# 42 Formative Assessment and Feedback Using Information Technology

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## Contents



**Abstract**

Formative assessment including feedback to students on their learning is widely recognized as an effective means to support student learning. Research has found that the potential of formative assessment in improving student learning is often not fully realized in classroom practice. IT provides a possible solution for overcoming some of the obstacles when implementing formative assessment. This chapter reviews various ways in which IT has been used in formative assessment, focusing specifically on digital learning environments, game-based assessment, classroom response systems, Web 2.0, and video feedback. The results suggest that using IT as a platform for feedback provides opportunity

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to individualize feedback, increase student engagement, collect learning evidence for all students, facilitate reflective processes, and support self-regulated learning. Reported potential challenges to the utilization of IT include time restrictions, limited response formats, technical difficulties, access to evidence of student learning for teachers, and teacher knowledge and skills. One key finding is that although innovations in technology have evolved considerably, many promising possibilities are not yet being exploited for the purpose of formative assessment. Most importantly, research demonstrates that not the technologies themselves, but the ways in which they are used impact on their formative potential. Bringing together IT and formative assessment may open up the potential for moving from convergent forms of feedback to more open, divergent feedback practices.

**Keywords**
Feedback · Formative assessment · Classroom practice · Technology · Student learning

## Introduction

Formative assessment is widely recognized as an effective means to support student learning (e.g., Black and Wiliam 1998). Feedback is a critical aspect of formative assessment (Hattie and Timperley 2007; Sadler 1989). Feedback in formative assessment refers to (i) insights into student learning provided to teachers and other stakeholders, and (ii) messages provided to students (by self, teachers, peers, digital devices, etc.) that are intended to directly influence their learning processes cognitively or metacognitively (Sadler 1989). Research has found that teachers and students do not necessarily fully engage with formative assessment processes, which in practice has resulted in disappointing outcomes. For instance, in the seminal work on feedback (e.g., Black and Wiliam 1998; Hattie and Timperley 2007), the importance of motivation in the feedback process is acknowledged in two ways: (1) feedback can motivate students to learn, and (2) students need to be motivated in order to use feedback to improve their learning. A recent review by Heitink et al. (2016) identified numerous prerequisites for the effective implementation of formative assessment in the complex reality of diverse classroom contexts. IT provides a possible solution for overcoming some of the obstacles when implementing formative assessment, such as providing timely individualized feedback on student learning in a way that engages learners.

This chapter evaluates the existing evidence of how IT has been used, and could be used, in formative assessment. The chapter commences with a brief overview of formative assessment and feedback to establish the conceptual framework in which the review is set. The following is a review of research into a range of IT tools and applications for formative assessment and feedback.

## A Brief Overview of Formative Assessment and Feedback Research

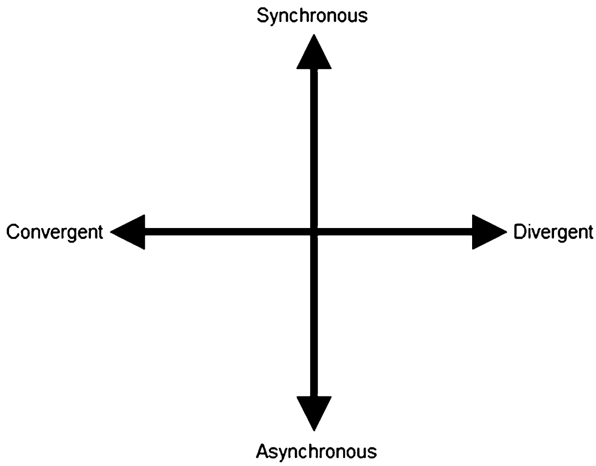
There is a long tradition of feedback research in education, yet evidence on feedback effectiveness is often inconclusive (Shute 2008). Research has demonstrated that the most frequently used type of feedback by teachers is praise, which unfortunately has limited value for student learning (Hattie and Timperley 2007). More elaborated feedback has generally been found to be more effective than simple corrective information (Hattie and Timperley 2007; Shute 2008). Results from a recent review suggest that formative feedback needs to be specifically related to the assessment task and student performance, and should provide suggestions for improvement (Heitink et al. 2016). Such feedback can positively enhance students' motivation for learning and result in improved learning outcomes (Hattie and Timperley 2007).

Most of the research on feedback in formative assessment has been conducted from a cognitivist perspective, in which feedback has been conceptualized as corrective information that is transmitted by an expert teacher to a passive learner, expected to result in improved learning (Evans 2013). However, recent literature increasingly emphasizes the importance of active student involvement in formative processes. For example, Black and Wiliam (2009) identify that internalization of feedback by the student is necessary for feedback to affect cognition. Thus, feedback is facilitative rather than directive, and ideally takes place in dialogue. The student's active role in seeking feedback is emphasized. Feedback may provide suggestions for improvement, but ultimately students decide what to do with feedback and whether to act on it (Evans 2013). Furthermore, the importance of the learning context and students' levels of motivation for learning have long been recognized to be fundamental to students' engagement with feedback (Black and Wiliam 1998).

A critical goal of formative assessment is to provide students with skills to self-regulate their learning (Black and Wiliam 2009). ▶ Chapter 41, "Assessment as, for, and of Twenty-First Century Learning Using Information Technology: An Overview" (Webb & Ifenthaler), in this assessment section of this handbook, contains a discussion of how theories of self-regulated learning relate to formative assessment practices. Self-regulated learners can effectively generate and use internal feedback, provide feedback, and become increasingly less reliant on externally provided feedback (Butler and Winne 1995). Peer and self-assessment can play an important role in developing students' self-regulatory capacities (Black and Wiliam 2009; Wang 2011). In peer assessment, students take on the role of assessor and provide feedback to their peers, demonstrated to be valuable in developing students' sense of quality (Yu and Wu 2013). Self-assessment requires learners to be actively engaged in monitoring their own learning progress, and generates internal feedback to self-regulate (Panadero et al. 2016).

Feedback practices can be understood within a two-dimensional continuum (Fig. 1), ranging from asynchronous (with a delay) to synchronous (real time) feedback interactions, and convergent to divergent feedback.

**Fig. 1** Dimensions of feedback interactions




Torrance and Pryor (2001) first described assessment as convergent with reference to the practice of assessing whether students have met specific learning goals, where typically the teacher is the sole assessor. This notion extends to feedback interactions (Pryor 2015), in which convergent feedback describes that which addresses but does not go beyond prespecified learning outcomes. Convergent feedback describes those feedback instances where the focus is on detailing correct responses and specifically identifying where errors have occurred and how to correct these, thus closing the gap between current and desired performance (Sadler 1989). In contrast, Torrance and Pryor (2001) described divergent assessment as being exploratory in nature where students are given a chance to demonstrate what they can do beyond the bounds of curriculum. Thus, divergent feedback describes feedback that goes beyond prespecified outcomes and corrective information. Students, teachers, and peers engage in a feedback dialogue in which the student identifies the type of feedback they require to progress their learning, and students may also provide feedback to the teacher. Students are also actively participating as self-assessors, providing feedback to themselves that extends their individual and internalized learning goals. Divergent forms of feedback involve students as co-constructors of meaning in feedback interactions.

Digital platforms provide opportunities for feedback to be instantaneous and continuous. They also provide opportunities for asynchronous feedback through, for example, voice and video recordings that deliver personalized messages. The form of feedback as corrective or extending thinking may occur synchronously or asynchronously dependent on the application and learning focus. Figure 1 provides a framework to consider the form of feedback made available through the digital platform. The following section provides an overview of the various digital platforms in terms of the type(s) of feedback interaction they facilitate.

## Formative Assessment and Feedback Using IT: Tools and Applications

### Digital Learning Environments

In digital learning environments, feedback is often provided to students based on their correct or incorrect response to a task, either immediately or with a small delay. The potential advantages of the convergent and synchronous application of automating feedback in computer-based assessment have long been recognized. As early as the 1920s, Pressey invented the "teaching machine," a machine that included multiple-choice questions and informed learners of the correctness of their responses, also known as knowledge of results. The purpose of providing such feedback was to reinforce correct responses, consistent with a behaviorist perspective on learning. Perspectives on learning and the potentials of technology have evolved considerably since; however, the way feedback is provided to learners in many digital learning environments is still remarkably similar to those in the teaching machine (e.g., Cayton-Hodges et al. 2015). And although computer-based assessments have been programmed onto a variety of tools, such as computers or tablets, the presentation of assessment tasks and feedback is still very similar to traditional paper-and-pencil formats with simple response formats and feedback in the form of ticks and crosses (e.g., Faber et al. 2017).

Currently, much of the research into digital environments with automated feedback involves a static set of tasks that is completed by all students, similar to paper-based tests (van der Kleij et al. 2015). Innovations in psychometrics and technology have opened up possibilities to tailor the difficulty of tasks to the ability level of the learner, which has the potential to enhance the effectiveness of digital learning tools. However, a recent meta-analysis (Kuo and Wu 2013) in mathematics and science indicates that both formative assessment and adaptive assessment are underutilized in digital learning environments.

While much of the previous research has focused on closed answer item formats such as multiple-choice, IT offers possibilities for providing automated feedback on more complex task formats. Automatic essay scoring systems have been developed for student writing tasks, which when utilized in conjunction with teacher feedback, have been shown to reduce teacher workloads and increase students' writing persistence (Wilson and Czik 2016). However, automated feedback on writing by itself may not be very effective; a recent meta-analysis reported an average weighted effect size of 0.87 for adult-provided feedback compared to 0.38 for automated feedback (Graham et al. 2015). For additional discussion of this topic, see also ▶ Chap. 43, Progress and Challenges for Automated Scoring and Feedback Systems for Large-Scale Assessments" (Whitelock & Bektik), in this assessment section of this handbook.

Regarding the effects of feedback in digital learning environments in primary, secondary, and tertiary education, a recent meta-analysis (van der Kleij et al. 2015) found an effect size of 0.05 for knowledge of results, which means that it is essentially just as effective as no feedback. The meta-analysis found substantial differences between the effects of different methods for providing feedback, and highlighted the need to take into account the complexity of the learning to be achieved. When the aim is for students to memorize or understand material, providing them with knowledge of the correct response is generally moderately effective (overall $ES = 0.32$). In the case of more complex learning, where the learner is required to apply their knowledge and skills, *elaborated feedback* works best (overall $ES = 0.49$). Elaborated feedback includes information additional to knowledge of results, such as an explanation, strategic hint, worked out solution, or a reference to additional study material. This type of feedback includes elements of instruction and goes beyond the correctness of the learner's response (Hattie and Timperley 2007), which can help students identify *how* they can improve. Van der Kleij et al. (2015) found that elaborated feedback is particularly effective when it gives students hints or strategic information which stimulates students to think deeply about the task and their strategies, thus supporting self-regulation.

Intelligent tutoring systems provide a platform for the provision of elaborated feedback (Narciss 2013) or scaffolding to support next-steps in student learning. When used in this way, students receive subtle and gradual feedback to enable them to recognize and correct errors in knowledge and strategy, and use feedback in subsequent tasks. This use of intelligent tutoring systems for elaborated feedback has been found to establish the conditions for students to develop self-regulated learning skills. For instance, Narciss and Huth (2006) compared the impact of knowledge of correct response and "bug-related tutoring" feedback, which provides explanations for errors in addition to knowledge of correct response, in a sample of 50 German fourth-grade mathematics students. Students in the bug-related tutoring condition demonstrated higher levels of mastery indicated by correctly solving two similar mathematics problems, greater ability to self-correct errors, and improved academic performance from pretest to posttest. The research also reported enhanced student motivation levels in the bug-related tutoring condition: "The positive feedback effects on motivation are consistent with the view of current motivation theories which assume that mastery experiences resulting from successful task completion and the feeling of personal causation are crucial for developing positive perceptions of competence" (p. 319). Extending on these findings, a Taiwanese study in fifth-grade science concluded that the option for students to request hints as a guide toward correct responses increased achievement compared to knowledge of correct response (Wang 2008). In Wang's study, students were also able to ask the teacher questions asynchronously.

Several studies have explicitly explored the relationship between digital platforms and self-regulated learning. In a 2011 study involving 123 seventh-grade biology students, Wang examined the effects of five peer-supported self-regulation strategies in an e-learning environment. The strategies involved the use of answer notes to explain students' reasoning for choosing a particular response and the review of their peer's answer notes. Students who had access to the self-regulation strategies scored higher on a self-regulation behavior questionnaire compared to the control group who did not. Regulation feedback including questions relating to, for instance, task comprehension, strategy use, and reflection on the solution was the focus of another study involving 65 ninth-grade mathematics students in Israel (Kramarski and Gutman 2006). In this e-learning environment, it was found that knowledge of results plus regulation feedback was significantly more effective than knowledge of results only ($ES = 0.44$). Timmers et al. (2015) used a similar self-regulation feedback strategy in their study of information literacy involving 50 thirteen-year-old students in the Netherlands, but also included a self-assessment component. They found significant positive improvements in performance and strategy use in girls only.

The effects of self-regulatory scaffolds have also been examined in the context of biology learning in a hypermedia e-learning environment for 53 tenth-grade and 58 seventh-grade students in the United States (Azevedo et al. 2005). Students were assigned to one of three conditions: no scaffolding, fixed scaffolding, and adaptive scaffolding. In the fixed scaffolding condition, students received a list of goals to guide their learning. In the adaptive scaffolding condition, students could request digital guidance from a human tutor, who would, for example, help them "monitor their emerging understanding" (p. 392). Students in the adaptive scaffolding and no scaffolding conditions outperformed those in the fixed scaffolding condition in terms of knowledge gain. Moreover, students in the adaptive scaffolding condition demonstrated better self-regulatory strategies.

A limitation of the research into digital learning environments has been the focus on textual feedback, with the potential of multimedia being underutilized (van der Kleij et al. 2015). Ostrow and Heffernan (2014) found the use of video feedback increased student engagement. Their study compared video and textual feedback in a digital learning environment for 139 eighth-grade mathematics students from the United States. The video feedback demonstrated a researcher reading a feedback message and referring to a worked solution on a whiteboard, while the textual feedback conveyed the same information. Students in the video condition spent more time engaging with feedback than students in the text only condition and completed subsequent mathematics problems more quickly. While the provision for students to ask questions and respond to teacher feedback was not an aspect of this study, it is an area requiring further consideration if feedback is to promote self-regulatory skills, dialogue, and deep engagement. In addition, researchers have called for systems that provide opportunities for classroom-integrated technology that informs the teacher of how students are engaging with the task (e.g., Faber et al. 2017). Further research is required into online systems that provide a range of feedback for both the teacher and the student while increasing the opportunity for dialogue about feedback and learning.

Gaming elements have often been incorporated into digital learning and assessment environments to enhance motivation or engagement (e.g., Wang 2008). The following section considers the form of feedback that game-based digital platforms may provide to teachers and students.

## Game-Based Formative Assessment

Game-based digital platforms through their design can offer challenge and an element of play that motivates students to participate in formative assessment

(Wang 2008). In primary and secondary classrooms, tablets are popular devices for educational games. However, research (Cayton-Hodges et al. 2015) has found that although the majority of applications claimed to be game-based learning environments, in many instances, the assessment components were presented as explicit tasks that interrupted the gaming experience. Assessment tasks were usually presented in multiple-choice formats. Some exceptions included rich interactions using an array of presentation and response formats, such as drag-and-drop using visuals and written responses. Feedback was communicated visually, including the use of videos, or via audio. In some of the apps, feedback involved specific guidance to learners during problem-solving, identifying specific errors and providing explanations, and the option for students to request hints. While the majority of feedback was corrective in nature, or provided an overview of the number of tasks correctly solved, there was evidence of more sophisticated and divergent forms of feedback.

Advances in technologies have resulted in the development of more complex game-based assessment systems, for example, in the form of simulations (e.g., Shute et al. 2017). Well-designed games have the capacity to collect a wide range of data about the user's performance as they progress through the game, such as response time and whether or not students request hints, and utilize this information to generate individualized formative feedback (Cayton-Hodges et al. 2015; Shute et al. 2017). Shute (2011) used the term "stealth assessment" to describe the seamless assessment and learning environment, whereby the individual is unaware of the assessment process during their engagement with a digital game. However, the analysis of complex performance data (that goes beyond the correctness of a response) and the subsequent translation to feedback that will be useful to learners is a challenging topic of ongoing research (Azevedo et al. 2010; Shute and Kim 2014). Shute and Emihovich examine the progress to date in ▶ Chap. 44, "Assessing Problem-Solving Skills in Game-Based Immersive Environments," in this section of this handbook.

## Classroom Response Systems

Classroom response systems or "clickers" provide opportunities for nearly synchronous formative assessment in classroom settings and are most suitable in a convergent assessment context. Clickers consist of a handheld device used by students to transmit their responses to questions, which are then aggregated and displayed in a graph via a projection screen (Kay and LeSage 2009). Previous studies have identified a number of formative assessment applications for clickers, including identifying students' (mis)understandings of instructional materials, assessing students' capacity to transfer knowledge, student self-assessment, and ascertaining students' current knowledge base and capabilities (Caldwell 2007).

Classroom response systems enable teachers to obtain responses from all students, and use this information to modify course content or pacing to address student needs (DeSorbo et al. 2013; Feldman and Capobianco 2008; Vital 2011). Such systems are particularly valuable for students who are experiencing difficulties with content and may be reluctant to participate in class discussion. Many studies of clicker use in schools have utilized simple handheld devices that allow for multiple-choice type responses, consistent with a convergent assessment paradigm. These appear to result in improved levels of student engagement (DeSorbo et al. 2013; Vital 2011) and achievement (Mun et al. 2009), possibly associated with increased demands for participation and the availability of (generic) formative feedback. Reported challenges regarding the use of clickers include the malfunction of the hardware, time pressure, student maturity levels, limited response formats, the construction of appropriate questions, utilizing feedback formatively, and discomfort with the new technology that interfered with students' learning (Kay and Knaack 2009; Lee et al. 2012; Vital 2011). However, with the increasing accessibility of technology and use in all aspects of life, it is anticipated that these issues would have diminished over time.

More advanced classroom response systems enable a broader range of response formats such as open-ended responses, therefore addressing some of the limitations of earlier systems (Shirley and Irving 2015; Irving et al. 2016) and opening up possibilities for more divergent assessment. A case study of the use of classroom response systems in elementary mathematics classes with the addition of interactive whiteboards and notebooks enabled opportunities for high cognitive demand questioning (Polly et al. 2014). Students were given time to solve a complex task and write down their solution steps before selecting a response on their clicker. A camera allowed students to project their work on the whiteboard and to discuss their reasoning and approach to solving the task. This resulted in deeper levels of student learning, as well as better teacher understanding of students' knowledge and problem-solving processes, which enabled teachers to provide students with more detailed feedback. In summary, the system facilitated the opportunity to elicit whole class responses which informed both teacher and student decisions about next-step teaching and learning.

## Web 2.0 Platforms for Mediating Feedback

Web 2.0 refers to web-based media that enables interactive authorship to generate content such as blogs, social media, e-portfolios, or wikis (Fendler 2011) in both synchronous and asynchronous communication. Teachers can gain information on student strengths and weaknesses, and levels of understanding and interest through student contributions to Web 2.0 platforms, thereby enabling formative assessment and adjustment of curriculum content as required (Ruday 2011). Web 2.0 supports cloud-based collaborative writing allowing for interaction between students and their peers and teachers to facilitate formative feedback and learning. It also provides a platform to provide open-ended assessment tasks and feedback that is more divergent in nature.

The capability of deep student engagement with assessment and multiple forms of feedback can be found in blogging software. For example, blogging software was used as a platform for a 'book club' for a third-grade class in the United States (Stover et al. 2016). Students utilized the blog to discuss the book, and to reflect on previous posts, reading-related skills, and habits. The teachers shared a rubric to facilitate student self-assessment of reading comprehension. The class discussed examples of blog posts and assessed their positioning on the rubric. Teachers interacted with students via the blog, providing comments to interrogate students' thinking and build comprehension. The blogs provided the teachers with more transparent information on student strengths and weaknesses in relation to reading comprehension and skills, which enabled them to differentiate instruction.

Another study, involving 40 Year 11 English students in China, used Facebook as the hub for peer and teacher feedback (Kio 2015). The teacher initiated and moderated a Facebook group for the class to provide peer support and feedback outside of school hours. To encourage participation, the teacher posted information about lessons, homework, assessment, and other activities. Students discussed class topics and provided peer feedback via the Facebook wall. While students reported that feedback from multiple peers was convenient and aided in motivation, it sometimes lacked the specificity and richness they required, and it remained a convergent form of feedback. A similar finding was found in a study that utilized a cloud-based platform for collaborative writing in four American schools Grade 6 to 8 English classes (Yim et al. 2014). The students used Google docs for simultaneous collaborative writing using the comment, highlight, and editing features. Students could choose who to share their work with, and request peer and teacher feedback over several rounds of revision. This resulted in focused dialogic feedback on the students' identified areas of need. However, while the platform overall supported the continual expansion and development of ideas through "the continuity of writing and revision" (p. 249), student feedback frequently focused on sentence-level features rather than broader-content-level issues. In addition, most students worked individually while providing, receiving, and using peer and teacher feedback rather than as a platform for collaborative writing. These studies demonstrate that the platform alone will not promote deep engagement – these skills need to be taught for the potential of the system to be realized.

The purposeful incorporation of an online platform with explicit instruction on self-regulatory skills was evident in a Scottish study involving 305 students aged 5–14 years (McLaren 2012). This study combined a multimedia "e-scape" portfolio and blog to assess and facilitate feedback on the skills of creativity, iterative design processes, and reflective thinking. Students were able to access a range of tools to record their thought processes including text, drawing, mind maps, photos, audio, and video. Examples of thought processes were captured using a rubric that required evidence of analysis skills, decision making, and justification. Students also recorded personal learning goals for the purpose of self-reflection and self-assessment. Each student was connected to the e-scape management system via classroom Wi-Fi, and teachers provided individual audio or textual feedback. Teachers indicated various approaches to feedback including probing for deeper thinking, encouraging self-reflection, or providing more information or instruction and directions for subsequent work.

## Video Feedback

Video feedback has been utilized in classroom contexts for teacher feedback (Ostrow and Heffernan 2014) as well as supporting self-assessment (O'Loughlin et al. 2013), peer assessment (Lenters and Grant 2016), and reflecting on the feedback process itself (van der Kleij et al. 2017). Ostrow and Heffernan (2014) suggested that "the use of video forces the learner to slow down and internalize the concept that is being taught" (p. 299). O'Loughlin et al. (2013) reported enhanced levels of motivation, engagement, and learning for students when video recordings of performance were used for self-assessment in an Irish physical education class of 23 nine- to ten-year-old students. In this case, rubrics were used to guide students in self-assessing their video-recorded basketball skills, and the teacher provided supplementary feedback as needed.

Using video for recording peer feedback has also been found to have instructional merit. Lenters and Grant (2016) reported on a Canadian trial using iPads and iPods as recording devices for peer feedback in fifth-grade writing. The teacher and students were familiar with written and face-to-face peer feedback processes using structures such as "I noticed . . ." or "I wondered about . . ." (p. 190). The teacher and students reported two benefits of using video recordings for feedback. First, students were better able to communicate their feedback in the way they intended, which they indicated resulted in fewer misinterpretations. Second, students could consult the recorded feedback as often as needed. Although some students reported a certain level of discomfort recording their feedback, many reported feeling more comfortable recording their feedback than having to discuss this face-to-face with their peer, which resulted in more objective feedback.

The use of iPads for videoing one-to-one teacher–student feedback conversations for supporting self-reflection and self-regulation was trialled in Australia with six teacher–student pairs in Year 9 (van der Kleij et al. 2017). Individual video-stimulated recall sessions were held with participants in which they were asked to stop the video recording and comment on the instances they identified as relevant. The video technology enabled teachers to self-assess their feedback practices and the effect of these on the student. Besides reviewing the feedback, students justified their responses to the feedback and considered their contribution to the conversation. Through this reflective process opportunities for self-regulation of both teachers and students were realized.

These studies demonstrate the relative benefits of video feedback over written or face-to-face feedback for both teachers and students. Video recording offers both a personalized connection with the feedback, as well as, in the case of peer feedback, some distance to provide more objective comments. Being able to articulate the feedback and demonstrate through examples enables individualized feedback otherwise not possible in limited class time. The opportunity to revisit the feedback is another benefit of video recording.

## Conclusion

Formative assessment and feedback have been shown to contribute to effective learning but, as has been shown, within the situated reality of classrooms there will be variable outcomes (Heitink et al. 2016). This chapter reviewed various ways in which IT has been used in formative assessment, focusing specifically on digital learning environments, game-based assessment, classroom response systems, Web 2.0, and video feedback. Using IT as a platform for feedback provides opportunity to individualize feedback, increase student engagement, collect learning evidence for all students, facilitate reflective processes, and support self-regulated learning. Reported potential challenges to the utilization of IT as a platform for divergent forms of feedback include time restrictions, limited response formats, technical difficulties, access to evidence of student learning for teachers (Faber et al. 2017), and teacher knowledge and skills, for example, in posing appropriate questions (Lee et al. 2012). However, most studies report on case studies in specific classes and more research on a larger scale is required to substantiate these findings.

One key finding is that although innovations in technology have evolved considerably, many promising possibilities are not yet being exploited for the purpose of formative assessment. Namely, digital assessment tasks frequently resemble paper-and-pencil tests, and feedback is often convergent, taking the form of ticks and crosses or written text of a corrective nature. Further, more research is warranted on the impact of regulation feedback and how this may enhance student learning (e.g., Kramarski and Gutman 2006). Moving forward, learning tasks could take place in, for example, 3D simulations, and feedback can be provided in the form of audio, video, and web links to online resources, on demand, or in dialogue with a virtual peer or teacher. It should be possible for students to ask for clarification or additional elaborations on feedback to enhance the usability of feedback. This would make feedback more accessible and engaging, and is likely to motivate students to engage with feedback.

Most importantly, research demonstrates that not the technologies themselves, but the ways in which they are used impact on their formative potential (e.g., Polly et al. 2014; Wang 2008). Skills in providing and accessing feedback need to be explicitly taught. As was highlighted in a recent review, teachers' knowledge and skills are vital to successful formative assessment practice (Heitink et al. 2016). For instance, if teachers do not have the skills to translate results into decisions for appropriate follow-up instruction and feedback (Lee et al. 2012), using IT will have limited formative potential. Another recurring issue is the quality of peer feedback (Kio 2015; Yim et al. 2014); if students do not possess skills in providing quality feedback, adding a digital tool for communicating such feedback is not going to enhance its effectiveness. Students need to be given guidance in the peer feedback process to make the process beneficial to both feedback providers and receivers (e.g., Lenters and Grant 2016).

Research to date suggests that formative assessment practices using IT are often convergent in nature, but possibilities exist for more divergent feedback practices. Once again, of importance here is how the technology is being used. For example, iPads can be used in very similar ways to paper-based materials, but also have the potential to be used by students to engage in formative assessment processes, through activities such as compiling digital portfolios to evidence their learning (Cumming and van der Kleij 2016), or by opening spaces for dialogue (van der Kleij et al. 2017). IT provides students with a platform for self- and peer assessment, and opportunities to develop a voice and exercise agency of their own learning journey. It can be designed to provide feedback with sufficient information to maintain achievable challenge, thus motivating students to continue. Developments in IT have produced promising results for providing timely, individualized, and challenging feedback that progresses student learning as well as scaffolding self-regulatory behaviors.

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