessment of student learning was limited to quantitative measures and thus did not reveal all aspects of student learning. Consistent with Smith are the findings of Angus and Watson (2009) in a study with students at an Australian University in blended learning environments that showed how online self-assessment quizzes provided students with immediate feedback which enabled them to improve their performance in summative assessment. Their study was not framed within a broader theoretical framework and was based on quantitative conceptualization in that the impact of formative assessment was measured only against students' improvements of grades in summative assessment. Dopper and Sjoer (2004) reported similar findings in their study with engineering students in blended environments. The study utilized self-test quizzes as a strategy for self assessment and their findings revealed that this provided opportunities for self monitoring, revision and scaffolding learning. However, the study was limited to within one class. Based on these studies, it appears that self-assessment and reflections can enhance learner understanding of learning goals and expected outcomes, which, in turn, support students towards self-regulated learning.

It is apparent that through enhanced formative feedback and learner engagement, online formative assessment can serve other functions that are beneficial in higher education whether in online or f2f settings. As detailed in the next section, a key function is online formative assessment as a means to foster equitable education.

4.2.3. Promoting equitable education

Online formative assessment can foster equitable education by providing diverse learning opportunities to students with a variety of individual needs. In our view, it facilitates responsive teaching and assessment that accommodate varying learning capabilities and styles, and supports progressive learning and development. This personalization is likely to increase equity for those who are able to study online. As identified in Jenkins (2005) review, effective online formative assessment focuses on what student know and are capable of achieving with tailored intervention guided by the learning goals rather than dwelling on the student weaknesses. Formative assessment places emphasis on empowering individual learners and promoting the worthwhile view that all learners are potential experts by providing learners with opportunities to demonstrate their expertise within a supportive learning community as they share their views, question and/or respond to others' views (teacher and peers) for purposes of shared understanding (Sorensen, 2005; Sorensen & Takle, 2005). Sorensen and Takle's findings are consistent with Vonderwell et al. (2007). These studies were based on a collaborative learning approach to facilitate online peer and self assessment. As noted earlier, Vonderwell et al. showed that online formative assessment can improve equitable education through diverse assessment activities that provide alternative means and multiple indicators for learners to demonstrate their capabilities. Lin (2008) within blended settings, also demonstrated that collaborative learning and formative assessment supported students to assess their own progress and achievements, and make decisions about where they need to improve to close their performance gaps thus fostering equity in education.

4.2.4. Summary of the functionality of online formative assessment

It is increasingly evident that through online formative assessment a learner and assessment-centered focus can be created where learners are actively engaged in the learning process. Online settings provide a dynamic environment where teacher and learners can collaborate to achieve shared meaning of learning goals, content and expected outcomes, and monitor progress towards their achievement. Through

opportunities for ongoing monitoring, learner strengths and weaknesses can be identified and formative feedback provided by both the teacher and peers to support individual learners to close their performance gaps. Formative feedback supports learners to interact meaningfully with learning activities/resources, knowledgeable others (teacher and peers) and self. These forms of interactions overlap to facilitate critical learning experiences such as active inquiry, contextual, collaborative, reflective and self-regulated aspects of meaningful learning. By implication, such opportunities for responsive instructions can cater for diverse learning needs thus fostering equitable education.

As previously noted, a number of authors (e.g. Van der Pol et al., 2008; Wolsey, 2008) have demonstrated that online settings can offer interactivity that may surpass interactions in f2f environments particularly in relation to opportunities for providing and reviewing feedback. They offer more opportunities for teacher and learners to share the role of providing feedback on peers' work. These in turn, enhance the level and quality of interactivity among online participants and positively influence the effectiveness and efficiency of formative feedback. Effective use of feedback supports individual learners to close performance gaps. Wolsey (2008) went further to illustrate that online settings can offer enhanced opportunities to provide more detailed and clearly written feedback that is integrated within student work. These are critical aspects in online settings in relation to enhancing meaningful dialog between the teacher and the learner. However, as Wolsey (2008) cautioned, in order to realize these benefits, the design of an online course is critical and requires careful design considerations from the outset in order to facilitate opportunities for effective formative assessment.

Other authors (Mackey, 2009; Sorensen & Takle, 2005; Vonderwell et al., 2007) demonstrated that meaningful learning and formative assessment activities can engage learners in collaborative, interactive and reflective discourse within a learning community that resonates with professional practices. This is likely to foster transferable learning and support learners to develop self-regulated learning strategies, which is an important disposition in online settings. It also appears that online formative assessment can contribute to improved performance in summative assessment if learners constantly review feedback to further their understanding. Inevitably, convergence of formative assessment and online affordances provide scalability and great flexibility when learning resources, processes and products can be shared concurrently among online participants.

The benefits of online formative assessment discussed here are facilitated through a variety of approaches that emerge from the reviewed literature including self, peer and e-portfolio assessment. Each of these techniques utilizes a variety of online tools such as asynchronous discussion forums, self-test quiz tools, and e-portfolios. It is important to note that these techniques overlap and can be intertwined and applied synergistically. Online formative assessment through these techniques can facilitate a multidimensional perspective to assessment for learning. The effectiveness of these techniques depends on innovative and appropriate utilization in order to make online formative assessment an effective pedagogical strategy. However, it is beyond the scope of this paper to explore these techniques in details.

While online formative assessment has the potential to afford these opportunities, it appears that it cannot produce desired effect without addressing issues associated with assessment. Indeed, as articulated in the previous section, it appears that there is need to reconceptualise fundamental issues of assessment within the context of online formative assessment. In the next section, we offer a discussion of the findings.

5. Discussion

Our findings suggest that online formative assessment can provide a means to align assessment with teaching and learning, and inevitably change how learning and assessment occur. In our opinion, such pedagogical enactments can potentially shrink the gap between learning to know and do, and assessing learning to meet formative and summative assessment purposes. It also follows that this would blur the gap between formative and summative assessment, and assist in achieving the desirable harmony among curriculum, pedagogy and assessment. Embedded assessment is centered within the concept of ongoing monitoring of learning and formative feedback, hence formative assessment. The findings of various studies (e.g. Crisp & Ward, 2008; Gijbels et al., 2005; Sorensen & Takle, 2005; Van der Pol et al., 2008; Vonderwell et al., 2007; Wang et al., 2008) indicate that effective use of online formative assessment can engage students and teachers in meaningful educational experiences as it provides them with opportunities to collaboratively identify the learning needs and devising strategies of how to meet those needs. This is through offering expanded opportunities to document, monitor and assess students' progress and achievements, which informs the desired formative feedback. In these ways, online formative assessment can play a crucial role in enhancing learning by creating improved learning environments that motivate students to actively engage and regulate their studies (Chung et al., 2006; Koh, 2008; Pachler et al., 2010; Wang et al., 2008).

Formative assessment makes extensive use of formative feedback, so we are pleased to note that the findings of this systematic literature review of online formative assessment fit well with Hattie and Timperly's (2007) meta-analysis and model. Within the summary of effect sizes calculated as a second order meta-analysis, they identified an effect size of 0.52 for, not online instruction, but "computer-assisted instructional feedback" in general (drawn from four meta-analyses). They also note:

A more detailed synthesis of 74 meta-analyses in Hattie's (1999) database that included some information about feedback (across more than 7000 studies and 13,370 effect sizes, including those in Table A.1) demonstrated that the most effective forms of feedback provide cues or reinforcement to learners; are in the form of video-, audio-, or computer-assisted instructional feedback; and/or relate to goals. Programmed instruction, praise, punishment, and extrinsic rewards were the least effective for enhancing achievement (Table B.1). Indeed, it is doubtful whether rewards should be thought of as feedback at all. (p. 82)

Although Hattie and Timperly did not refer at all to online learning and much of their research is drawn from studies of K-12 education, the model they produced can be useful to discuss the evidence found in this systematic literature review of online formative assessment. A paragraph in their conclusion provides a useful summary for our purposes:

The model discriminates between four levels of feedback: the task, the processing, the regulatory, and the self levels. Effective feedback at the task, process, and self-regulatory levels is interrelated. FT [feedback at the task] is more powerful when it results from faulty interpretations, not a lack of understanding. It is most effective when it aids in building cues and information regarding erroneous hypothesis and ideas and then leads to the development of more effective and efficient strategies for processing and understanding the material. Feedback at the process level is most beneficial when it helps students reject erroneous hypotheses and provides cues to

directions for searching and strategizing. Such cues sensitize students to the competence or strategy information in a task or situation. Ideally, it moves from the task to the processes or understandings necessary to learn the task to regulation about continuing beyond the task to more challenging tasks and goals. This process results in higher confidence and greater investment of effort. This flow typically occurs as students gain greater fluency and mastery. Feedback that attends to self regulation is powerful to the degree that it leads to further engagement with or investing further effort into the task, to enhanced self-efficacy, and to attributions that the feedback is deserved and earned. When feedback draws attention to the regulatory processes needed to engage with a task, learners' beliefs about the importance of effort and their conceptions of learning can be important moderators in the learning process. (p. 102)

Noteworthy in this quote from [Hattie and Timperly \(2007\)](#), is that effective formative feedback focuses on both products and processes of learning and assessment, and facilitates self regulatory processes among the students. Self regulated learning refers to “an active constructive process whereby learners set goals for their learning and monitor, regulate and control their cognition, motivation, and behavior, guided by their goals and the contextual features of the environment” ([Pintrich & Zusho, 2002](#), in [Nicol & Macfarlane, 2006](#), p. 202). Self regulation creates a learner and assessment centered focus where the teacher becomes a facilitator as opposed to an expert, and learners assume a more active role. This can foster shared purpose and responsibilities among learners and the teacher in ongoing monitoring, assessment and provision of feedback to their peers. These are critical requirements particularly in online learning environments where learners are expected to assume primary responsibility for their learning. [Nicol and Macfarlane \(2006\)](#) through their synthesis of research literature within the context of higher education developed a model of effective formative feedback underpinned within the concept of self-regulated learning. Within their model, they explicitly identified seven characteristics (principles) of effective formative feedback.

We affirm that the seven principles of [Nicol and Macfarlane \(2006\)](#) feedback model are an essential condition for effective formative feedback (as the most critical element within online formative assessment processes) that sustainably supports adequate scaffolding and the development of self regulation dispositions among online learners. As these authors identified effective formative feedback:

1. helps clarify what good performance is (goals, criteria, expected standards);
2. facilitates the development of self-assessment (reflection) in learning;
3. delivers high quality information to students about their learning;
4. encourages teacher and peer dialog around learning;
5. encourages positive motivational beliefs and self-esteem;
6. provides opportunities to close the gap between current and desired performance;
7. provides information to teachers that can be used to help shape teaching. ([Nicol & Macfarlane, 2006](#), p. 205)

Effective formative assessment also entails embedding a variety of ongoing and authentic assessment activities within online teaching and learning processes to facilitate active cognitive engagement and offer enhanced opportunities for ongoing assessment of learning and provision of ongoing formative feedback. As identified through our findings, engagement with ongoing and authentic assessment activities requires and/or stimulates learners to interact with others, particularly the teacher and peers. In order to successfully accomplish the assessment activities, learners are stimulated to engage meaningfully with others as they asynchronously share and validate their understanding of content and the expected outcomes. Moreover, authenticity inherent within the formative assessment activities can require learners to interact with others within and/or beyond the online classroom. Through the assessment activities being ongoing and authentic to facilitate meaningful interactions, it also implies that these interactions organically become dynamic ongoing processes thus facilitating development of an interactive online learning community that reciprocally support individual learners to enhance their understanding of content and improve their achievement of the expected learning outcomes through ongoing and interactive formative feedback. Moreover, a variety of ongoing assessment activities offers multiple sources of evidence of learning and ultimately provides learners with diverse opportunities to demonstrate their capabilities and illuminate their learning needs. For instance, learners may be required and/or stimulated to engage with others within collaborative online discourse as exemplified by [Sorensen and Takle \(2005\)](#) and [Vonderwell et al. \(2007\)](#). In these studies, authenticity was facilitated through collaborative interactions and reflective online dialog using asynchronous discussion forums as a tool for supporting ongoing formative assessment by self, peers and teacher. Based on the findings of these studies, framing formative assessment processes within threaded asynchronous discussions provided a unique opportunity to enhance the online discourse and achieve meaningful engagement in two ways: firstly, it facilitated opportunities for internal feedback (reflection or interaction with self) through providing the students with ample opportunities to review the feedback they receive (responses from others) and revisit related previous exchanges. Secondly, it provided learners with adequate opportunities to review and reflect upon previous contributions (by self or others), and this assisted them to reconstruct their thinking and compose deeply-thought ideas which they posted online as their new contributions and/or responses (feedback) to others' ideas. Moreover, as demonstrated by [Mackey \(2009\)](#), authentic formative assessment activities motivated learners to interact with varying contexts (online and f2f), and with others (within and beyond online contexts) as they accomplished activities that required them to interact with real-life professional contexts. [Lin \(2008\)](#) and [Wang \(2009\)](#) demonstrated how students' engagement with process-oriented e-portfolios created an authentic learning context that supported collaborative learning and assessment. These process-oriented e-portfolios were framed within collaborative learning approaches which entailed individual students developing and progressively documenting their reified artefacts while also sharing with the teacher and peers (by being public to others), as well as reflecting on their learning processes and products. Within these formative assessment processes, individual learner also have opportunities to share their developing thinking and progress in relation to accomplishing the assessment activities which elicits the necessary learning support, which they receive as formative feedback from the teacher and peers. Through such valuable learning experiences, online formative assessment supports engaged and deep learning.

In order to facilitate such effectiveness for formative assessment within online contexts as discussed here, it will require also the course teacher to ensure opportunities for ongoing documentation of learners' progress and achievement as evidence of learning and sharing of this evidence by being visible (public) to all participants. To achieve effective collaboration within these formative processes, it will also require fostering shared responsibility among all the course participants (the individual, peers and the teacher) as an online learning community with shared goals. In the same vein, it will require explicit clarity of learning goals and shared meaning of expected outcomes (rubrics) from the

outset. In these ways, online formative assessment can offer a systematic strategy for facilitating meaningful interactions and development of a collaborative online learning community and in turn enhance opportunities for adequate learner support and scaffolding learning through ongoing monitoring and provision of formative feedback. This can ultimately support meaningful engagement and higher-order learning. Through these elements, effective online formative assessment will inevitably help in addressing important issues within online learning contexts in relation to achieving and sustaining meaningful interactions and adequate scaffolding in order to address the challenges of learners' frustrations due to the physical interaction barriers (as compared to f2f settings), and lack of the required self-regulated learning dispositions. Ludwig-Hardman and Dunclap's (2003) study have explicitly identified these challenges as critical in online learning.

As it has emerged through the findings, online formative assessment is facilitated through various techniques or strategies such as self and peer formative assessment, as well as teacher engagement with formative assessment. Findings of this review suggest that these techniques are operationalized through systematic utilization of a variety of online tools such as asynchronous discussion tools, self-test quiz tools either as stand-alone web-based tools or as features within web-based learning management systems (LMS). Web-based e-portfolios have also been used as a tool for online formative assessment. Framing use of such online tools within the concept of formative assessment will offer a systematic strategy for enhancing opportunities meaningful interactions within supportive learning communities and inevitably create more opportunities for interactions and ongoing learning support in online settings that are typically limited as compared to f2f settings. In f2f settings learners have more opportunities to interact with peers and the teacher as well, thus creating more opportunities for the teacher to informally assess learners' understandings.

This notwithstanding, these enactments which are core to online pedagogy will essentially depend on teachers' beliefs. Leading scholars (Shepard, 2000; Gipps, 1999) in assessment of formal learning have long argued that teacher beliefs greatly influence their conceptions about what is valued as learning, and by implication, how learning is assessed. In their review of research, Larreamendy-Joerns and Leinhardt (2006) reinforced these ideas within the context of online learning and observed that online courses require:

Professors to render explicit account of pedagogical moves and assumptions that pass unnoticed in day-to-day teaching practice but are worth re-enacting in online environments. These pedagogical elements include, among other things, the faculty members' conception of the discipline and the learner; the varieties of student–teacher interactions that they believe are conducive to learning, their use of disciplinary and pedagogical representations, and their take on student assessment. (p. 597)

Therefore, effective application of formative assessment requires most educators to reconsider what is valued and commit to use assessment in diverse ways to effectively gather information about students' understanding and enable them to continually reflect on their own needs as well as those of their students. This is part of self regulation processes referred to by Hattie and Timperly (2007), albeit more appropriate in higher education contexts. Given the need to reconsider and develop more mature pedagogical strategies, it becomes less surprising that the reviewed empirical studies drew extensively on teacher education and many at the graduate level.

A study by Niles (2007) contrasted the espoused beliefs and practice of two engineering educators teaching online, only one of whom had been prepared professionally to teach. There was a large gap between espoused beliefs and practices of the less prepared teacher and this suggests that many faculty in higher education may need extensive professional development and support to make effective use of formative assessment in online and blended learning in higher education. Few of the studies reviewed included much detail on support for faculty and related professional development, and this aspect is therefore beyond the remit of this literature review. However, we note this as a limitation and return to it in our recommendations for future research in the next section.

6. Conclusions and recommendations for practice and future research

This review of the literature provides a range of evidence of the value and practice of formative assessment in online higher education, including blended learning. Among other reviewed articles, the 18 key empirical studies include more than 16 with case studies of a wide range of teaching and learning strategies from which educators can learn and be inspired to develop their practice. Given the prevalence of distance learning and common expectations on an e-campus to complement the traditional facilities of a university (Larreamendy-Joerns & Leinhardt, 2006) and the evidence of its effect (US Department of Education, 2009), it is important that faculty and those who lead and support them with educational technology have models to draw upon. This review indicates that formative assessment is an important strategy that needs further research and more widespread implementation in ways that increase self regulation by learners. However, the paucity of studies and the fact that most were found in teacher education also indicates that such inquiry is likely to require improved professional development for faculty in other disciplines.

This review provides evidence that online formative assessment has a potential to engage both teachers and learners in meaningful educational experiences. It offers a pedagogical strategy that forms a foundation for shifting the assessment culture in ways that support diverse learning needs and foster equitable education. In particular, it offers online learners opportunities for enhanced interactivity and formative feedback, which in turn, engage them with valuable learning experiences including active, contextual, interactive, collaborative, multidimensional, reflective and self regulated aspects of meaningful learning. In these ways, online formative assessment can support higher education to meet the needs of the 21st century learners.

In order to realize this potential, various aspects of validity and reliability that emerged as pertinent have been raised and discussed through this review. Of particular importance among these aspects is ensuring: a variety of ongoing and authentic assessment activities, appropriate learner autonomy, effective formative feedback and teacher's role in fostering shared purpose and understanding of learning goals, content and expected outcomes. Ongoing and authentic assessment activities and appropriate learner autonomy coupled with adequate teacher's guidance play an important role in facilitating and sustaining multifaceted interactivity with content, tools, others (within and beyond the online classroom) and with interaction with self (reflectivity). This in turn, can foster meaningful engagement and development of self regulatory dispositions. Effective formative feedback is critical to the effectiveness of online formative assessment particularly in relation to aspects of immediacy, adequacy and interactivity. In order to foster deep learning particularly in online settings, formative feedback should not to be an end in itself but an iterative and dialogic process that promote reflective thinking and self regulatory strategies among the students. The adequacy and interactivity of feedback can be enhanced by the uniqueness of online settings (as compared to f2f settings) in relation to offering opportunities for revisiting previous contributions by self and/or others within the online discourse. This can

enhance formative feedback processes in important ways: it facilitates opportunities for internal feedback (reflection or interaction with self) because it provides students with ample opportunities to review the feedback they receive (responses from others) and revisit other related previous exchanges. In the same vein, the students have ample time to review and reflection upon previous contributions before they compose their responses as feedback to others. As identified within this review, such opportunities can be suitably enhanced by enabling ongoing documentation and sharing of processes and products of learning and assessment within online courses. Such opportunities also facilitate shared role in formative assessment where individual, peers and the teacher assume an active role in assessment for learning. This implies ongoing assessment by self, peer and teacher as formative assessment strategies. In online settings, these strategies can be suitably supported by web-based tools such as asynchronous discussion tools and LMS with discussion forums features. Web-based e-portfolios framed within collaborative learning approaches can also be useful tools for online formative assessment. Effective online formative assessment also requires the teacher to play a key role in fostering shared understanding of purpose and expected learning outcomes.

Further empirical research about online formative assessment will require a systematic and rigorous approach in order to achieve useful findings that can inform effective practices. One way forward would be to conduct the research within real-world contexts that focuses on in-depth investigation into the design and embedding of formative assessment within online courses grounded within congruent theoretical perspectives, making those perspectives explicit along with the teacher's beliefs as well as uncovering important professional development and organizational characteristics and factors. Such a systematic approach may offer an effective framework for how to achieve a pedagogical design that operationalizes validity and reliability, identified as problematic in this review. Other topics identified by the authors include research of the selection and complementary use of online tools including LMS with self-test quiz and online discussion tools, and electronic portfolios. Although the key studies reviewed included these tools, it would be timely and useful to have better information on effective strategies. In particular, it would be useful to conduct further research in varying contexts in order to provide further understandings about which tools support the optimum level of meaningful interactions and other valuable experiences for online learners within various disciplines and particular subject areas. It would also be useful that further studies exemplify which tools would best fit students with varying characteristics or at different academic levels such as students at both undergraduate and postgraduate levels. It is also important for further research to examine the best configuration for these tools for them to effectively facilitate the desirable formative processes. For instance, to exemplify the effects of enabling certain capabilities such as publicity (visibility) features within these online tools on learners' experiences in varying online learning contexts. This would help to provide insights such as the extent to which visibility of learning and assessment processes and products foster shared purpose and collaborations within formative processes. Moreover, it is paramount for further research to determine the best levels of learners' involvement and autonomy in determining these configurations, which would help to contribute towards understanding how to foster shared responsibility among the teacher and learners. In addition, almost all of the studies researched at course rather than at programme or institutional level. This is interesting because research into electronic portfolios has shown that the goals and purposes of a course and a programme can conflict and reduce the effectiveness of formative assessment (Hassall, 2007; Strudler & Wetzel, 2008).

Through this review, implications for practice are clearly emerging. In particular, online educators need to recognize and emphasize the value of embedding assessment within learning processes and the value of assessing products as well as processes of learning. There is also need to foster shared understanding among students about what is valued in assessment and their roles within this process in order to achieve desirable educational outcomes.

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Appendix A

Table A.1

A sample of two papers to illustrate criteria applied in analyzing the literature.

Author	Year	Mode of study	Discipline/Subject	Purpose/central focus
Pachler et al.	2010	Blended	Multidisciplinary: Teacher education, Social sciences, Veterinary training	To explore how the current theoretical perspectives and pedagogical practices relate to formative e-assessment : Aspects of practice that constitute formative e-assessment

Methodology: Design-pattern based methodology, qualitative approach; involved various practitioners' from 16 different education contexts within UK. Contexts included work based learning, distance education, further education, postgraduate and different undergraduate and postgraduate university programmes.

Theoretical framework: Moments of contingency (intervention) and Laurillard's conversational framework as a view of learning

Strengths: Research framed

within a theoretical framework; included different context thus enhancing generalizability

Weaknesses: Limited methods of data collection (practical inquiry days and interviews), data only reflects teachers' point of view who presents their observations, experiences and perceptions as narratives; student learning experiences and outcomes, and perceptions are not presented; does not address the differences arising from the variety of contexts.

Summary of major findings

- Teachers, individual learners and peers are key components in formative assessments and need to be actively engaged with learning processes
- Integrating formative e-assessment into teaching and learning itself does not lead to effective formative assessment, rather, effectiveness is determined by learners and teacher actions and responses
- However, the nature of technological resources may influence effectiveness of formative assessments depending on how the tools are designed and actually used
- Aspects such as opportunities for monitoring learner progress, formatively useful and timely feedback, meaningful (e.g. case-based) activities, reflective practice, shared responsibility, dispositions towards self directed learning, self scaffolding interventions (non pre-specified sequence of instruction), mentoring and clarity of learning goals which are key opportunities of formative assessment that can be enhanced by technological resources, hence formative e-assessment can afford these opportunities

Table A.1 (continued)

Author	Year	Mode of study	Discipline/Subject	Purpose/central focus
Gaytan and McEwen	2007	Online	Multi-disciplinary: Teacher, Business, Technology, Arts and Science education	To enhance understanding of effective instructional and assessment strategies in online learning environment

Methodological approach: Survey design
Strengths: Large numbers of participants were studied (participants included 85 faculty and 1963 students in online courses at two Universities. Both teacher and students' experiences and views are presented)
Weaknesses: No theoretical framework presented but some perspectives of authentic learning are emerging; did not employ interviews as a data collection tool. This is a key tool in descriptive research method, which could have helped to dig deeper understanding of data obtained from survey.
Summary of major findings

- Formatively useful, immediate and continuous feedback is a critical component of formative assessment in online learning that helps to enhance student understanding of learning goals and content
- Monitoring and assessing student progress need to be enabled to allow determination and provision of meaningful feedback
- Assessment activities need to be well planned and explicitly explained to enable the learners to easily understand what is required of them; "Assessments must be carefully and systematically planned to require students to demonstrate that learning has occurred by completing a specific piece of work at various stages in the course and be given meaningful feedback" (p. 126)
- There is need to use a variety of assessment tasks and/or techniques, "effective assessment techniques, as perceived by faculty and student respondents include projects, portfolios, self-assessments, peer evaluations, weekly assignments with immediate feedback, timed tests and quizzes, and asynchronous type of communication using the discussion board" (p. 127)
- Frequent, dynamic and meaningful interactions among online participants (teacher and learners) are essential in promoting active participation, strong learning community, collaborative learning, which are key aspects of formative assessment. "The value of e-mail messages, chat room conversations, and discussion board postings should not be ignored as they provide opportunities for the instructor to learn whether the students understand the instruction and are correctly interpreting the assessments" (p. 129)
- There is need to have shared understanding of expected processes and outcomes by providing very clear rubrics
- There is need to provide room for gathering student perceptions about what and how they are learning

Appendix B

Table B.1

Summary of the 18 key empirical studies included in this review.

	Author and Year	Mode of study	Discipline (Subject)	Purpose/central focus
1	Chung et al. (2006)	Blended	Electrical engineering (engineering courses)	The impact of online formative assessment (using interactive online discussion : discourse tool) on student learning, interaction, and engagement with the Content and its usefulness in relation to providing instructors with information about students' understanding
2	Crisp and Ward (2008)	Online	Teacher education	To provide a tool to improve understanding of pedagogical psychology and to explore the potential of more innovative techniques of computer-assisted assessment to motivate students and to assess deeper learning
3	Dopper and Sjoer (2004)	Blended	Engineering education	Effectiveness of online assessment system etude (applies item banking principle) as a formative self-assessment tool
4	Feldman and Capobianco (2008)	Blended	Teacher education (Physics)	Integration of technology enhanced formative assessment (FA) into teachers' practice: to understand if and how FA becomes an integral part of a teacher's practice
5	Gaytan and McEwen (2007)	Online	Multidiscipline: Teacher, Business, Technology, Arts and Science education	To understand instructional and assessment strategies that are most effective in online learning environments
6	Herrington et al. (2006)	Online	Multidiscipline: Teacher Education and Arts education	Creating authentic online learning contexts through synergies among learners, task and technology
7	Lin (2008)	Blended	Teacher education	To investigate and understand the teacher candidates' perception of learning experiences and processes that occurred in the collaborative development of e-portfolios
8	Mackey (2009)	Online	Teacher education	Impact of blending online and professional practice contexts in ICT professional development for teachers
9	Mackey and Evans (2011)	Online	Teacher education	Impact of networking across online and real contexts in ICT professional development for teachers
10	Pachler et al. (2010)	Online and Blended	Multi discipline: teacher education, social sciences, veterinary training, Geoscience education	To explore the current theoretical perspectives and pedagogical practices that relate to formative e-assessment: Aspects of practice that can be considered to constitute effective formative e-assessment
11	Smith (2007)	Blended	Geoscience education	To examine the relationships between formative assessments and exam grades in two course; in both face to face settings and using online quizzes
12	Sorensen (2005)	Online	Teacher education	Impact of networked and collaborative online learning in ICT education for in service teachers
13	Sorensen and Takle (2005)	Online	Multi discipline: Physical sciences and teacher education	Effective principles for collaborative online learning and its assessment
14	Van der Pol et al. (2008)	Blended	Health care and educational science	The link between the nature of students' feedback, the way it is evaluated by the receiver, and its consecutive use for the revision of students' products
15	Vonderwell et al. (2007)	Online	Teacher education	Asynchronous online discussion as a tool for self and peer formative assessment
16	Wang (2009)	Blended	Teacher education	To evaluate the effects of student collaboration on electronic portfolio construction
17	Wang, T-H et al. (2008)	Blended	Teacher education	To enhance pre service teacher assessment literacy using WATA (Web-based Assessment and Test Analysis) system as an assessment literacy development model
18	Wolsey, (2008)	Online	Multi discipline: Teacher education, and other disciplines not stated	Student perception to formative feedback and its effect on student learning experiences in an online graduate programme

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