

## Exploring formative e-assessment: using case stories and design patterns

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This article presents key findings from a Joint Information Systems Committee-funded project, which aimed to identify existing practices where technologies contribute to formative assessment and identify processes that take place around formative assessment where technologies play a significant role. Using a design pattern methodology, the project developed a range of cases of formative e-assessment with practitioners across a variety of settings through a series of participant workshops. From a selection of these cases, we identified key elements in how practitioners described the problems and solutions they addressed regarding assessment in relation to learning within their different contexts. The patterns were analysed to highlight aspects of them, which are considered critical in theoretical analyses of formative assessment. We provide an overview of the project and discuss an illustrative case and pattern, followed by an analysis which suggests the particular contribution of technologies to formative assessment. Ultimately, for assessment to have formative effects, tutors and students can be identified as appropriating both social *and* technological resources in learning situations and engaging with both to learn how to take control over learning experiences.

**Keywords:** formative; e-assessment; cases; design patterns

### Introduction

This article reports on the outcomes of the recent Joint Information Systems Committee (JISC)-funded project, ‘Scoping a vision for formative e-assessment (FEASST)’ led by the WLE Centre for Excellence and the London Knowledge Lab. The project aimed to identify current practices in post-16 education sectors where technologies play a key role in formative assessment, and to propose a way forward based on a better understanding of their use. The project first conducted a review of literature on formative assessment, e-assessment and formative e-assessment to establish the key issues. This identified contested ideas about what is meant by formative assessment and established a theoretical overview, which was used to guide the project, based on Black and Wiliam’s (2009) ‘aspects of formative assessment’. Using a design pattern methodology (developed by the Planet Project), the project developed a range of case studies of formative e-assessment with 27 practitioners across a range of sectors through a series of Practical Enquiry Days (PEDs). In our PEDs, practitioners reported on cases from

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their own experience, and on the basis of these they identified proto-patterns. Proto-patterns are patterns which are in the first stage of development and have not yet been verified by other practitioners who recognise the pattern as something which is also present in their practices. Selected patterns were then refined and elaborated by the team in consultation with the original contributors, and were also analysed against the findings from the literature review. These 'mature' patterns were further scrutinised by a group of 12 software developers to apply them to problem-based scenarios in a variety of learning contexts. This paper reports the main outcomes of the project using an illustrative case and pattern to identify where formative aspects of assessment were found to be supported by the use of electronic tools.

## **Background**

In recent years, important work on formative assessment has been carried out in the UK, largely within the school sector (Black and Wiliam 1998; Black et al. 2002). It is increasingly recognised that this work should find more widespread inclusion in post-16 pedagogy (see, e.g. the OECD publication on adult learning, Looney 2008). There are well-established arguments that further and higher education practitioners can enhance the learning of their students by incorporating practices of formative assessment that have found so much currency in the school sector (Juwah et al. 2004). A persisting challenge for post-16 education however remains the alignment of assessment practice with research findings, which clearly show that the successful use of assessment to support learning is premised on the notion that a learner will improve most if they understand the aims and processes of their learning, for example, possess reflexivity at a metalevel, know where they are positioned in relation to the intended learning outcomes and how they can achieve them or close the gap in their knowledge, skills and/or understanding. Formative assessment centres on activities by teachers and/or a learner or a group of learners who provide information that yields feedback suitable to make necessary modifications to teaching and learning activities, for example those that lead to the learner having a better understanding of what they are trying to learn, what is expected of them and how to make improvements. Formative assessment can thus be seen to be premised on high-quality interactions, including questioning, listening, responding and reflecting, between teacher and learner(s), learner and learners as well as the learner with her- or himself. In this way, assessment can be seen to be integral to learning processes.

The increasing prevalence of ICT in teaching and learning presents new challenges to e-assessment, as well as new opportunities. In the UK policy context, e-assessment tends to be understood as 'end-to-end electronic assessment processes where ICT is used for the presentation of assessment activity, and the recording of responses' (JISC 2007, 6). This suggests that the main priorities for 'e-assessment' have been institutional strategy, the development of standards, technical infrastructure and learning support tools and much less the pedagogical dimension of practice. The latter is on the increase, though, not least in view of a recent policy focus on personalisation and e-portfolios. We argue that effective e-assessment needs to take account of the human-centric, social dimension as well as technological, data-gathering and management perspectives. More attention needs to be paid to the social than has been the case until now, and to the ways in which a learner

appropriates social and interactive as well as technological resources within formative assessment contexts.

### **Issues from the literature**

The literature was reviewed to establish what views of formative assessment should provide a theoretical foundation for the study. Considerable differences exist in perspectives on formative assessment regarding teacher roles, adaptivity (i.e. practices of accommodation, modification and change in response to feedback) and learner self-regulation. There are widely differing theoretical emphases in the literature. Within e-assessment, there is a tendency to conflate formative and summative assessments with a view of ‘adaptivity’ as a core component of e-assessment processes (‘Adaptivity’ here indicates practices of modification on the part of learner and teacher, which may or may not itself involve the use of technology). Very broadly speaking, formative assessment is seen as those practices which enable the learner to adapt and close the gap between current understanding or attainment and a further stage or level, that is it has a future trajectory. Within schools and face-to-face post-16 contexts, both teachers and learners are active in these practices and the adaptation of practice concerns pedagogical strategy as well as learning activity. Summative assessment, with or without feedback, is that in which a score or level attained contributes to a final award. The domain includes a wide variety of perspectives and practices under the term ‘formative assessment’ which prioritise different educational goals. Components have been identified to reflect a variety of actors, learning intentions, roles and activities and the mechanisms involved in enabling progression of learning towards measurable attributes. Among these, a core component around which there is much difference is the role of the ‘teacher’ and to what extent their role in formative assessment includes adaptation of pedagogy. A further issue is around how far automated response/feedback can bring about formative effects in the learner. Some examples of formative e-assessment can be argued to be serial summative assessment, that is a series of summative assessments in which the feedback derived from the assessments (principally the scores) is deemed to bring about adaptive effects by impacting on the learner’s motivation and strategies to increase performance, that is a sustained learner engagement with summative scores or levels over varying time intervals, which is itself deemed to bring about adaptive effects by impacting on the learner’s motivation and strategies to increase performance. Formative assessment appears to be equated with ‘low stakes’ assessment or ‘practice’ assessment in preparation for contributing towards high stakes summative outcomes. It is clear that, in all these scenarios, the role of ‘evidence’ is core (how it is used, generated, by whom/what and affecting whom/what). When thinking about assessment as a noun, it is useful to distinguish the event, which generates the evidence (e.g. a test as ‘an assessment’) and the evidence itself (the score). Mechanisms focus on the generation and the use of evidence by actors in the assessment process, which has a variety of relations with ‘feedback’. Feedback channels are varied: teacher–learner(s), learner(s)–teacher, learner–learner(s). Increased frequency, speed and the amount of assessment are a driver to improve student access to feedback – but is this performing a formative function? In all these issues, learner self-regulation (Nicol and Macfarlane-Dick 2006) is a core feature in gauging the formative effects of pedagogic processes linked to motivation and emotional factors, which affect learner engagement with feedback.

***'Key aspects' of formative assessment***

Within this heterogeneous domain, the recent work by Black and Wiliam (2009) develops a theory which provides a granular perspective on constituent aspects of formative assessment, which has significance for a range of educational settings. They provide a framework which suggests that formative assessment consists of a number of 'key aspects' which come into play to varying degrees within different pedagogical contexts. The aspects revolve around the area where the learner is going, where the learner is right now and how he/she can get there and examine the role played by the teacher, peers and learner. Five 'strategies' are related to these aspects, so that a constellation of practices is presented, which suggests that a set of relations exists between the various participants and the range of practices which constitute formative assessment.

The five strategies are:

- (1) engineering effective classroom discussion, questions and learning tasks that elicit evidence of learning;
- (2) providing feedback that moves learners forward;
- (3) clarifying, understanding and sharing learning intentions and criteria for success;
- (4) activating students as owners of their own learning; and
- (5) activating students as instructional resources for one another.

These strategies take effect in 'moments of contingency', which are instances where the teacher and the learner exercise the capacity for things to be 'otherwise' in terms of the learner's understanding or attainment. The consequences of this cannot be pre-determined, and the contingency contains within it the potential for both learners to struggle before they make long-term gains and teachers before they become more successful in their strategies. Contingency is core to a forward-looking perspective of learning over time:

Moments of contingency can be synchronous or asynchronous ... synchronous moments include teachers' 'real-time' adjustments during one-on-one teaching or whole class discussion. Asynchronous examples include teachers' feedback through grading practices, and the use of evidence derived from homework, or from students' own summaries made at the end of a lesson ... to plan a subsequent lesson. They might also include responses to work from the students from whom the data were collected, or from other students, or insights learned from the previous lesson or from a previous year. (Black and Wiliam 2009, 10–11)

This focus on 'contingency' provides a conceptual lens for 'what counts' in developing cases and patterns of formative e-assessment. There is wide heterogeneity in the literature and frequent slippages between terms like 'assessment' and 'learning' and between 'formative' and 'summative' (especially in papers exploring computer-based assessment tools). Defining 'formative assessment' in relation to technologies is therefore complex and contentious. Black and Wiliam's framework helped to identify the core meanings of 'formative assessment' and provided an organisational device to inform project participants' thinking about the key processes involved. It is not proposed as an all-encompassing 'theory' but works as a map of the domain.

	Where the learner is going	Where the learner is	How to get there
Teacher	Clarify and share learning intentions	Engineering effective discussions, tasks and activities that elicit evidence of learning	Providing feedback that moves learners forward
Peer	Understand and share learning intentions	Activating students as learning resources for one another	
Learner		Activating students as owners of their own learning	

Figure 1. Key aspects of formative assessment (Black and Wiliam 2009).

The domain map (Figure 1) adopted from Black and Wiliam reflects a theoretically coherent account of ‘what is out there’, by which it is possible to make sense of the range and diversity of what currently constitutes formative assessment. It became obvious that the domain would have broad and permeable parameters, both between formative and summative assessment practices and between different aspects of formative assessment. This is in line with the argument that technologically supported learning contexts demand a rethink about distinctions between formative and summative assessments, which acknowledges that technologies form part of a shift towards ‘modernising’ (Elliott 2007) assessment in contemporary collaborative and personalised learning contexts. Such contexts create learning conditions in which there is a ‘blurring’ of the boundaries (Bull and McKenna 2004) between formative and summative assessments, with a focus on how the learner *uses* a variety of types of assessment opportunities as the main location of debate about their formative potentials. In terms of computer-assisted assessment (CAA), Bull and McKenna make a distinction between the idea that it can *be* formative in itself and the idea that it *has a role to play* in formative assessment. The notion that formative and summative assessments become ‘blurred’ is important:

Perhaps CAA offers a sort of bridge between formative and summative assessments ... the line between formative and summative assessments is a blurred one which is more to do with when the assessments are delivered and what is done with the marking and feedback rather than a precise difference in kind. (Bull and McKenna 2004, 12)

This is helpful as, when the distinction between formative and summative is located in the assessment itself, it results in a meaningless or contradictory formulation. E-assessment practices need careful examination of how they relate to core concepts of formative assessment. Mackenzie’s (1999) term ‘scored formative’ is indicative of this, which describes the practice of automatically assigning and recording numerical scores for computerised coursework. In this context, the feedback functions formatively only according to the wider pedagogical framework of which it is part. This is an important point and highlights the fact that technological practices co-exist and

interact with other social, cognitive and motivational elements within learning contexts.

The inter-relationship between ‘the teacher’s agenda, the internal world of each student and the inter-subjective’ (Black and Wiliam 2009) is core to identifying formative assessment practices. This inter-relationship may take a wide variety of forms (e.g. the teacher need not necessarily be present) and result in varying outcomes (e.g. the learner may not make the desired progress), but the learner’s active engagement with feedback is a consistent element of it. The ‘teacher’s agenda’ can be difficult to ascertain in contexts where technology carries out traditional teachers’ roles. Teacher interventions, pedagogical adaptation and the fostering of self-regulation (Nicol 2007) are crucial aspects of formative assessment in much of the literature based on interactional instructional contexts. Questions are raised about how technology satisfies the role of the ‘social turn’ in formative e-assessment and contributes to the ‘internal world’ of each learner. Fundamental to this complex domain are tensions associated with e-assessment in which practices are driven by state-of-the-art technological know-how rather than pedagogy. The conclusion that distinguishing formative and summative assessments, involving attendant technological tools, is not a productive way forward, and the project focused rather on understanding how assessment involving the use of technologies can be used formatively.

### ***The conversational framework***

Laurillard’s conversational framework (2002, 2007) was also used to locate cases and patterns of formative assessment within a broad conceptual frame of reference for understanding learning where technologies play key roles. The conversational framework captures cycles of interaction between learners and teachers involved in concept formation and has long been influential in the design and analysis of e-learning. It offered a basis for considering how technology might support the use of formative assessment within a wider view of interactive pedagogical processes. The diagram below (Figure 2) represents a learning activity that covers the full conversational framework through a combination of teaching methods such as lecture/book/web resource + tutorial/discussion environment + fieldwork/lab/simulation + collaboration environment.

Formative assessment practices potentially overlap with most of the elements of this framework, that is it corresponds to most of the elements of the learning process, perhaps other than those elements which relate to the teacher’s initial presentation of the concepts.

At the simplest and minimal level:

- Teacher assessment can be seen in this framework in the Adapt a Task practice environment for learners’ needs activity – where the task might be an assessment task – and then the results of the assessment are fed back to the learner in the feedback on action activity.
- Assessment is formative if this feedback either results in the learner adapting his/her conception (reflects on feedback in relation to task and action), changing his/her approach to the task (adapts approach to task to current conception) and ultimately adapting his/her action (revises action) and/or the teacher reflects on learner’s practice and so modifying the learning and assessment task (adapts a task practice environment for learners’ needs).

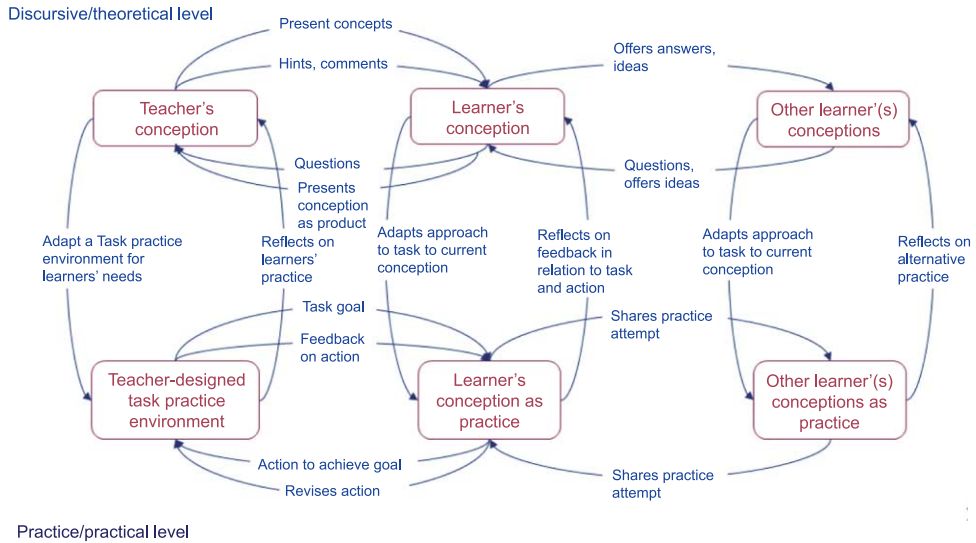


Figure 2. Laurillard's conversational framework.

- Peer assessment is included in the framework where learners share their activities (shares practice attempt) and as a consequence reflects on this (reflects on alternate practice), changing their concepts and hence 'Adapts approach to task to current conception'.

This correspondence was seen to be sufficiently strong to merit adoption of this framework for analysis of activities within formative assessment.

### Methodology

The project methodology drew heavily on the Participatory Methodology for Practical Design Patterns, which originated in the Learning Patterns project (Mor and Winters 2008; Winters and Mor 2009), and which has been extensively developed by the Planet Project 2009 ([www.patternlanguage.network.org/](http://www.patternlanguage.network.org/)). The workshop methodology was based on foregrounding practitioners' voices in the development of cases and patterns of formative e-assessment. It enabled practitioners to reflect on the challenges they faced and methods for addressing them. The methodology called for a sequence of collaborative workshops in which project participants actively constructed cases and patterns, which provided distillations of key features of practice in a particular learning context. Nineteen cases and 18 patterns were created collaboratively using a project wiki. The first two workshops were dedicated to sharing participants' experiences in the form of case stories, and the third used the most developed case stories as a basis for constructing design patterns. The final two workshops evaluated these patterns by applying them to problem scenarios – again, derived from participants' professional experiences. Six scenarios of use were presented during these final workshops. These workshops (PEDs) demanded high levels of practice-based reflection related to formative assessment. Twenty-seven participants took part in total across the first four days, who were

practitioners and had used technologies for learning in a range of settings (higher education, further education and work-based learning). Their discussions were also informed by inputs from the team offering analysis of relevant literature and research perspectives on formative assessment. Team members reviewed the patterns, negotiated discrepancies with their authors and added a layer of theoretical justification and commentary reflecting the relevant literature. Within the time constraints of the project, seven mature patterns were developed from a total of 18, which were worked on in the PEDs. The final PED involved 12 software developers who were not part of the earlier process, and engaged them in design tasks, drawing on the cases and patterns we had produced. This allowed us to refine and review the outputs and observe how they would be used by developers to address context-specific problems and challenges in technology applications aimed at supporting assessment for learning.

### **Cases of formative e-assessment**

In each small discussion group, the participants drew on their contextualised experiences as practitioners of using technologies as part of formative assessment. In each group, the participants took on roles of narrator, author and reporter to articulate cases of practice in which technologies were used to support formative assessment. The group discussion refined the narrated case within the wiki. Following the workshop, five main cases were identified from which patterns relevant to formative e-assessment could be derived. The cases were selected on the basis of range, so that a variety of the following features were represented: assessment focus, technology used, role played by the technology, socio-pedagogical setting and institutional setting. An illustrative case called 'Academic Writing' is presented below (Pachler et al. 2009), which appears on the project wiki (<http://patternlanguagenetwork.myxwiki.org/xwiki/bin/view/Groups.FormativeEAssessment/>). The assessment focus is students' critical understanding of the features of academic writing, as part of academic literacy demanded in a master's-level initial teacher education programme which takes place in a university. A wiki is used in a face-to-face class teaching situation, and its role is to aid communication between learner, teacher and peers, through the presentation and organisation of student thinking. The students learn in a collaborative group discussion environment structured around socio-constructivist pedagogy.

#### ***A case of 'Academic Writing'***

*Situation: the setting in which this case occurred*

PGCE ICT trainee teachers embarked on a postgraduate course with M-level elements requiring academic reading and writing in this social science context. These ICT trainee teachers were a group of 23 students who came from varying backgrounds. Most had limited experience of reading research papers in social science as their degrees were quite technically based. Some already had master's qualifications, although these were usually MSc rather than MA. Many were from minority ethnic groups and English was not their first language. Most had limited experience of academic writing. Therefore, writing 8000-word assignments was a significant and potentially daunting challenge. This, however, was only one of the challenges in an



intensive programme where much of their time was spent in school placements where they were learning practical elements of teaching.

*Task: the problem to be solved, or the intended effect*

The aim was to enable trainee teachers to develop strategies for reading academic papers. This formed as part of a structured programme to develop their ability to write assignments on a range of educational issues.

*Actions carried out to fulfil the task*

The students were set in pairs to perform a brainstorming task for about 10 minutes around the question ‘How do you go about reading an academic paper?’ and writing a list on paper. During that time, the tutor walked around and listened to the talk to ensure that they were engaging with the task and to assess their general level of understanding.

Next, a set of ideas was built up on a wiki by one of the students using a Tablet PC linked to a data projector so that a developing list could be seen on the screen by the whole group. Each pair contributed an item in turn. As each item was added, other members of the group commented on its appropriateness, value and position in the developing list. Elements of the list were moved around in the wiki page to create an order as agreed by the group. Agreement was checked by raising hands at intervals. For some contentious ideas, alternatives were included and the need for flexibility owing to individual preferences was discussed. For example, some students reported finding skim reading especially difficult, while some preferred to keep electronic notes, others preferred paper.

Then, students worked in pairs to read a paper and to highlight and annotate it electronically with salient comments in relation to a writing task. Then, in a whole-group discussion, a group showed their annotations, and others commented.

The next task to be done individually after the session was a short writing task based on an analysis of the paper. This would be diagnostically assessed by a writing-support tutor who would design one or more support and feedback sessions for those identified as needing additional support. Further, whole-group activities would refer to the strategy and build on recommendations from the writing-support tutor.

*Results: what happened? Was it a success? What contributed to the outcomes?*

A master strategy with variations was developed as a list that could be referred back to. Students started practising how to apply this. Adjustments were made throughout. First (and unexpectedly) one student alerted the tutor that her partner had not understood the task as he had thought we were talking about reading exam papers. Therefore, a brief whole-group question-and-answer session was held about the range and the nature of academic papers. The paired discussion then proceeded without adjustment. The whole-class discussion was a process of continuous adjustment in which students suggested different approaches, and various ideas were pursued. The developing list was continually changed to reflect the consensus of the group.

*Lessons learned from the experience*

The electronic facilities provided:

- a visual display of the consensus from the discussion as it developed;
- a means for a pair of students to jointly read and annotate a document;
- an aid for students in displaying and explaining their findings to the group; and
- a record that individuals can refer to.

Thus the ‘e’ in e-assessment in this formative context aids communication and presentation. The formative nature of the activities derives from the responses of the lecturer and other students that enable a series of feedback loops. These result in continual relatively small adjustments in the ongoing process and feed into future planning. The hope is that individual students are also making adjustments in their thinking.

In this case, it is possible to see a full utilisation of Laurillard’s practical and discursive/theoretical levels of the conversational framework, in the series of interactions which form feedback and feed-forward loops around the building of concepts between the teacher, individual learner and peers. The wiki acts to enable collaborative reflection on ideas, allowing them to be revisited and modified as a result of a carefully guided discussion by the tutor. A peer review of ongoing development of ideas is a core formative activity. The wiki facilitates a formative assessment channel of many to many, and contingency is built in through synchronous ‘real time’ adjustments in thinking which both feed into the wiki and stimulated by its recording of the dynamic discussion of all the groups. It is an example of the inter-dependence of technology and social interaction in the ways feedback is generated and loops are formed between the various players involved to develop thinking. Participants are involved in appropriating social and technological resources, and actively construct the ongoing context for their learning, made up of their interactions with each other and with the technology. There are opportunities for students’ understanding to move forward based on all three types of actors involved in roles in three key formative assessment strategies (Black and Wiliam 2009) within this context: the tutor role (providing feedback that moves learners forward), the peer role (activating students as instructional resources for one another) and the individual learner role (activating students as owners of their own learning).

### **Patterns**

The patterns (see Pachler et al. 2009) were developed in the project wiki by group authorship within the workshops and with the project team members between workshops. The full and most recent version of these patterns is available on the project wiki at <http://patternlanguagenetwork.myxwiki.org/xwiki/bin/view/Groups.FormativeEAssessment/patterns>.

An example of a design pattern of formative e-assessment is presented here, ‘try once, refine once’. Patterns are by nature densely linked to each other and to case stories. Although the pattern presented is derived from a virtual learning environment, patterns from the project have high applicability to face-to-face environments where technologies are used. The pattern methodology produces a brief summary and visual motif, followed by a detailed description of the pattern. This is reproduced here (Figure 3) as it was developed on the wiki.

*A pattern: try once, refine once* ([www.purl.org/planet/Patterns/t1r1/](http://www.purl.org/planet/Patterns/t1r1/))



A **two-step** question-answering system which encourages students to consider their initial answers to skills-based questions very carefully, and, on receiving feedback on their errors, to give as much thought to the refinement process.



Figure 3. A pattern: try once, refine once. Reproduced from [flickr.com/photos/maplessinseattle/2844627566](http://flickr.com/photos/maplessinseattle/2844627566). (License: <http://creativecommons.org/licenses/by-nd/2.0/deed.en>)

### *Problem*

Large numbers of students follow a skills-based course. Lack of immediate feedback for students leads to fossilisation of errors and misconceptions – however, providing immediate feedback in an iterative fashion can also hinder effective learning since students are able to ‘grope their way’ step by step to a correct solution without necessarily having to think about each answer as a whole.

### *Context*

This pattern applies to skill-based learning situations where multiple misconceptions in exercise answers are possible. It is particularly applicable to foreign language learning, but could also work for other skill-based fields. The range of assessment types this approach might be suitable for would be those in which students’ answers can contain multiple errors, for which detailed feedback indicating the source and the type of each of the errors can be generated/given, without revealing exactly what must be done to correct them.

### *Solution*

Students are posed questions of a type, which elicit answers that can contain multiple errors. If a student’s answer is entirely correct, a mark of 100% is awarded. If their answer contains errors, a mark is given which contributes to a percentage of the total mark for the question, along with detailed – yet generic – feedback on the location and the type of the errors. Students are then permitted a second attempt in which to refine their answer. The mark for the second attempt contributes to the remaining percentage

of the total mark for the question. Feedback on any remaining errors is also given along with the correct answer(s). No further attempts are permitted.

The two-attempt limit and unequal weighting of the marks for the initial attempt and the refined answer are crucial to this pattern, since they prevent students from adopting a mindless iterative approach, in which they begin with a ‘stab-in-the-dark’, then allow the system/tutor to guide them step by step to the correct answer (often via numerous minimally altered attempts).

The marks ratio can vary, but showing a distinct favouring for the first attempt works best – ensuring that students give careful consideration to all components of their first answer and equally careful consideration to improving it in the face of the diagnostic feedback. If the ratio is skewed too far in favour of the second attempt, then students tend to exhibit less care over the construction of their initial answer. If the ratio is skewed too far in favour of the first attempt, then students are less inclined to try and correct non-perfect answers.

The marks ratio could be adjusted according to the amount of information in the feedback. The less information in the feedback, the higher the second mark should be, the more information in the feedback, the less the second mark should be (Figure 4 Sequence diagram from [www.websequencediagrams.com/](http://www.websequencediagrams.com/))

In terms of the conversational framework, ‘try once, refine once’ is concerned with the learner’s action to achieve task goals, feedback on action and reflection on feedback leading to a change in the learner’s conception. It occupies the left-hand side of the framework, with a focus on individual reflection, revision and adaptation as a basis for a learning ‘conversation’ with oneself in response to automated teacher feedback on evidence of skill-levels. Individual cognitive work in response to feedback is core. The conversational framework, however, provides no specific justification for the division of marks or form of feedback. Regarding Black and Wiliam’s (2009) theory of formative feedback, this is an example of *key strategy 5*, ‘activating students as the owners of their own learning’. ‘Contingency’ is created via a near-synchronous or asynchronous feedback cycle by which subsequent attempts are related to degrees of learner confidence as well as competence (students could do each exercise in a single sitting or in several sittings over a period of weeks). A particular clue as to why the assessment practice proposed in this pattern has formative effects is provided by Hattie and Timperley (2007, 95) who write:

The degree of confidence that students have in the correctness of responses can affect receptivity to and seeking of feedback. Kulhavy and Stock (1989) noted that if confidence or response certainty is high and the response turns out to be a correct one, little attention is paid to the feedback. Feedback has its greatest effect when a learner expects a response to be correct and it turns out to be wrong. As Kulhavy and Stock noted, ‘high confidence errors are the point at which feedback should play its greatest corrective role, simply because the person studies the item longer in an attempt to correct the misconception’.

Because 75% of the marks will be given for the first attempt the students are likely to give answers in which they have a considerable degree of confidence – so, if the answer is then found to be incorrect, then this is a situation where the feedback will be most effective. There is a high degree of contingency in this sequence of choices and actions, in a context where the learner has to take responsibility and invest highly in both attempts. A previous work related to this pattern has been undertaken by Fowler (2006, 2008) in developing effective feedback on whole-phrase input in computer-assisted language learning (CALL). In the CALL exercises from which this

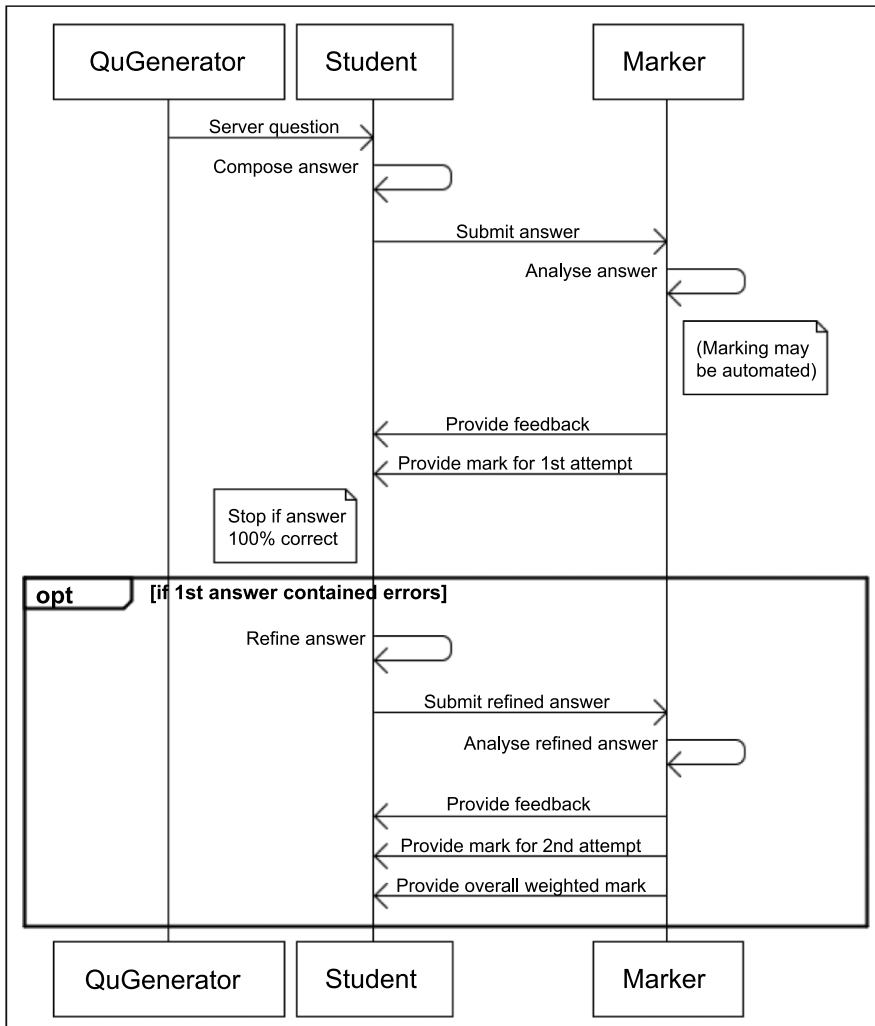


Figure 4. Sequence diagram for ‘try once, refine once’, designed by Alison Fowler.

pattern was drawn, the ratio of marks between the first and the second answer attempts was 3:1. This proved optimal for the original situation but is obviously easily altered for other assessment types. ‘Try once, refine once’ led not only to marked improvements between the first and the second answer attempts, but more importantly to demonstrable improvement in accuracy (and speed) of answering as users progressed through exercises. In other words, students became able to formulate their foreign language sentences more accurately and with greater rapidity, which is a significant measure of success in language learning.

### Discussion

By developing cases of practice which use technologies *formatively*, we have been able to identify patterns which capture core features of formative assessment processes. The

patterns suggest that there are key technological attributes or ‘resources’, which appeared to make a difference to the learner’s potential for improvement, because of the way the technology contributed to potential actions which are made possible within moments of contingency. The technology does not in and of itself *create* these moments of contingency. These depend on the set of human responses, motivational factors and socio-interactive contexts, which create opportunities for the choices made by a learner and actions taken in conjunction with feedback and interaction offered by electronic tools. The tools do have particular shaping effects on the types of choices and actions which can emerge. The technologies we describe in the case and pattern have effects of *constituting* the learning environment and contingent possibilities as part of it. The following is a set of technological ‘resources’ identified by the project which appear in the patterns we abstracted from practice:

- (1) Speed
  - (a) Speed of response is often important in enabling feedback to have an effect.
  - (b) It supports rapid iteration – in many cases the ability to give feedback quickly means that the student’s next problem-solving iteration can begin more quickly.
- (2) Storage capacity
  - (a) Ability to access very large amounts of data, so that appropriate feedback/additional work/illustrations can be identified to provide individualised learning pathways based on evidence of learner needs (examples include customising digital library resources to identified individual learner needs within a domain content knowledge base).
- (3) Processing
  - (a) Automation – in some situations, the e-assessment system can analyse responses automatically and provide appropriate feedback (examples include feedback on grammar in language learning-support systems).
  - (b) Scalability – can often be the result of some level of automation.
  - (c) Adaptivity – systems can adapt to students.
- (4) Communication
  - (a) Often the advantage of the technology is that it enables rapid communication of ideas across a range of audiences and allows this range to be controlled. It can be just one person, a group, a class or more.
  - (b) The communication resource means that aspects of communication can be captured and given a degree of semi-permanence.
  - (c) This semi-permanence supports the sharing of intellectual objects (examples include ‘audiofiles’ which mediate ‘authenticity’ in feedback).
- (5) Construction and representation
  - (a) Representation – the ability to represent ideas in a variety of ways and to move and translate between these representations.
  - (b) Technology can support the learner in the construction of representations of their own ideas.
  - (c) By representation, technology enables concepts to be ‘shaped’ and therefore affects their meaning, that is, representation makes use of symbols which help meanings develop.
  - (d) In representing their ideas in digital artefacts (creating these intellectual objects), a learner opens up a window on their thinking (examples include using mobile devices to capture images representing key learner

- practices and using interactive white boards to support and capture concept formation through visual representation of understanding).
- (6) Mutability – shared objects are not fixed, they can change/be changed easily and quickly (examples include the use of a wiki to support building collaborative frameworks of ideas over time within critical audience conditions).

These resources form part of complex environments, both virtual and physical, in which learners and teachers interact in multiple ways in order to bring about enhanced learning. They emphasise that ideas, roles and ways of developing and communicating ideas are not fixed. The concept of ‘context-making’ offers a way of understanding the ways in which a learner interacts with these technological resources to develop choices and actions which affect future learning. ‘Context’, in technologically enhanced learning situations, becomes a malleable concept, whether it is applied to individuals communicating in a physical space or online. Sharples (2007) has suggested that ‘context’ is not a fixed environment in which people learn. Instead it is what people do – they make changes in the ways they interact with others and with technologies, and thus change the learning conditions which exist and which shape what can be done next. Context is constantly evolving and being re-made by learners. Sharples thus draws on Cole’s distinction (1996) between context as ‘that which surrounds us’ and ‘that which weaves us together’. The argument is that context creation with technologies allows for high degrees of agency among learners: ‘Context is continually created by “minds in motion” within distributed learning systems’ (n.p.). He accords a high level of agentive capacity to minds which interact with technologies and with other individuals (teachers, peers) to shape thinking: ‘context is a dynamic and historical process constructed through interaction between people, technology, objects and activities within a pervasive medium to enable appropriate action’ (Sharples 2007, n.p.). ‘Appropriate action’, as a consequence of context, is one way of seeing what is necessary for ‘moments of contingency’ to be productive for a learner. Appropriate action is a necessary pre-requisite for assessment to have formative effects. Sharples highlights the person as agentive in appropriating evidence created with or by technologies to effect change. Such a perspective emphasises that learning is dependent on the ‘social turn’ in conjunction with the technological one. From this point of view, formative assessment can be seen as part of what Koschmann (2003) has called a ‘sociogenic’ practice. This involves processes of appropriating the social and technological resources produced in learning situations, and engaging with both to learn how to take control over learning experiences. The conversational framework likewise captures the practices by which individual learners appropriate a range of social *and* technological tools to differing degrees within a sociogenic view of learning environments as contexts which learners and teachers create as they participate in sequences of engagement. It is possible to see formative assessment as part of a ‘sociogenic’ experience of learning with technologies, involving moments of contingency, which are generated by social and technological resources. This is an area which merits further investigation, focusing as it does on the human-centric aspects of formative assessment in relation to technologies.

## Conclusion

This article has presented questions, explored within the project, about how technologies contribute to formative assessment. We have presented an illustrative case and a

pattern developed by the project to demonstrate how we explored the conceptual complexities involved by grounding the methodology in practitioner experience and participation as well as theoretical perspectives. The project findings suggest that formative e-assessment is an extremely complex phenomenon, and is best understood as a set of processes involving both technological and social resources by which individuals (both learners and teachers) are enabled to engage agentively with evidence of learning, in order to effect changes in understanding. Such engagement is crucial to ‘moments of contingency’ and can take a wide range of forms, both synchronous and asynchronous. Formative processes take place within broader frameworks of learning, which are based on the roles of the participants (teachers, individual learners, peers) and a range of practical and discursive actions in which they participate. In the cases and patterns developed by the study, technologies do not in themselves bring about formative effects. ‘Formative e-assessment’ is better understood as multiple processes involving technologies to greater or lesser degrees, where evidence is generated about a learner’s state of understanding relative to desirable goals, and where individuals are enabled to take actions which have formative effects. We conclude that there is no definitive amount or use of the technology which determines ‘formative e-assessment’. We should rather be concerned to understand more about how technological resources can work *formatively* in conjunction with other social and individual cognitive resources within a coherent view of learning as ‘conversational’.

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