

**ASSESSMENT AND LEARNING:
IS ASSESSMENT AN
AFTERTHOUGHT OR IS IT AT THE
HEART OF THE LEARNING
PROCESS?**

Dr Bob Gomersall

Assessment and Learning: Is Assessment an Afterthought or is it at the Heart of the Learning Process?

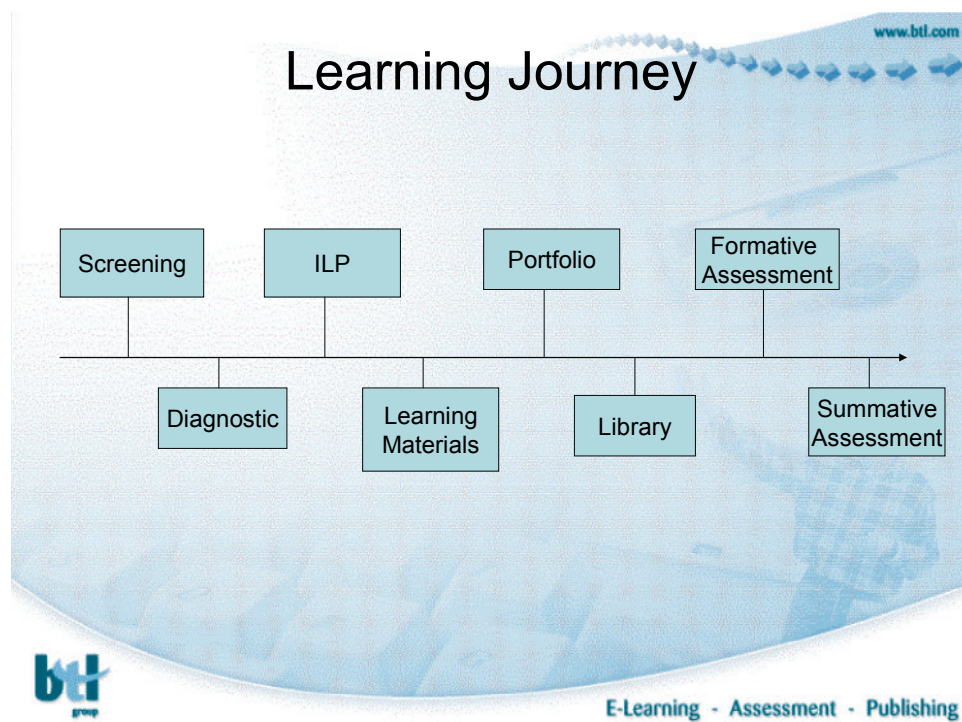
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Abstract

An approach to learning is described which is built on techniques developed for on screen assessment and formative assessment. It aims to provide a high level of motivation, immediate student centred feedback and a high level of learner control. The technology (known as btl engage™) can be applied to any area in which on screen assessment material is already available, extending it into areas such as revision, interactive worksheets and e-learning.

Background

The traditional Learning Journey consists of a series of learning experiences followed at the end of the process by a summative assessment. Some typical examples are set out below.



The format and style of the final assessment will drive the learning styles throughout the process. If the summative assessment is paper based, as is usually the case, the learning will reflect this. If the summative assessment is screen based then it is reasonable to expect that the learning styles will change, becoming more screen based themselves, but in addition there is no reason to assume that the traditional linear Learning Journey will remain intact.

In addition the Learning Journey has traditionally been driven by the teacher. Furthermore, a growing interest in formative assessment (Black and Wiliam (1998)) has led to this being seen as one of the key learning experiences in the Learning Journey, with much of the feedback taking place through a teacher or via scores and statistics (Mann and Glasfurd-Brown (2006)) . Whilst progress in this area is seen as very significant, it is hardly the self-regulating route of Yorke (2003) or the student centred route that is the natural consequence of e-learning and e-assessment.

Two innovations are therefore likely to lead to a re-shaping of the Learning Journey – on screen assessment leading in turn to more on screen student centred learning. The aim of this paper is to show how a student centred approach to formative assessment can re-shape the Learning Journey. The pragmatic reasoning behind the approach is set out, along with some practical actions and early results.

Current Position in e-assessment and e-learning

There has been a rapid development in the use of on-screen testing, with large numbers of candidates taking tests in this form. In some areas, such as Skills for Life testing in the UK, the majority of tests are already on screen. A number of lessons have already emerged (see for example Osborne C and Winkley J (2006)).

- The majority of candidates prefer on screen tests.
- The results are better than those of candidates using paper based tests, although the reasons are not well understood.
- Where work is automarked candidates appreciate the rapid feedback of results.
- The administrative benefits offer greater opportunities for formative, screening and diagnostic assessments.
- The separation between assessment and learning is likely to be less distinct in the e-world than it is when using paper based systems.

On the e-learning side the current position has been very carefully set out by Clarke (2004) and Clark and Mayer (2002). Clarke's book provides a comprehensive survey of all aspects of e-learning. Clark and Mayer conduct a very careful analysis of what does and does not work in an e-learning context building their arguments on a solid research base. Their arguments are

facilitated by some simple classifications of e-learning approaches, which can in principle be applied to any learning context (not just in e-learning).

Of particular interest in the current context is Clark and Mayer's classification of the three types of e-learning, as shown in the table.

Type	Description
Receptive	Show and Tell
Directive	Tell and Do
Guided Discovery	Problem Solving

The short descriptions – “show and tell” etc – are a shorthand for describing the interaction of the learner with the environment, and this will be developed further below.

Works of the above type are extremely useful to e-learning developers. They do exactly what they set out to do - describe how things are done *now* rather than how they *might be* done in the future. To compare this with the early days of the railway, when trucks were pulled by horses, these e-learning books provide excellent manuals for the maintenance of the railway line, the grooming of the horse and the oiling of the truck's wheels.

In fact Clark and Mayer also briefly look into the future, and try to discern the shape of the steam engine. This paper attempts to build on some of those ideas.

Theory

The obstacle we face is that we have no adequate framework for our thinking to allow us to predict the outcome of any given course of action. Since this is the most basic requirement of a “theory”, we have to conclude that we do not have an adequate theoretical base – notwithstanding the work of Clark and Mayer which provides an excellent empirical base founded on psychological research. Indeed it may well be that given the complexity of the situation no theory in the scientific sense of the word will be possible for a long time yet. On the other hand, if we are to make progress there is a need for some pragmatic guidelines, and the purpose of this paper is to suggest how these might be put together.

The aim is to create a framework which can guide our thinking, allow us to see traditional approaches in perspective and indicate a way of moving forward so that the predictions of what will and will not work can be tested against the actual outcomes.

The discussion will be structured in three parts as follows.

- Interactions of the learner with the environment
- Thought processes of the learner
- Routes through the learning materials

The approach will not draw heavily on psychological theory but rather on simple pragmatic concepts which have proved useful to the author in generating real solutions that people are willing to pay for.

Learning Elements

Most of the interactions the learner has with the environment can be summarized in a single word – **Tell, Show, Guide, Try/Do, and Assess**. Clearly this list is not comprehensive, since it should also include touch, taste and smell, but in the context of paper based and on screen learning and assessment these are less relevant – for now!). The aim of this section is to argue that each of these actions can be described as a Learning Element or building block, from which a learning experience – and in particular an e-learning experience – can be built up.

Taking the three types of e-learning described by Clark and Mayer, we can see how the Learning Elements are assembled in those particular instances.

Receptive = Tell + Show

Directive = Show + Do

Guided Investigation = Guide + Do

Each of the methods consists of a pair of Learning Elements. A little thought shows that many other combinations are possible, and indeed correspond to well understood teaching and learning styles. Of course a learning experience may consist of one Learning Element or many. Effective teachers have always invoked the full range of Learning Elements, subject to the limitations of the classroom. In Table 2 there is an assessment of the level of usage of the different Learning Elements in traditional teaching, along with a summary of some of the new opportunities offered by e-learning.

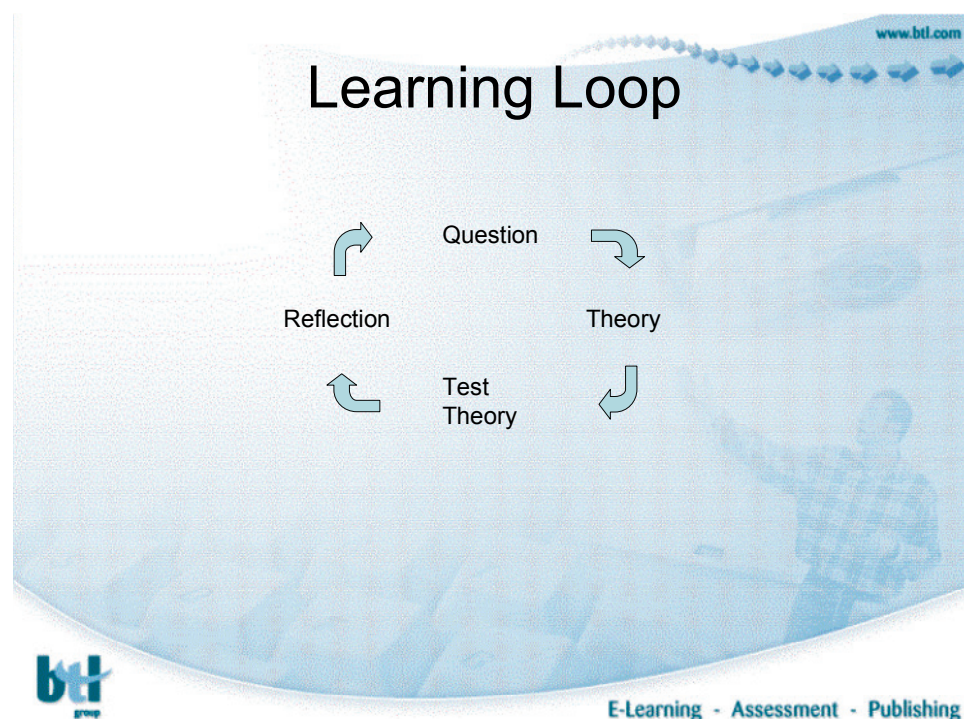
Table 2: Use of Learning Elements - Traditional and e-learning

	Traditional Learning	e-learning Opportunity
Tell	Very large	Opportunity to provide a more consistent quality
Show	Large	Opportunity to improve quality using colour, animations, video, images etc
Guide	Modest (limited by teacher time)	Major opportunity to provide feedback
Try/Do	Modest	Vast opportunity - Feedback can add motivation
Assess	Large	Major opportunities - instant feedback, simpler administration, opportunities with formative assessment, screening and diagnostic.

Thought Processes of the Learner

The previous section deals with the interaction between learner and environment. This section considers a pragmatic way of looking at the thought processes of the learner. This is of course the subject of a vast amount of literature. However, in order to remain faithful to the initial aim of pragmatism, the approach in this section is to set out some simple ideas for framing our thoughts.

The basis of this is the proposition that learning is a (hopefully) streamlined version of what happens when someone learns something for the first time i.e. when it is discovered. This is well understood and has been described by many authors such as Popper and Kuhn. Just as *discovery* can be described as acquiring knowledge or understanding that was previously unknown, so *learning* can be described as acquiring knowledge or understanding that is unknown to the learner, but is already known or understood by others. An equivalent view is that for an individual any learning represents discovery for the first time. Handy (1989) gives a simple summary of this approach, drawing on the ideas of Kolb, which is encapsulated in the “learning loop”.



Referring to the diagram above, the following describes the key features.

1. **Question:** The learning is initiated by a problem, a question, a puzzle, a challenge to be met or a dilemma to be resolved.
2. **Theory:** The learner then formulates a theory of how to address the problem and arrive at an answer. This may be very simple and held in the head or it may be very complex and require the use of

additional external tools such as written language or mathematics. The term “theory” is used in its widest sense, from a loose hypothesis to a well established scientific theory.

3. Test Theory: The predictions of the theory are then tested against experience and existing knowledge. These may accord with existing experience (the “expected” result) or they may not.
4. Reflection: If the results of the theory are as expected then the learner may move on to a new question or problem. If the results are unexpected then the learner will need to re-visit the question and re-formulate the theory.

The above is a simple summary of the so-called “scientific process”, but in practice it is the method by which all reliable knowledge is gained. In science the predictions of theory (initially known as a hypothesis) are tested against experiment, and if the predictions do not accord with the experimental outcome then the theory has to be re-visited and amended. In principle it only requires one type of experiment to disagree with the predictions of a theory (“falsification”) for the theory to be abandoned. In practice of course it will require a lot of checking and re-checking of experiments before any such thing happens, especially in the case of theories which are at the heart of our scientific culture, but that is still the way it works. The works of Kuhn and Popper deal with this area in great detail.

The point about this is that all learners – if they really learning - are going round and round this loop, being driven each time by a problem or question. This is an internal process and it goes on all the time. The problem a teacher faces is how to direct this learning in the way desired rather than the way the student wishes (which may be more concerned with something entirely different – and probably more interesting - such as getting a girlfriend or improving performance in a computer game).

This gives us an insight into the problem of teaching – namely to persuade the student to move round the learning loop. Many good teachers usually start by outlining the problem before embarking on an explanation. In so doing they are seeking to drive the student round the loop. Whether it works is a different matter. The student may write notes, but actually think about how to get to the dining room before the queue gets too long – a much more pressing problem. Some teachers never answer questions except with another question. In the right hands this is another very effective technique, which repeatedly drives the student round the learning loop. Whole courses have been devised around this concept of a Socratic Dialogue (see for example www.physics.indiana/~sdi), and most people have encountered teachers who have adopted this approach to a greater or lesser extent.

This then leads to a hypothesis about the learning process: *Learning is most effective when it follows as closely as possible the discovery route or learning loop.*

It follows that *learning is most effective when it is led by a problem or a question*. This is the opposite of the approach taken traditionally, in which learning material precedes assessment. Broadly speaking the teacher explains the material, the students learn it and are then tested on it. There is sometimes a cursory mention of the question being addressed by the particular knowledge being imparted, but this is seldom the centerpiece of the activity.

Leading with a question was the basis of the Socratic Dialogue approach and more recently underpinned the discovery learning approach adopted in much of Nuffield Science. In practice the approach to the latter had to be significantly modified because it was not easy to constrain the problem sufficiently in a practical context to avoid huge wastes of time – but handled well the approach did have a real impact on teaching and learning which permeates science teaching of all types today.

In the context of e-learning, two points need making. Firstly it is clear that e-learning can offer a new approach to the learning loop, driven by the learner rather than the teacher. Secondly, and rather more specifically, the use of simulation offers the opportunity to constrain a problem much more precisely than was ever possible with practical work. (Adding this to the other opportunities presented by simulations hints at the wider possibilities offered by this approach (Thomas et al (2005))). In addition the range of applicability is much wider, covering all subjects and many areas which are otherwise impossible as a result of being too large, too small, too expensive, too dangerous, too complex or – significantly – too abstract.

Finally, feedback in the e-learning context can in principle take place at precisely the point at which it is required – at the point of cognitive conflict. It should therefore be possible to highlight the *location* of an error without giving an explanation. This would be a significant step forward because it would face the student with a question or problem at precisely the right point, and avoid the need to plough through large amounts of correct work in order to “find a mistake”. A method for achieving this is described below, following a summary of the points outlined so far.

Summary so far

So far the following points of view have been advanced.

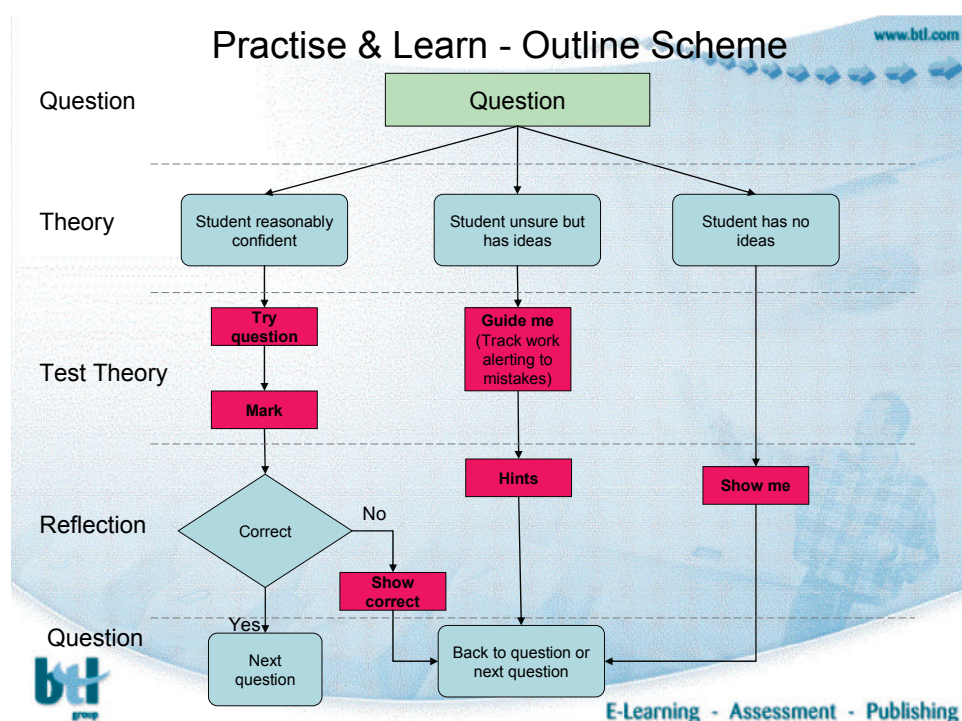
1. The learning process involves a number of types of interaction with the environment which can be characterized as *Learning Elements*. These include **Tell, Show, Guide, Try/Do and Assess**.
2. Learning is most effective when it follows as closely as possible the discovery route or *learning loop*; when it is initiated by the learner and is an *internal* (rather than an imposed) process; when it is *led by a problem or question*; and when there is feedback at the level of the individual question or part question.

3. The most important feature of feedback is to highlight the *location* of an error rather than to supply a correction or explanation.

On the basis of these hypotheses, the e-learning challenge is therefore to devise a means of combining the Learning Elements, and a route through them, which motivates the learner to follow the learning loop as effectively as possible. This is addressed in the next section. Initial trials look very promising, due in part to the opportunities offered by immediate feedback, but also as a result of the inherently student-centred nature of the approach.

* btl engage™

The technology known as btl engage has been designed by the author with the aim of taking advantage of the conclusions set out earlier. The outline scheme is set out in the following diagram.



Learning starts with a question or problem, as shown in the diagram. This is important not only from an educational point of view, but also from a practical perspective, because it constrains the number of routes that need to be made available to the learner to manageable proportions. The question itself may in fact have been chosen by the learner or a teacher, depending on the circumstances, and indeed the approach to selecting questions opens up a whole range of new opportunities for learning (see later).

The learner is initially in one of three broad states of mind – reasonably confident, unsure but has ideas or has no ideas at all. The three available routes are designed to meet these three different situations. A reasonably confident learner can take the **Try/Do** option and attempt to answer the question. When complete this can be automatically marked, with an option to

be given the correct answer if an error is made. At the other extreme, the learner who has no ideas can simply opt for **Show** and can be taken stepwise through a model solution.

The unsure student has an intermediate option – **Guide**. In many ways this is the most interesting because it attempts to imitate the situation of a teacher looking over the shoulder of the learner, pointing out mistakes and possibly dropping hints. The computer tracks the work of the learner and at each step an indication is given that it is correct or incorrect. As a result, the learner can proceed confident in the knowledge that they are on the right track. As soon as a mistake is made it is flagged up and the learner can focus all their mental energy on solving the problem in hand, rather than, as is all too often the case traditionally, devoting a lot of effort into locating the error in the first place. Finally hints can be made available and even additional tutorial material.

The combined effect of the above scheme is to provide the equivalent of a series of questions, with worked answers available for every one, with the opportunity to try any without being told the answer and yet immediately check at the end, and finally the opportunity to have work checked on a real time basis without feeling any of the pressure normally associated with a teacher looking over the shoulder.

In summary, btl engage aims to provide a framework for student centred learning which draws on the ideas set out above. In particular it addresses the following issues.

- It sets out to provide thorough coverage of three Learning Elements – **Show**, **Guide** and **Try/Do** – along with a simple development route to involving all Learning Elements.
- It aims to follow as closely as possible the idea of the Learning Loop, and most importantly it is led by a problem or question.
- Feedback is integral to the process, and a key feature of **Guide** is the ability to highlight the location of an error in real time.

As described above, the route through the materials can be determined by the learner. In practice there is nothing to stop a teacher using the materials in a more restricted way, providing a route through the learning content.

Applications of btl engage™

The technology can be applied in a number of different ways.

Interactive questions: These may be set out rather like textbook questions, classified by type and graded according to the level of difficulty. Students could be directed to the best starting point by a teacher, but in practice it may well be more effective for students to determine their own starting point, and their own pace through the material.

Interactive worksheets: These would be similar to interactive questions.

Interactive revision materials: These may involve questions on a wide variety of subject matter, with little connection between one question and another. As a revision tool it would be potentially very powerful.

Learning materials: Carefully selected questions could in principle guide the learner through any learning materials. In practice, it may well be that there is no difference between this and interactive questions – simply a much more comprehensive set of questions. Indeed it is possible that the traditional approach to teaching in which the content is explained and then the learners tested may indeed have no place at all in the student centred e-learning world.

In practice it is likely that the traditional distinctions between questions, worksheets, revision materials and learning materials will become increasingly blurred. This in turn suggests that the linear Learning Journey could well be replaced by a question led screen based “socratic dialogue” in which the student has much more direct control over the learning.

A sample screenshots in which the technology has been embedded in a learning package (Practise and Learn) is shown below. Each entry by the learner is marked as soon as it has been entered, providing instant feedback.

The screenshot displays the 'Btl engage™ – Guide Me' interface. At the top, the title 'Btl engage™ – Guide Me' is shown in large blue letters. Below the title, a navigation bar includes 'File', 'View', 'Control', and 'Help'. The main content area is titled 'Practise & Learn' and contains a question: 'Add and subtract fractions - section b'. The question asks to 'Change $\frac{2}{5}$ and $\frac{1}{3}$ into equivalent fractions with the same denominator.' Below the question, there are two sets of fraction bars. The first set shows $\frac{1}{3}$ as a single bar divided into three equal parts, with one part shaded blue. The second set shows $\frac{2}{5}$ as two bars, each divided into five equal parts, with two parts shaded blue. Below the fraction bars, there are input fields for the numerators and denominators of the equivalent fractions. The first input field shows $\frac{1}{3} = \frac{3}{15}$ and the second input field shows $\frac{2}{5} = \frac{2}{15}$. At the bottom of the interface, there are buttons for 'Try question', 'Guide me', 'Show me', 'Next question', 'Previous question', and 'Mark'. A small 'btl group' logo is visible in the bottom left corner, and the text 'E-Learning - Assessment - Publishing' is in the bottom right corner.

Predictions, Benefits and Issues

In principle many of the proposed theoretical criteria for improvements in learning are met by btl engageTM. If the theory is to have any value then these predictions need further testing.

To date a simple qualitative trial has been conducted with a small group of Year 10 students (Brumfitt M (2006)). The content was aimed at revision of fractions, an area that is notoriously difficult. The students provided anonymous feedback through a simple questionnaire, and in summary the following benefits were identified by the learners.

- The students liked the look of the tool and found navigation “nice and easy”.
- They found that the “Guide Me” and “Show Me” tools were interesting to work with, and that they were particularly useful with questions that they were not very confident in answering. One individual comment was that “‘Guide Me’ was extremely useful because it gave you a chance to still answer the question off your own back with a slight nudge in the right direction, whereas in a text book, although the workings out are shown, they give the answer as well – preventing you from answering the question”.
- The potential for revision was highlighted particularly.
- It was pointed out that when using textbooks to revise it was necessary to jump around constantly from chapter to chapter, which could be time consuming, whereas using the tool everything they needed was literally a few clicks away. This was found to be a much more practical way to revise.
- The students genuinely enjoyed it and were impressed with the functionalities.

Feedback from the teacher of the group and a student teacher was enthusiastic but otherwise broadly similar.

The issues that emerged were as follows.

- The extent to which learners should have freedom of navigation through the menu of questions needs further work.
- A timing function should be considered.
- Availability to learners at home as well as at school is a key consideration.

Clearly further thorough trials are required to establish just how effective the proposed methods are, and indeed to establish whether the learning process is significantly speeded up, whether levels of motivation and engagement improved, or the process shows some other practical measurable benefits. It

is predicted that there will be significant benefits, and the early work is promising - but the basic proposition remains to be properly tested.

* Subject of a patent application in the UK and US.

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