Exploring Formative e-Assessment: Using Case Stories and Design Patterns

This article is intended for the Special Issue on 'Approaches to assessment that enhance learning': eds Stylianos Hatzipanagos and Rebecca Rochon.

Abstract

This article presents key findings from a 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 existing practices where technologies contribute to formative assessment and identify processes which 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 range 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 for how they displayed aspects 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, individuals 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 a recent Joint Information Systems Committee (JISC) funded project entitled 'Scoping a vision for formative e-assessment (FEASST)' led by the WLE Centre for Excellence and the London Knowledge Lab at the Institute of Education, University of London. 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 better understanding of their use. The project first conducted a review of literature on formative assessment (including assessment for learning), 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 (forthcoming) 'aspects of formative assessment'. Using a design pattern methodology (developed by the Planet Project[1]), the project developed a range of case studies of formative e-assessment with twenty-seven practitioners across a range of sectors through a series of Practical Enquiry Days (PEDs). In our PEDS practitioners

[1]

reported on cases from their own experience, and on the basis of these they identified proto-patterns. Selected patterns were refined and elaborated by the team in consultation with the original contributors, and were also analysed against the findings from the literature review. The patterns were further scrutinised by a group of twelve 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 and assessment for learning has been carried out in the UK, largely within the school sector (Black and Wiliam 1998; Black et al 2002). It is increasingly recognized that this work should find more widespread inclusion in post-16 pedagogy. One challenge for post-16 education remains the alignment of assessment practice with research findings which clearly show that the successful use of assessment for learning is premised on the notion that learners will improve most if they understand the aims and processes of their learning, i.e. 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 learners that provide information that yield feedback suitable to make

necessary modifications to teaching and learning activities, i.e. those that lead to learners having a better understanding of what they are trying to learn, what is expected of them and how to make improvements. Assessment for learning can be seen to be premised on high quality interactions, including questioning, listening, responding and reflecting, between teacher and learners, learners and learners as well as learners with themselves. In this way, assessment can be seen to be integral to learning processes.

The increasing prevalence of ICT in teaching and learning presents a challenge in the area of assessment in technology-enhanced settings. 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, p. 6). This indicates that the main priorities for 'e-assessment' have been institutional strategy, the development of standards, technical infrastructure and learning support tools and much less on 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 learners appropriate 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, adaptvity and learner self-regulation. There are widely differing theoretical emphases in the literature and, within e-assessment, a tendency to conflate formative and summative assessment, within a view of 'adaptivity' as a core component of e-assessment processes. ('Adaptivity' here indicates the flexible responsiveness on the part of learners and teachers which may or may not itself involve the use of technology). 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 learners. Some examples of formative e-assessment can be argued to be serial summative assessment. 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 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 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 amount of assessment is 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 learners' engagement with feedback.

'Key aspects' of formative assessment

Recent work by Black and Wiliam (forthcoming) provided a framework which suggests that assessment for learning – their term for formative assessment –consists of a number of 'key aspects' and five broad strategies. The key aspects revolve around the where the learner is going, where the learner is right now and how she can get there and examines the role played by the teacher, peers and the learner.

FIGURE 1 ABOUT HERE

Figure 1: key aspects of formative assessment (Black and Wiliam, forthcoming).

The five key 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':

> …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, forthcoming)

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 slippage between terms like 'assessment' and 'learning', and '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.

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 re-think about distinctions between formative and summative assessment, 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 assessment, with a focus on how learners *use* 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 assessment become 'blurred' is important:

> perhaps CAA offers a sort of bridge between formative and summative assessments…the line between formative and summative assessment 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. (2004, p. 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 for 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 computerized 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, forthcoming) 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 learners' 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 (Nichol 2007) are crucial aspects of formative assessment in much of the literature based in 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 where practices are driven by state-of-the-art technological know-how rather than pedagogy. The conclusion was that distinguishing formative and summative assessment, 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 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.

FIGURE 2 ABOUT HERE

Figure 2: Laurillard's Conversational Framework.

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, other than perhaps 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 learners' practice and so modifying the learning and assessment task (Adapts a Task practice environment for learners' needs).
- Peer assessment can be seen where learners sharing their activities (Shares practice attempt) and as consequence reflect 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 originates in the Learning Patterns project (http://lp.noe-kaleidoscope.org/; Mor & Winters 2008; Winters and Mor, 2009), and which has been extensively developed by the Planet project. 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 face and methods for addressing them. The methodology calls for a sequence of collaborative workshops in which project participants actively construct cases and patterns which provide distillations of key features of practice in a particular learning context. Cases and patterns are 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 these 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. These workshops (Practical Enquiry Days) 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 who 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 key 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. The final Practical Enquiry Day involved twelve 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, participants drew on their contextualized experiences as practitioners of using technologies as part of formative assessment. In each group, participants took on roles of narrator, author and reporter, to articulate cases of practice where 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, which is taken from 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 masters 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 organization 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 were embarking on a postgraduate course with M-level elements requiring academic reading and writing in this social science context. These ICT trainee teachers are a group of 23 students who come from varying backgrounds. Most have limited experience of reading research papers in social science as their degrees are quite technically based. Some already have masters qualifications although these are usually MSc rather than MA. Many are from minority ethnic groups and English is not their first language. Most have limited experience of academic writing. Therefore writing 8000 word assignments is a significant and potentially daunting challenge. This is however only one of the challenges in an intensive programme where much of their time is spent in school placements where they are 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 forms 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

Students were set the task in pairs of brainstorming 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 the 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 and while some preferred to keep electronic notes others preferred paper.

Then students worked in pairs to read a paper and 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 a 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 will refer to the strategy and build on recommendations from the writing support tutor.

Results: What happened? Was is 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 nature of academic papers. The paired discussion then proceeded without adjustment. The whole class discussion was a process of continuous adjustment where 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*
- *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 utilization 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 carefully guided discussion by the tutor. 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 in to the wiki and are 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, forthcoming) 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 were developed in the wiki by group authorship within the workshops and with project team members between workshops. The full and most recent version of these patterns in available on the project wiki at: http://patternlanguagenetwork.myxwiki.org/xwiki/bin/view/Groups.FormativeEAssessment/Process+Models+&+Design+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 as it was developed on the wiki.

A pattern: Try Once, Refine Once (http://purl.org/planet/Patterns/t1r1/)

FIGURE 3 ABOUT HERE

Figure 3: Try Once, Refine Once.

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 skills-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 skills-based fields. The range of assessment types this approach might be suitable for would be those in which student answers can contain multiple errors, for which detailed feedback indicating the source and 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 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.

(Sequence diagram from http://www.websequencediagrams.com/)

FIGURE 4 ABOUT HERE

Figure 4. Sequence diagram for 'Try Once, Refine Once', designed by Alison Fowler.

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 skills-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 (forthcoming)

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 p. 225) 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. Previous work related to this pattern has been undertaken by Fowler (2008,

2006) in developing effective feedback on whole-phrase input in computer-assisted language learning (CALL). In the CALL exercises from which this pattern was drawn, the ratio of marks between the first and 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 first and 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 key features of formative assessment processes. The patterns suggest that there are key technological attributes or 'resources' which appeared to make a difference to the learners' potential for improvement, because of the way the technology contributed to creating moments of contingency. The technology does not in and of itself *create* these moments of contingency however. These depend on the set of human responses, motivational factors and socio-interactive contexts which create opportunities for the choices learners make 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. Where these resources are made available to learners, they have an important contribution to make in that they help constitute moments of contingency.

(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 individualized learning pathways based on evidence of learner needs. (Examples include customizing 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 learners in the construction of representations of their own ideas.

c. By representation technology enables concepts to be 'shaped' and therefore affects their meaning, i.e. representation makes use of symbols which help meanings develop.

d. In representing their ideas in digital artefacts (creating these intellectual objects) learners open 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 learners interact 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 learners. 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. 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 key questions explored within the project, about how technologies contribute to formative assessment. We have presented an illustrative case and 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 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 key players (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'.

Acknowledgements

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Figure captions

Figure 2: key aspects of formative assessment (Black and Wiliam, forthcoming).

Figure 2: Laurillard's Conversational Framework.

Figure 3: Try Once, Refine Once.

Figure 4. Sequence diagram for 'Try Once, Refine Once', designed by Alison Fowler.

Figure 1: key aspects of formative assessment (Black and Wiliam, forthcoming).

<table>
<tr><td></td><td>Where the learner is going</td><td>Where the learner is</td><td>How to get there</td></tr>
<tr><td>Teacher</td><td rowspan="3">Clarify and share learning intentions

Understand and share learning intentions

Understand learning intentions</td><td>Engineering effective discussions, tasks and activities that elicit evidence of learning</td><td>Providing feedback that moves learners forward</td></tr>
<tr><td>Peer</td><td colspan="2">Activating students as learning resources for one another</td></tr>
<tr><td>Learner</td><td colspan="2">Activating students as owners of their own learning</td></tr>
</table>

Figure 2: Laurillard's Conversational Framework.

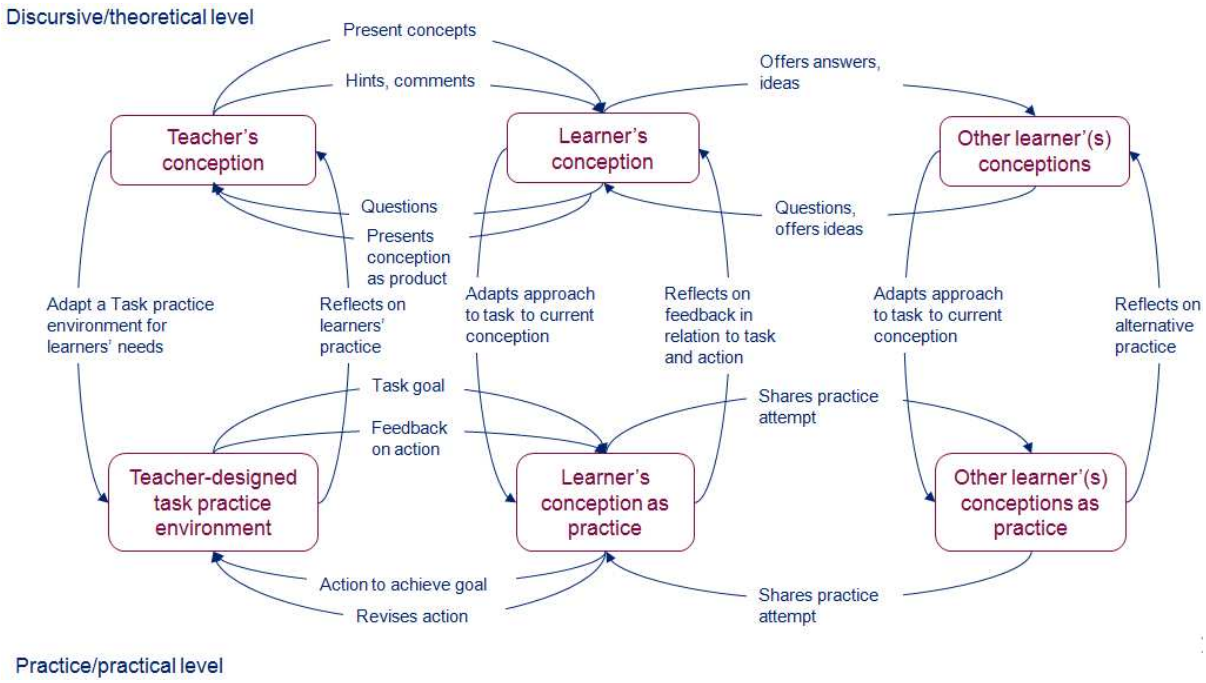

Figure 3: Try Once, Refine Once.

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 4. Sequence diagram for 'Try Once, Refine Once', designed by Alison Fowler.