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Using an online formative assessment framework to enhance student engagement: a learning outcomes approach

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Abstract

Students learn best when they are fully engaged in the learning process, are motivated to test their learning against known standards, and are offered targeted and timely support to address personal learning needs. This is usually achieved through summative assessment, but this in itself can influence what and how students learn, rather than encouraging continuous reflective learning.

This paper presents initial findings from work on the implementation of an online interactive formative assessment framework. The framework has been designed from a constructivist and interventionist perspective, using a learning outcomes approach. It aims to enhance student awareness, understanding and recognition of competency levels, and to allow testing of ongoing academic progress at predetermined and self-selected points throughout the year. By working through the formative assessments it is hoped students will become more self-directed and confident in their learning skills, and that this in turn will improve retention. Preliminary results indicate students rate the assessments as enjoyable, and are using them to reflect on personal academic progress.

Introduction

Whether we like it or not, assessment is central to the learning experience and can be viewed as *'…the single biggest influence on how students approach their learning'* (Rust et al, 2005). Assessment alters how and what students decide to learn, as well as how much time and effort they prioritise to different tasks and learning resources. Each interaction a learner has with the assessment process impacts on future learning experiences, further influencing the development of their learning approach (Struyven et al, 2005). Assessment also plays a fundamental role in maintaining and enhancing learner motivation through the provision of personalised feedback, allowing the individual to reflect on their learning, clarify misconceptions, obtain a sense of the level of competencies attained, and gauge how they are progressing (Orsmond et al, 2005; Prowse et al, 2007). For continued academic progression to be made, some form of external interventionist support is required (Vygotsky, 1978). One way of providing such support within today's environment of mass education is through the effective use of online assessment tools. Supporting learning and teaching through ICT increases the potential for frequent and timely assessment of and feedback on learner progression, which can theoretically be offered 'on demand' to meet individual learner needs. Furthermore, as discussed by Gipps (2005), as educational practices become more reliant on computing technology, assessment methods should also follow suit to ensure parity of approach throughout the learning experience.

If assessment is to function as an effective mechanism to promote learning progression, it must measure current learning, as well as support and encourage future learning (Gibbs & Simpson, 2005), and should provide individuals with clear opportunities to assess progression and recognise the levels of competency achieved (Challis, 2005). Furthermore, all approaches used must be fully integrated with the assessment practice and be explicitly linked by clear learning outcomes. In other words, a constructivist approach to learning, teaching and assessment is imperative (Rust et al, 2005), enabling all aspects of learning as defined by Brown et al (1997, quoted in Orsmond et al, 2005), as *"…changes*

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in knowledge, understanding, skills and attitudes brought about by experience and reflection upon that experience", to be tested. Furthermore, for an effective learner support framework to work, all stakeholders must be able to *explicitly* recognise how it can contribute to the quality of an individuals learning experience.

Helping learners to learn more effectively through scaffolding

In general, learning is a social experience that occurs at a personal level, and which must be internalised before it can be applied and adapted for future use. Working from Vygotsky's principle of social interaction (1978), effective learning will only occur within an interventionist environment where there are opportunities to develop, apply and expand new skills and knowledge, supported at appropriate points and in appropriate ways to meet an individual's learning needs. This concept, frequently referred to as 'scaffolding', is central to a constructivist approach to learning and teaching (Sharma and Hannafin, 2007). It works reactively by allowing learners to access support in the form of learning materials, generic resources and tutor support at a time that meets their needs, as well as proactively, by flagging areas of potential conflict, while suggesting additional learning resources and methods of support, to resolve such issues.

Although the rise in use of ICT and technology-enhanced virtual learning environments throughout education is one way in which learning can be scaffolded to help individuals develop beyond their personal capabilities (Sharma and Hannafin, 2007), as Kirkwood and Price (2005) stated: *"…ICT can enable new forms of teaching and learning to take place, [but] cannot ensure that effective and appropriate learning outcomes are achieved. It is not technologies, but educational purposes and pedagogy that must provide the lead, with students understanding not only how to work with ICT, but why it can be of benefit for them to do so."* Therefore, as stakeholders are presented with increasing opportunities to manage, test and support their learning using online tools, it is paramount that these are carefully designed to ensure that the individual's learning experience is enhanced in accordance with

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Vygotsky's principle of assistive learning support. This needs to be done in an environment that simultaneously matches the conflicting needs of today's mass education to improve standards and retention rates, whilst remaining as cost and time effective as possible.

Study in Context

This study has been funded by the Centre for Open Learning in Maths, Science, Computing and Technology (one of the UK's Centre of Excellence in Teaching and Learning), to develop and implement an integrated Student Online Formative Assessment (SOFA) for a UK Open University (UKOU) upper level 2 undergraduate open and distance learning (ODL) course in Earth System Science. The course, *'Our Dynamic Planet'* (S279), forms part of the Geosciences study programme and was presented for the first time in 2007. It attracted ~500 students at the start of its first year and equates to ~300 hours of study, completed over a 9 month period. It is formally assessed by four summative assessments and an unseen open-book end of course examination. Throughout the course, students are expected to use and apply a wide range of scientific knowledge and skills (from Biology, Chemistry, Geology, Physics and Maths), and develop higher level cognitive skills that permit holistic and critically subjective approaches to analysing current concepts and theories within Earth System Science, to be taken. The core learning resources include two course text-books, an online study calendar and course website, interactive multimedia activities (DVD-ROM), and optional online and face-to-face tutorials, in addition to ongoing personal tutor support. The SOFAs have been designed to complement these resources, enhance student learning and aid recognition and awareness of skills development.

Student Online Formative Assessments (SOFAs) – structure, support and pedagogic approach

The main objectives of the SOFA framework are to:

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- develop a 'safe', formative learning environment to test depth of learning and application and enhance awareness, understanding and recognition of personal strengths, weaknesses and achievements;

- use a constructivist approach (goal-directed and knowledge-building) to offer appropriate flexible and timely levels of support to allow individual testing of academic progress at predetermined and self-selected points throughout the academic year; and

- encourage a self-directed, integrated and paced approach to learning and a more confident, motivated and satisfied awareness of academic progression.

At present, the SOFA framework encompasses seven assessments, based on specific chapters within the first course book, with the eighth assessment providing an instant revision tool (see appendix). Each SOFA consists of ten interactive questions developed within *OpenMark*, a web-based system created by the UKOU, and being integrated into Moodle. Users have up to three attempts to correctly answer each question, with instantaneous and targeted formative feedback provided after each incorrect attempt. Two levels of complexity have been developed into the SOFAs, with this increasing in each assessment on a question-by-question basis, as well as between SOFAs. The SOFAs are accessed via the online study calendar, with students invited to '*Check your understanding…'* at the end of each week, designed to encourage regular self-assessment and provide opportunities to apply newly gained knowledge and understanding, out-with the summative assessments. Each assessment commences with suggestions on how to work through the questions and reminds students they are not expected to get all questions correct first time (or on their first complete attempt of each assessment). Students can choose to answer questions sequentially or in any order they wish, completing the whole assessment in one sitting or over a series of attempts, as the system records which questions have been completed and which have yet to be attempted. As the majority of questions contain alternative variables, when repeating a question, students are automatically presented with a new version. Students can end the

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test at any time (triggering personalised summary feedback on the whole assessment) and can repeat an assessment (or particular question) as many times as they wish.

In addition, *OpenMark* automatically collates quantitative information at the individual user and group levels, offering insight into how students are engaging with different aspects of learning. This can be used to identify common misconceptions and deficits in skills and knowledge. In addition, the system logs the time spent on each assessment, offering tangible evidence into how students are physically engaging with the assessment, course content and skills.

Feedback on learning

Each SOFA offers variable advice including: general hints and/or information preceding a question; stepped and targeted feedback after each attempt; summary feedback at the end of each question; and final summary feedback at the end of each assessment. All feedback is formative, with the final summary commenting explicitly on how each of the learning outcomes have been demonstrated, providing an indication of the level of academic competency attained at that point in time.

Within each question, the staged levels of feedback targeted at incorrect responses commences with a '*Try again'* comment plus help on minor omissions or errors. The second stage offers more specific advice and guidance: highlighting and commenting on specific (common) errors; showing by example how to approach particular aspects of questions; offering tips and suggestions on how to progress; and encouraging students to refer to specific learning resources before attempting the question again. The final feedback provides students with the expected answer along with a worked example, while referring them as appropriate to relevant learning resources. In addition, the feedback emphasises which skills have been developed and states why these are important at a particular point in time and in future, putting learning into context. Each final feedback concludes with a list of the learning outcomes tested by this particular question.

Intrinsic and extrinsic values – encouraging learners to use the SOFA

To enhance individual progression through targeted and timely support, it is imperative that stakeholders recognise:

- the extrinsic and intrinsic values of the SOFAs, in relation to aiding individual (and community) levels of progression by successfully demonstrating learning outcomes;

- how formative assessment can enhance the learning experience;

- the SOFAs as integral to the learning experience and not as a supplementary resource, designed to as a remedial learning aide; and

- that they can interact with it easily, without fear of technical difficulties or time constraints (eg it supplements rather than distracts from the rest of the course).

Each of these points relate to the five principles of learning skills development outlined by Simpson (2002, p135), in which he states there is '*no absolute set of learning skills appropriate for all ODL students at every stage*', with learners using learning methods that are most familiar to them, refusing to change unless they can see a direct and immediate personal benefit. This corresponds with the findings of Kirkwood (2003) and Kirkwood and Price (2005) who examined learners' use and perception of different learning media, and who discovered that when faced with an array of learning media, individuals allocated time according to which resource was perceived as most 'cost effective' in terms of overall time management and tackling summative assessments. Kirkwood (2003) also reported that although learners recognised the intrinsic value of different learning resources, the level of integration of a resource was paramount to whether it was perceived as sufficiently important to be an effective use of time. Where a particular medium was perceived as 'bolted on' to the core resources, learners were unlikely to use it allocating study time to more 'valued' and 'central' resources. The general consensus on use was summed up by one learner who stated: *"People are too busy… they won't [access the*

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learning resource] unless they know it's absolutely essential, and if it's essential, they should have

provided you with [it]" (Kirkwood, 2003).

Evaluation methods

At the time of writing, analysis and critical evaluation of the first year of use of the SOFAs is ongoing, examining levels and styles of usage alongside perceived values of this framework, from the perspectives of the students and tutors. A full account of results from quantitative data automatically collected within *OpenMark* and quantitative and qualitative data from the online questionnaire (at end of each SOFA) will be presented elsewhere, along with the results of continued investigations into usage and non-usage patterns by different stakeholders. The results presented in this paper meanwhile are based on a first round of targeted interviews using a Success Case Method (SCM) approach, to gain qualitative insight into the perceived value of this learning support framework. Although a detailed account of these interviews and their full implications on the effectiveness and future development of the SOFAs is beyond the scope of this paper, a summary of key findings is presented for consideration.

A Success Case Method (SCM) approach

The Success Case Method (SCM) evaluation technique was originally devised to investigate why particular practices worked for some individuals/organisations but not for others, and how this insight could be used to improve practices for others (Brinkerhoff, 2003). It uses a mixture of quantitative and qualitative social science research methods, combining story-telling with scientific analyses, turning emotive findings into practical solutions. As such, SCM is useful for assessing social practices, outcomes and impacts, areas that are typically difficult to quantify (Brinkerhoff, 2003, p.xi).

The SCM technique uses the premise that data for the majority of studies will form a normal distribution curve, with 'absolute success' and 'absolute failure' occurring at extreme ends. Extracting useful information from the core of a normal distribution curve is fraught with difficulties due to additional 'noise'

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associated with 'satisfactory' practice. In contrast, by focussing on the ends of the distribution, it easier to extract and compare extreme perceptions, opinions and practices, and so determine key influences and how these can be used to improve general practice. Within such studies, it is important to recognise that the definition of 'absolute success' and 'absolute failure' will vary between stakeholders, and that failure does not necessary represent the complete absence of success.

The SCM evaluation technique uses a five steps process: i) developing models of what 'success' and 'non-success' look like; ii) locating verifiable success and non-success cases via a preliminary questionnaire; iii) identifying the most 'powerful' (i.e. most useful) stories; iv) documenting extreme cases; v) communicating findings and making recommendations for improvement (Brinkerhoff, 2003, p29; Williams, 2007).

Within this study, success was defined as the SOFAs being proactively used to test understanding, with results allowing users to identify strengths, weaknesses and misconceptions, gauge personal progression, and enable targeted revision and on-going development. The resultant outcome of success were predicted to be a more confident and motivated user able and willing to take responsibility for their own learning progression and aware of personal achievements. (Non-success meanwhile was represented either by the non-use of the SOFAs or by use of the SOFAs but failure to recognise how to use this to direct learning and aide future progression.)

Success Case Method Interview process

Two key stakeholders were identified for investigation –students and tutors, with a four-step questionnaire (step ii) provided electronically to each group, from which ten students (eight potential success cases and two potential non-success cases) and two tutors (one potential success and one potential non-success case) selected to participate in detailed telephone interviews (steps iii-iv). Each ~1-hour interview used the standard SCM protocol in which success case stories investigated: i) what was used that worked; ii) what results were achieved; iii) what value was perceived; iv) what helped;

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and v) what could be done to make further improvements; the non-success case stories followed a simpler protocol examining: i) the barriers; and ii) suggestions on how to make it a success (Brinkerhoff, 2003, p142-145). In this first round of interviews, non-success case stories focused on individuals who tried all of the SOFAs, but did not find the experience valuable. Examples of use, effectiveness and/or failure described by each interviewee were verified by referring to quantitative data collected by *OpenMark* and cross-referencing with external sources (eg other students/ tutors, assignment grades etc).

Results

Summary review of SCM interviews – identifying values

Examination of student records revealed the SCM interviewees came from across the academic spectrum, with some relatively new to ODL whereas others were more experienced in terms of the number of courses successfully completed. Prior educational experiences also varied (from no declared higher secondary qualifications to completed tertiary degrees), as did employment status, age and gender. Although the sample size in this first study is too small to reach definitive conclusions, on the basis of evidence available, there is no correlation between the variables listed above and the level of perceived success or non-success. In contrast to the student group, differences in duration and breadth of teaching experience of the tutors interviewed during this initial study may have impacted on their perceived value of the SOFAs, in terms of their facilitative role and perceived levels of engagement. Before definitive conclusions can be reached, additional tutoring staff must be interviewed. As the issues raised and discussed by students and tutors were found to be comparable, results have been combined and will be considered from the perspective of what underlies the successful use and perceived value of the SOFAs, compared with non-success case examples.

Success case stories

Analysis of success case stories indicates these individuals adopted a constructive approach to their learning (and teaching), consistently looking for positive and practical solutions to problems as they arose. They typically used a range of deep-level and strategic learning approaches, varying tactics to address both extrinsic and intrinsic needs. They were organised and methodical in their learning approach, and expressed a belief that all resources should be tried 'at least once' to gauge their potential value to meet a defined and/or declared learning need. The majority also expected some level of immediate extrinsic benefit upon use of the SOFAs.

The level of personal confidence expressed by individuals in this group varied, with some very confident in their ability to recognise strengths and weaknesses and to successfully learn and apply new concepts, altering their approach to match perceived needs at specific points in time. Others were less certain in terms of their ability to demonstrate new knowledge, skills and understanding at the expected academic standard. All individuals expressed an intrinsic desire to increase their confidence in their academic abilities and application of learning, whilst simultaneously seeking extrinsic motivation, typically in the form of physical evidence to demonstrate tangible progression.

Each success case individual stated they immediately recognised extrinsic and intrinsic values of the SOFAs, in terms of: consolidating and clarifying learning; offering a 'no risks' environment in which they could make mistakes without fear of reproach; assessing academic progress on a regular basis; recognising and resolving misunderstandings, gaps or common errors prior to the summative assessments (i.e. before it was 'too late'); and benefiting from exposure to alternative ways of learning. All found the system easy to access and use, liked the structure and format of the SOFAs (described as like '…a mini exam, in that you don't know what the questions are going to be beforehand and have to really think about them to get the answer', and as '…a game, but designed to be like a real test…'), and set personal goals to consistently improve on previous results.

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These individuals also altered how they used the SOFAs depending on what they wanted from a particular experience. For example, several individuals described how worked through each question with the intention of obtaining an accurate indication of whether they had understood the issues and could apply the skills it was testing, whilst at other times due to time pressures or recognition that they did not understand the topic being testing, they would skip through the three attempts to reach the final explanation, reading through this and relating it back to their learning, before attempting an alternative version of the question to determine whether they could now apply this knowledge and understanding. Another common adaptation in usage style was to return to a SOFA several days (or weeks) after first use, to determine which topics could be answered easily, compared with those that proved more problematic. Individuals stated this enabled them to reinforce their learning and demonstrate they were retaining this learning, and so making their progress more explicit.

Although responses to the online questionnaire did not rate the SOFAs highly as a useful pacing mechanism, on reflection it was apparent that the success case interviewees recognise them as pacing learning, describing how results from each SOFA made them stop and reflect on what they had learned and could apply. All of the success case students reflected on how the SOFAs had made them return and review particular sections of the course and retest themselves, before progressing with their studies. Several also described how they were aware that they tended to skim read materials, believing they had absorbed, synthesised and understood the content, only to discover once they tried to apply this during summative assessments that they had not understood it. They therefore rated the SOFAs as 'invaluable', enabling them to regularly test themselves and receive 'real feedback' on the effectiveness of their learning approach and the ability to apply this learning.

One of the most valued aspects of the SOFAs was the targeted feedback, identified as helping to demonstrate learning, boost confidence and aid progression. One student stated how without fail, the feedback always commented on the exact errors and omissions in her answers. This helped her recognise an explicit relevance of this to her personal progression, explaining that when the feedback

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continuously flagged a particular error or made the same corrective comment, that this implied this was a 'real issue' that needed to resolved, rather than a simple, one-off error. She went on to describe how after completing early SOFAs and using the feedback to identify where she had gone wrong, that she started to use the summary feedback to identify which skills needed to be improved, thereby moving from using the feedback as a reflective tool to focussed feed-forward advice.

Others described similar scenarios in which the final learning outcomes summary was used to gauge progression and determine which areas to focus on. For many, obtaining a 'not yet demonstrated' or 'just demonstrated' result provided a personal challenge, the goal being to increase this to 'demonstrated' or preferably 'well demonstrated' status. This was achieved by repeating specific questions related to the relevant learning outcome(s), and comparing summary results to ascertain whether improvement had been made. This in turn enabled a sense of achievement to be attained, with the extrinsic motivation being to continue using this tool to aide progression.

None of the success case interviewees wanted to replace the SOFAs with conventional ODL print-based assessments, recognising the need to be online to gain the targeted feedback and the personalised learning outcomes summaries. These two forms of feedback were therefore perceived as being of more intrinsic value in terms of demonstrating learning and allowing progression to be assessed, than the flexibility offered by paper-based assessments that could be completed anywhere and at anytime (i.e. without needing to access a computer). Having access to personalised and timely feedback was perceived as one of the major factors enabling a growing sense of confidence in learning and the recognition of constant and consistent progress that could be independently review as and when required.

Non-success case stories

Analysis of the interviews with non-success cases, indicated that one of the main concerns was time management. All felt under pressure to maintain their learning pace with that suggested on the study

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calendar, stating that they felt there was sufficient work to complete in the course texts and multimedia activities without accessing supplementary resources (eg online activities and forums, additional reading and optional tutorials). Each individual also expressed a preference for learning from books, resorting to computer-based activities only where necessary, viewing these as auxiliary to the core learning resource and subconsciously ranking them as less 'cost effective' in terms of offering an explicit route to address the demands of the summative assessments.

These individuals also did not expect the SOFAs to be academically challenging and so became quickly demoralised when they got questions wrong. Even though they acknowledged they were not expected to get all of the questions correct, they did not believe this advice related to them and saw incorrect answers as a personal failure. This sense of failure was not helped by being told to 'try again', with confidence and motivation dropping with each incorrect attempt. This resulted in these users either entering nonsensical answers to get to the summary explanation or trying hard but making progressively more mistakes, culminating in further perceived 'failure'. The demotivational impact of incorrect answers resulted in these individuals not perceiving the summary explanations as helpful as they felt unable to relate this to what they had been doing or recognise how to use it to enable progression.

In terms of the style and format of the SOFAs, these individuals felt they were '…under examination conditions and so not allowed to have fun'. They also felt they were 'cheating' by looking at the course books (even though most questions explicitly required them to do so, to obtain the answer). They also found it logistically difficult to switch between working on-screen with their course texts. When asked why they continued to access the SOFAs after their first negative experiences, they stated that they 'did not want to feel they were missing out on anything'.

Each of the non-success cases expressed a preference for the text-based assessments or downloadable files that contained the questions and answers, as they could read the question and immediately compare their thoughts with the expected answer, or read the question and expected answer straight-off. They felt such approaches offered a more efficient use of their time, compared to

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devising their own answer (which was likely to contain errors and omissions) for something that not part of the summative assessment and therefore of low extrinsic value.

To be of any value, these users felt the SOFAs should fulfil a different role '…filling gaps in prior knowledge' and be pitched at a much lower (remedial) level in which '…everyone would get all of the questions right first time', and suggested the SOFAs should be downloadable files or located in the course text, to improve flexibility of access. Therefore for non-success case users, flexibility to use this resource whenever and where-ever desired, out-ranked any additional feedback and guidance offered by making the SOFAs interactive and online.

Discussion

Value of the SOFAs – improving experiences and future implications

A growing number of studies have demonstrated a link between the style and format of an assessment and the learning approach it encourages its users to adopt (eg Gibbs & Simpson, 2005; Haigh, 2007). Where the assessment focuses on information recall, surface and strategic learning approaches are more likely; in contrast, if students are required to apply and demonstrate different cognitive and key skills, and/or reflect on learning progression, they are more likely to use and develop deeper learning approaches. As well as encouraging a deeper approach to learning, effective formative assessment systems should engender a sense of self-belief, and motivate the user to continuously strive to enhance their academic knowledge, skills and application. They should also provide a low stakes environment in which users can try different learning approaches and make mistakes in the knowledge that appropriate support and advice will help develop learning skills needed for high-stakes activities (eg summative assessments).

Preliminary results indicate that when the SOFAs have been perceived as valuable, students have developed and used a deeper, more reflective inquiry-based learning approach. This is most evident in

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the change in usage style of the feedback and learning outcomes summaries, where success-case users moved from a strategic approach of determining where and why mistakes had occurred, to a deeper, more reflective approach where feedback was used in a feed-forward sense to focus attention areas to enable ongoing progression.

It is also apparent that the SOFAs were perceived as a 'safe environment' in which to test learning and application, without fear of reprimand or penalties. The fact that the majority of the success case interviewees altered the learning approach used to meet immediate learning needs, indicates a level of confidence in the framework to support learning progression and develop personal awareness of strengths, weaknesses and achievements. For these users, getting questions wrong did not equate to failure, as the summary feedback enabled positive analysis of errors and misconceptions to allow ongoing progression. This notion of the SOFAs as a personal support tool (Chi Ng and Murphy, 2005) to be used as and how an individual decreed, increased the extrinsic and intrinsic value of this resource, enabling individuals to focus on personal needs and performance, without the fear of being watched or compared with others. Overall, implications from the success case interviews coupled with feedback from the online questionnaire, indicate that the majority of users perceived the SOFAs as:

- providing a formative safe, learning environment to test learning and enhance awareness of personal strengths, weaknesses, achievements and progression;

- allowing individuals to recognise and resolve misunderstandings through targeted feedback, and recognise progress by repeating specific questions/assessments;

- encouraging recognition of the value of the different learning resources and how these can aide learning progression; and

- offering timely self-directed study options, that enable individuals to check the effectiveness of their learning approach and resolve gaps in knowledge and misconceptions at an early stage prior to engaging in high stakes activities.

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Academic level and function

Feedback from non-success case interviews suggest that the academic level of the SOFAs needs be reviewed. Repeatedly being told to 'try again' served to demoralise these users, resulting in them feeling they were unable to cope with the academic demands of the course. Ehrlich (1995, cited in Haigh, 2007) described a similar experience in which earlier versions of self-assessment quizzes proved too challenging, resulting in his students becoming demoralised by their apparent lack of ability rather than being motivated by positive results.

Furthermore, although one of the objectives of the SOFAs was that it should not be viewed as a remedial support system, it is clear that some users approached it from this perspective. Either improved information about the role and intended outcomes of the SOFAs need to be provided, or the SOFAs need to incorporate a pre-course remedial section to enable students to review and revise underlying skills, knowledge and understanding.

Conclusion

Effective learning will only occur in a supportive and interventionist environment where the individual can benefit from personalised feedback on academic accomplishments, obtain explicit guidance on what is needed for further improvements, and is encouraged to develop, apply and expand new skills and knowledge (Vygotsky, 1978; Mayes, 2001). The SOFA framework attempts to do this by providing users with the opportunity to test learning and recognise achievements 'on-demand', whilst receiving targeted guidance on how to address remaining weaknesses and misunderstandings. By explicitly linking results to the levels of competency demonstrated for each of the learning outcomes tested and relating these to the skills needed to tackle the summative assessments, learners are provided with an extrinsic motivation to engage with this support framework, whilst simultaneously developing a deeper approach to learning. The SOFA framework also responds directly to QAA recommendations to enhance assessment methods by assessing a broader and deeper range of cognitive skills, using

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formative assessment to support effective learner progression. It also encourages learners to become more aware of their academic abilities, developing skills and competencies, and hence be more able to assess and reflect on academic performance. In conclusion, as Boud (1986, quoted in Challis, 2005) stated *"The development of skills in self-assessment lies at the core of higher education, and as teachers we should be finding whatever opportunities we can to promote self-assessment in the courses we teach"*; the SOFA framework provides its learners such an opportunity.

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Appendix: Accessing the SOFAs

The following links allow open access to any user interested in testing the SOFAs, as presented to students on *Our Dynamic Planet* in 2007. Although many questions refer to specific diagrams and information in the course text, this does not prohibit users from working through each question (inserting random answers if required) to observe the stepped levels of feedback. The course starts by examining the formation and early evolution of the Earth, before investigating internal processes, and interactions between the atmosphere, biosphere, hydrosphere and geosphere on the evolution of the planet.

https://students.open.ac.uk/openmark/s279-07.book1chapter1world/

https://students.open.ac.uk/openmark/s279-07.book1chapter2world/

https://students.open.ac.uk/openmark/s279-07.book1chapter3world/

https://students.open.ac.uk/openmark/s279-07.book1chapter4world/

https://students.open.ac.uk/openmark/s279-07.book1chapter5world/

https://students.open.ac.uk/openmark/s279-07.book1chapter6world/

https://students.open.ac.uk/openmark/s279-07.book1chapter7world/

The following links ('SOFA 8'), offer four 'random' assessments consisting of questions from SOFAs 1-7, plus more focussed assessments on specific skills.

Random SOFAs

- *https://students.open.ac.uk/openmark/s279-07.book1chapter8ran1world/*

- *https://students.open.ac.uk/openmark/s279-07.book1chapter8ran2world/*

- *https://students.open.ac.uk/openmark/s279-07.book1chapter8ran3world/*

- *https://students.open.ac.uk/openmark/s279-07.book1chapter8ran4world/*

Defining geological terms

- *https://students.open.ac.uk/openmark/s279-07.book1chapter8geotermsworld/*

Mathematical problems

- *https://students.open.ac.uk/openmark/s279-07.book1chapter8mathmodworld/*

- *https://students.open.ac.uk/openmark/s279-07.book1chapter8mathtaxingworld/*

Understanding geological processes

- *https://students.open.ac.uk/openmark/s279-07.book1chapter8geoprocessmodworld/*

- *https://students.open.ac.uk/openmark/s279-07.book1chapter8geoprocesstaxingworld/*

Working with diagrams

- *https://students.open.ac.uk/openmark/s279-07.book1chapter8diagmodworld/*

- *https://students.open.ac.uk/openmark/s279-07.book1chapter8diagtaxingworld/*

Working with tables

- *https://students.open.ac.uk/openmark/s279-07.book1chapter8tablesworld/*