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PROGRESS REPORT

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# Progress Report

There are many systems and websites that offer Technologically Enhanced Learning (TEL). Yet none seem to be founded on the academic literature. Therefore, the evidence for the effectiveness of TEL is scant and contradictory.

TEL has a dubious academic reputation. John Hattie

(Hattie 2009) in his thorough statistical survey of educational practices found that it had a marginal impact. However, most materials are “shovelware”

(Chou & Liu 2005), i.e. just a place in which to make pre-existing materials available. It is therefore not surprising if the TEL results are then similar to pre-TEL results.

This work takes a different approach. The academic literature on different good practice in education. These items of good practice have then been turned into a format suitable for TEL. It should be noted that the format of the materials would change as additional good practices are discovered. The format presented here should not be viewed as THE good practice, but rather as reflecting the current thinking on good practice.

The methodology will be:-

1. Identify good practice in the format of materials.
2. Identify good practice in teaching methods.
3. Build TEL materials based on these principals.
4. Statistically analyse the results to assess how each identified item of good practice performs in a TEL environment.

It is hoped that this statistical analysis would make TEL more efficient in delivering learning. It is not expected to replace teachers and lecturers, but to make their efforts more effective by giving alternatives for those who learn differently.

## The Background

The concept of individualised learning goes back at least as far as the Socratic School of Athens in around 380BCE. Others including Comenius

(Comenius 1986), Rousseau

(Rousseau & Bloom 1979) and Fröbel

(Froebel 1885) also made similar points well before modern educational institutions were created. In fact, the liberal educationalist of the 1960 based their views on these pioneers.

The idea of a liberal education, one based on the needs of the learner rather than a curriculum, is not new. The Socratic School sought to develop wisdom through the questioning of the logic of an individual. More recently, practical educationalists, such as Pestelozzi

(Pestalozzi 1894) and Fröbel

(Froebel 1885), tried to encourage young children to think by providing structured play to develop understanding. Rousseau talked in his novel Emile, first published in 1762, about an idealised education in which the individual is guided through increasing levels of attainment by a mentor. These all pre-dated set curricula and formalised education.

The 19th century saw the introduction of mass industrialisation and these efficiencies of scale were used when planning the education of the masses. The original teaching system in England (and then by implication, the Empire) was based on large classes, a teacher and trusted pupils to guide the learners through rote learning. Each pupil was expected to follow “the rules”, whether these were times tables, letter formation, spelling or behaviour.

There were two experiments between the wars in breaking this mould in Chicago. The first was the Winnetka Plan

(Corcoran 1927) which was inspired by the work of John Dewey. The other was the work of H.C. Morrison of the University of Chicago

(Morrison 1926) who wrote about the need to teach the individual over the curriculum. Both sought to break the subject matter into smaller pieces and require the students to master these pieces. Also, they both disappeared without trace after their originators retired during World War II.

But the 1960s saw great changes in social outlook. Not only were people looking for greater freedom in their adult life, but also in how education was provided – the mood of “liberal education” was in vogue. The publication of *Taxonomy of Educational Objectives*

(Bloom 1956) set things in motion by considering the needs of the learner as opposed those of the teacher.

This trend was reversed in the more pragmatic 1970s. The emphasis shifted back towards teacher controlled education and anything that smacked of liberal education was dismissed. Many of the ideas were consigned to the educational wilderness. The number of articles citing the ground breaking *How Children Fail*

(Holt 1966) had plateaued by the early 1970s[[1]](#footnote-1) and then started to decline as we moved into the 1980s.

## Stage 1 - Identify good practice in the format of materials.

Several educational babies may have been thrown out with the liberal education bathwater after the 1960s. The Keller Plan (also known as the Personalised System of Instruction)

(Keller 1968) and Mastery Learning

(Bloom 1968) survived in pockets, but never became mainstream. Both the Keller Plan and Mastery Learning, described in greater detail below, required the curriculum to be broken in small pieces which were taught and assessed in sequence. Paper-based materials were used to teach and the student had to pass a test on each topic at 80% or above before moving on. This approach encouraged topics to be understood before moving on to the next task.

### The Evidence

The technique of meta-analysis came into more general use in the 1990s. It is a statistical technique which analyses the results of groups of studies in an area – hence the term meta-analysis. John Hattie used this technique to analyse the results of 8,000+ studies in education

(Hattie 2009) to see which techniques worked and which did not. He accommodated the Hawthorne Effect

(Landsberger 1958), where people react positively because they are being watched during an experiment, by only accepting a change beyond 0.4 standard deviations as having a positive effect. Anything below that was deemed either of little impact or as being detrimental if it was below 0.

Computer assisted instruction (which includes all types of computing devices) achieved a score of 0.37 SDs[[2]](#footnote-2), i.e. a score that made its effects neutral. This implied that the time, money and effort spent on this area was in vain.

However, the scores for Mastery Learning (Bloom)[[3]](#footnote-3) and the Keller Plan (Keller)[[4]](#footnote-4) show positive effects of 0.58 and 0.53 respectively.

The interesting questions are why the techniques of these systems have not been included in standard TEL systems and what effect would doing so have?

### A Model of School Learning (1963)

John B Carroll wrote what he thought was a throw-away paper

(Carroll 1963) on allowing students to progress at their own pace rather than that of the teacher. The paper put forward the argument that there were five factors which determined whether a student acquired a new concept:-

1. Aptitude for learning this task
2. Ability to understand instruction
3. Quality of instruction
4. Time allowed for learning (opportunity)
5. Time the learner is willing to spend in learning (perseverance)

Those teaching cannot affect the first two items on the list above. The third item, quality of instruction, is the same for all those in a class. Therefore the determinants of learning become the final two items, which Carroll expressed as:-

Equation - Carroll's degree of learning, version 1

This implies that students will only learn a portion of any syllabus and that this quantity of learning could be increased by allowing students to travel at their own pace. Block

(Block & Burns 1976) amended this formula by taking the elements described by Carroll as being determinants of the degree of learning to give:-

Equation 2 - Carroll's degree of learning, version 2

### Mastery Learning (1968)

Benjamin Bloom read the paper by Carroll took the idea further

(Bloom 1968). He argued that if ability is normally distributed then standard teaching methods would ensure that the results of assessment would also be normally distributed. However, his research implied that most students (he claimed 95%) could understand a topic if allowed sufficient time. He estimated that the ratio of the difference in time needed to master a topic between the most able and least able was approximately 1:6, i.e. for every hour needed by the most able, the least able would need six hours. His studies showed that this ratio decreased as students got used to the process and suggested that the ratio might decrease to 1:3 in the longer term.

The paper also argued that student understanding (and therefore performance) could be enhanced if students had to master a task before moving on the next one on a course.

Bloom called this system mastery learning.

### Personalised System of Instruction (1968)

At the same time as Bloom was working on mastery learning, Fred Keller and his colleagues at the University of Brazil devised a system of teaching based on the work of B.F. Skinner

(Keller 1968). In their Personalised System of Instruction (PSI) the syllabus what segmented in tasks each of which covered a single learning concept. There were five essential elements:-

1. New material should be presented through written text rather than lectures.
2. Units of content should be created that could be sequenced to form a logical route of progression.
3. Proctors are used to help the students. These are either peers who have completed this course successfully or externals who have the relevant background. They should no be the course tutors.
4. The students should progress at their own pace by fully completing each task. A task is completed when the proctor (a qualified peer or external person) verifies that the student has mastered the content, usually via a test.
5. Mastery must be demonstrated via a series of tests or practical exercises which are marked by the proctors.

This system is still in use by some schools in the United States

(Hattie 2009) but is not common. The main arguments that have been put forward against PSI are; that too few instructional methods are used to engage the students, effort has to be put in upfront by teachers to create materials and testing methods, that the dropout rates are high and that there is decreased human interaction. Each of these criticisms will be re-examined in later chapters.

### The differences between PSI and Mastery Learning

Bloom came from a background in teaching whilst Keller was behavioural psychologist so one might expect there to be major differences in the detail. Both PSI and Mastery Learning break the syllabus into smaller pieces, they both insist that the student should master a task before moving on to the next, both expect clear objectives to be set and they both involve tests to see whether mastery has occurred.

However, there are also significant differences:-

1. PSI requires there to be proctors whilst Mastery Learning does not.
2. PSI requires the student to study preliminary written materials whilst Mastery Learning merely requires learning objects.

### Conditions of Learning (1970)

At the same time as Bloom and Keller, Robert Gagné was writing about the conditions under which learning could take place and how learning materials should be structured

(Gagne 1968). Gagné, like Keller, was a behaviourist and also drew his inspiration from the works of B.F. Skinner.

He postulated that there are eight kinds of learning of increasing complexity:-

1. **Signal learning** – This is the most basic form of learning. It is a Pavlovian response which involves no thinking on the part of the learner. It is an automatic response to a given stimulus, for example, a teacher asks what is two plus two and expects the answer four. This is repeated so often that four becomes associated with two plus two and we automatically know that the answer is four without the stimulus having to be given. This is internalised learning, i.e. learning we do not have to consider.
2. **Stimulus-response learning** – This is another form of internalised learning, but this time involving rewards and punishments. This Skinnerian approach assumes that the stimulus (reward or punishment) is received after the act and therefore reinforces that learning. For example, praise when a behaviour is deemed good and disapproval when it is bad, i.e. when potty training or learning to play a particular tune.
3. **Chaining learning** – This occurs when there is a chain of level 1 or 2 types of learning are linked together. For example, when someone learning to play the piano moves from learning specific tunes to being able to play a new one based on the learning of the previous ones.
4. **Verbal association learning** – This is similar to chaining, but relies on verbal cues, such as mnemonics or hearing the term ‘conditioning’ and knowing that there are the two types, classical and operant. The learner is starting to classify their learning.
5. **Discrimination learning** – This is a rather higher form of learning in which the learner differentiates between situations. For example, as pointed out under signal learning, being asked what ‘two plus two’ gives would usually get the automatic response ‘four’. However, if the respondent is in a class on number bases then either 10 or 11 might be acceptable alternatives. The answer given will be determined by the situation even though the stimulus (“What is two plus two?”) is the same.
6. **Concept learning** – Addition would be an example of concept learning that is introduced at a young age. Learning the process of addition starts with conditioned responses for the single digit values, but moves on to a generalised concept when two (or more) digit numbers are involved. The concept of addition has become more flexible by treating the ideas of carrying and position value as affecting the class of numbers generally.
7. **Rule learning** – Here concepts are chained together to form general rules. For example, learning how to add is merely one concept in the rules of arithmetic which are learned in primary school. This allows problems such as 2 + 3 × 4 to be solved (which many still get wrong).
8. **Problem solving** – This level of learning allows the student to use previously learned rules and concepts to develop new solutions to problems which have not previously been tackled. For example, a chemist might be required to find a new compound to reduce the cost of producing ink.

According to Gagné those learning should master skills and repeat them often so that they become embedded. Later skills should then be built on those, thus echoing the views of Vygotsky

(Vygotsky 1978) with his Zone of Proximal Development.

This led Gagné to consider how new learning materials could best be structured. His theories developed over the four decades in which he was writing. By the end he had decided that there were nine steps through which successful instruction should go:-

1. **Gain attention** – Do something which gets the student to engage with the fact that teaching is about to begin, such as presenting a problem, introducing a new scenario or playing music. This ensures a starting point from which to launch the other steps because learners tend to do what is stressed and ignore that which is ignored

(Pollock et al. 2015).
2. **Inform the learner of the objectives** – This need not be done in a formal fashion, i.e. “We are covering learning objective 2.3.”, rather it should be made clear what the learner will gain from completing this task and therefore how to gauge success or failure. In a meta-analysis study, Marzano

(Marzano 1998) showed that this could raise achievement by 34%.
3. **Stimulate recall of prior learning** – This can be accomplished in two ways; practice of previous material via testing

(Butler 2010) which allows the learners to retrieve and reconstruct previously acquire facts or concepts. Alternatively, scaffolding (building upon their zone of proximal development) occurs when prior knowledge is pointed out, support is given to build new knowledge and then the scaffold is faded out as that new knowledge becomes secure. Mind mapping and note taking are two techniques which are used to scaffold. Whilst mind mapping has the slightly larger effect

(Marzano 1998), it is not clear whether this is due to the novelty of drawing rather than writing, a preference for one rather than the other or that mind mapping is the better tool.
4. **Present the materials** – These should be sequenced in small chunks, echoing the work of Bloom and Keller, to avoid overload. Latterly, Gagné has suggested that there are two methods in which the work could be sequences; using Bloom’s Taxonomy

(Bloom 1956) or his list of eight learning strategies (see above). Alternative methods of generating a path through the matter to be learned would be concept mapping

(Novak 1977), behavioural objective mapping

(Gronlund 1970) and the creation of learning hierarchies

(Gagne 1968).
5. **Provide coaching on how to learn** – This helps to break down the barriers to learning by increasing the metacognitive skills of learners, giving them more confidence and ensuring that less precise thought patterns are avoided

(Son 2012).
6. **Elicit performance** – Get the learner to practice the new skill or apply the new knowledge. This helps to embed the learning as well as provide its context. This may not always involve imitation, but may also happen through vicarious learning

(Bandura & McClelland 1977). For example, a child is more likely to be quiet if it sees that one gets told off when being noisy.
7. **Provide feedback** – This can be in the form of a quiz, a one-to-one discussion or a formal test. Hattie

(Hattie & Timperley 2007) notes that feedback gives a huge advantage when correctly implemented. It needs to be positive, appropriate, concentrate on what went well and give clear, non-judgemental guidance on improvement.
8. **Assess group performance** – The learning process should be assessed by those teaching to see what worked and what needs to be improved. This teaching metacognition can then feedback to improve the next round of learning. Interestingly, neither Hattie nor Marzano have carried out meta-analyses in this area. The few studies there are in this area concentrate on developing guidelines of good practice in self-evaluation of teaching rather than whether it is effective. The most modern study found

(Martin 1952) was over 60 years old.
9. **Enhance retention and transfer to a job** – Here the intention is to help the learner internalise the new materials by encouraging them to paraphrase the content, use metaphors, generate their own examples or create mind maps. This should be followed up by encouraging the student to explain how this might be applied in a work situation. This helps the material to become ever more familiar and thus more accessible. This process was described by Vygotsky

(Vygotsky 1978) who proposed four levels of internalisation. His fourth level of internalisation, internal thought, is the conventional meaning of the word.

## Later Task-Oriented Work

The end of the optimistic educational ideas of the 1960s saw the end of development in this area. Some studies looked at the effectiveness of the Keller Plan, Mastery Learning and Conditions of Learning, but none extended the concepts until the work of John Biggs in-1996.

Constructive alignment theory

(Biggs 1996; Biggs 2014) focusses on the student – what can they do once they have been through the process of learning – and disregards how the teacher got them there. Biggs defined a four-step approach:-

*“The operational framework for this teaching design at the unit level is in its basics:*

1. *Describe the intended learning outcomes (ILOs) for the unit, using one verb (or at most two) for each outcome. The ILO denotes how the content or topics are to be dealt with and in what context.*
2. *Create a learning environment using teaching/learning activities (TLAs) that require students to engage each verb. In this way, the activity nominated in the ILO is activated.*
3. *Use assessment tasks (ATs) that also contain that verb, thus enabling one with help of predetermined using rubrics to judge how well students’ performances meet the criteria.*
4. *Transform these judgments into final grades.”*(Biggs 2014)

This is analogous to the approach taken by Keller, Bloom and Gagné, in so far as the material is broken down and the method of acquisition of learning is left to the student. However, this approach brings the definition of intended learning outcomes and their assessment to the table.

### Identified good practice from Stage 1

Some educators in the 1960s advocated abandoning a set syllabus in favour of allowing students to devise their own curricula. This was shown not to work, hence the backlash against this form of education. The problem identified was that the students were being asked to create a road map to a place they had never been. They therefore wandered aimlessly around the countryside as their whims took them.

A guide was needed, which is where the work of Carroll, Bloom, Keller and Gagné scored so highly. They kept the syllabus and broke it down in small tasks. The student was then allowed to progress through the tasks at their speed. Crucially, there was supervision included which made it difficult for the student to just slack off. It is therefore proposed that two points be learned from this stage:-

1. The syllabus should be broken into atomic tasks so that all aspects of the syllabus are covered.
2. A monitoring system should exist to ensure that students are progressing and will achieve.

## Stage 2 - Identify good practice in teaching methods.

On top of the list of techniques used in the Bloom and Keller systems (peer involvement, atomised tasks, regular monitoring and standardised materials), there are many other tricks in the armoury of the educationalists.

The diagram on the next page shows which general areas have been identified.



Figure - Teaching and Learning Theories

Each of the main areas shown above is examined to see what, if anything, can be learned from each area.

### Learning Styles

Learning styles were very popular in the 1980s and ‘90s. However, the paper by Riener and Willingham

(Riener & Willingham 2010) made the case that they do not exist. The position taken here is somewhere between the two extremes. It seems intuitively obvious that people have preferred learning styles, but it is not necessarily true that these are fixed. A student may prefer to be taught today, perform better with videos or text tomorrow.

What is certain is that if preferences exist, a class will contain all of them. The person teaching cannot perform in the optimal way for everyone. Even if that were possible, the teacher could not know which is applicable to each student today. This is where technology can step in by allowing each student to select their own preference.

The one learning style categorisation on which most seem to agree is that is that of Pask

(Pask & Scott 1972). He postulated a split between serialists and holists. Serialists prefer to see the parts and then construct a view from those, whilst holists prefer to have an overview into which that parts can be slotted. This causes major problems for educationalists who then have to decide which way they want to present their course.

Fleming

(Fleming & Mills 1992) suggested that there were four learning styles; visual, aural, reading/writing and kinaesthetic. Whilst these may or may not exist, some students will prefer each strategy. Again, whoever is teaching cannot deliver each simultaneously. TEL could give each student the opportunity to select the mode which suits them.

Gregorc

(Gregorc 1982), Dunn and Dunn

(Dunn 1984), Myers and Briggs

(Myers et al. 1985), Felder and Silverman

(Felder et al. 1988), Honey and Mumford

(Honey & Mumford 1989) and Hermann

(Herrmann 1991) all produced inventories of learning styles which are statistically unique, but covered in the works of Pask and Fleming.

### Identified good practice

Splitting the subject contents for a course into tasks would allow the tasks to be ordered and placed in topic groups. If each of these groups is a topic, then students could elect to either work first with the tasks of the groups, i.e. take a serialist or holist approach for each topic. They could switch strategies with each grouping. The points learned are:-

1. Tasks can be grouped into menus/sub-menus so that both serialists and holists can choose the method that works for them.
2. Materials can be developed in text, audio and video formats, thus allowing the student to choose their preferred form.

### Deep/Surface Learning

Ference Marton and Roger Säljö

(Marton & Säljö 1976) proposed that learners had different aims when studying. Some were genuinely interested in the subject and saw the qualification as secondary – these are deep learners. Others saw the subject matter as a means to an end, e.g. gaining a qualification which would secure them a particular job. All the second category wanted was to pass – these are surface learners.

This categorisation was extended by Noel Entwistle

(Entwistle et al. 1979). He argued that there was a third category, surface learners, who had neither interest in the subject nor the qualification. These students did the minimum not to get thrown off during the year, but were unlikely to be motivated to progress.

### Identified good practice

Ideally, all students would be deep learners, but the reasons some fall into other categories needs to be addressed. The category into which a student falls can, in some cases, only be discovered at the end of an academic year when the final exam or coursework results come out. This is too late for those who are not deep learners. The points learned are:-

1. Student participation needs to be monitored throughout the course and this means small tasks
2. Constant monitoring is required of performance on the tasks.

### Metacognition

An independent learner will progress more efficiently than one who relies on “Miss/Sir” all the time. They will find ways of solving problems in ways that work for them. These independent learners develop strategies to cope with unknown situations. This metacognition, defined by John Flavell

(Flavell 1976) was expanded upon by Kruger and Dunning

(Kruger & Dunning 1999) as well as Chabris and Simons

(Chabris & Simons 2010).

The Dunning-Kruger, effect as it is known, describes what happens when an individual misunderstands their scope of knowledge. Someone who feels they have a better grasp of a subject than they actually enjoy, will underestimate the effort required to pass and overestimate their expected grade. Experiments at this university have shown that the converse is also true. Those whose work is in the upper quartile underestimate their grade.

Chabris and Simons created a short video of people passing basket balls between each other. Viewers were asked to count the number of passes during the video. It is therefore a surprise that half the people who watched the video (<https://www.youtube.com/watch?v=IGQmdoK_ZfY>) did not notice another person, dressed in a gorilla costume, walk in front of those passing the ball and wave its arms about, then walk off. The conclusion that they came to was that we can miss the obvious when concentrating on something else. For example, a student who is struggling to understand something may miss the very piece of information that makes it clear. The teacher knows that all the information has been given, but the student does not.

### Identified good practice

One-shot teaching assumes that students use the techniques used by the teacher and that the student has access to all the information. If that were true then all students would get 100%. The points learned are:-

1. Linear forms of study will hinder metacognition, so non-linear paths should be available, e.g. a hierarchically organised menu system.
2. A lack of an appreciation of the size of the subject may cause a misunderstanding of the scope of the subject matter, so that should be clear, e.g. a hierarchically organised menu system.
3. Students need to be able to review concepts and skills as often as it takes for them to feel comfortable with them. A variety of computer-based materials is likely to be more flexible than, say, a text book.

### Cognitive Dissonance

According to John Festinger

(Festinger 1957), humans will seek to minimise their discomfort by rationalising their situation. An oft quoted example is that of the fox in one of the fables by Aesop in which a fox sees a bunch of juicy grapes that are just out of reach. The fox rationalises not being able to get any grapes by saying that they are probably sour anyway.

Students do much the same thing when a topic appears out of reach. They can be tempted to rationalise this as the course not being one which interests them or is not relevant to their career. Some teacher prefer to stretch their students, which is good if the support is there, but can lead to cognitive dissonance if it is not.

Alex Michalos

(Michalos 1985) expanded on this theme by suggesting that dissatisfaction is the distance between what one has and what one wants. These are relative to what others have, the best one has had in the past, what one expects to have in the medium term, what one feels one deserves and what one needs.

### Identified good practice

The problem here is that students can feel discouraged if they do not grasp the subject matter or skill as quickly as seems to be expected of them. There are two factors at work here; the acquisition of the concept or skill and the perceived difficulty in getting it. The points learned are:-

1. Feedback and encouragement should be available quickly and easily.
2. There should be safety nets in place to provide alternative routes to success.

### Flipped Classroom

The flipped classroom has become very popular recently. Salman Khan

(Tucker 2012) developed the idea by accident when trying to help his nephews learn mathematics. Rather than teach first and then set homework, the homework is to watch the video and then discuss the contents in class, thus flipping the usual way of teaching. This give students several bites at the cherry and can allow previous misunderstandings, misconceptions or gaps to be worked on before they become a problem.

Bergman and Sams

(Bergmann & Sams 2012) pointed out that students do not need teachers to impart knowledge, rather they need them when they get stuck. They saw that students felt less threatened by education when they could review a concept or skill and then get help on the sections that concerned them.

### Identified good practice

Flipped teaching allows teachers to teach, i.e. reach those who have problems, rather than take time covering ground that reaches some and loses some. The point learned is:-

1. Give students an opportunity to try for themselves (helping them become independent learners) and then use the classroom to fill in the gaps. TEL needs to provide a variety of ways learners can explore.

### Threshold Concepts

The idea was explored originally by David Perkins

(Perkins 1999), but was popularised by Meyer and Land

(Meyer & Land 2003). It postulates that students may find a topic difficult because the understanding of a lower level topic is missing. The missing topic has to be revisited (or even visited for the first time) before progress can be made. There are many reasons why this might be the case. For example, the sequencing of the topics be wrong, the student may have been absent when that topic was covered or the concept was not acquired on the first visit. Whatever the cause, progress is being hampered and a way has to be found to overcome the hurdle.

If and area like this is left unresolved then either the student may catch up, if the area is relatively small, or might mean that permanent damage is caused. In either case, the educational process is hampered. This makes identifying such areas rather important.

### Identified good practice

There should be a way for the progression of concepts to be mapped. The map can then be used in the reverse direction to identify the concept causing the problem. This can then be visited, along with any subsequent concepts, to allow a more thorough and confident progress through the syllabus. The point to be taken from this:-

1. There should be links to underlying concepts which allow any holes to be filled.

### E-Education

There was some excitement in the 1990s and early 2000s when it was realised that the paths students took through TEL materials could be analysed and predictions made about what was to be presented next. Peter Brusilovsky

(Brusilovsky 1994) and Paul de Bra

(Bra & Calvi 1998) led the way in defining adaptive learning as it came to be known. However, there are two problems with this approach.

The first problem is that people change their mind about what suits them, have different areas of expertise or just reject an automated offering. For example, a student studying, say, business studies might see something that excites them about nuclear physics. They do not want to be nuclear physicists, but they are motivated to get a general overview. TEL is not at the stage where this level of telepathy is realistic yet.

The second problem is that the adaptive learning approach diminishes the role the student plays in their learning, thus hindering their metacognitive skills. Any advantage gained by better sequencing would be cancelled out by the loss of metacognitive skills.

Adaptive learning has been omitted from the lessons learned for these reasons.

### Self-Paced Learning

This has been covered above and will therefore not be covered here.

### Gamification

There have been several attempts at gamifying learning. Sebastian Deterding et al

(Deterding et al. 2011) defined gamification as “*the use of game design elements in non-game contexts*”. A major initiative saw the massively multiplayer on-line game (MMOG) being used to teach key skills in English and mathematics in the late 1990s and early 2000s. Whilst some, such as Paul Gee

(Gee 2003), Thomas Connolly

(Connolly et al. 2012) and Cagin Kazimoglu

(Kazimoglu 2013), found great benefits.

Others such as Sebastian Deterding

(Deterding 2015) a short while later found 62 reasons why gamification did not work. Bradley Wiggins

(Wiggins 2016) found current gaming techniques to be similar to traditional learning materials. Hattie

(Hattie 2009) did not have a category for gamification when analysing teaching strategies, but included it under simulations. This category scored 0.34 (where 0.4 is the threshold for an effective strategy), meaning that its usefulness was, at best, minimal.

Therefore, gamification is being excluded from this study for two reasons; its effectiveness seems to be marginal which means that it is not worth the amount of effort involved.

### Experiential Learning

This is sometimes confused with hands-on learning. The difference is that experiential learning relies on a level of reflection about the processes being experienced. John Dewey

(Dewey 2007) was an early advocate of this approach in the 1930s. It was a meant as a riposte to those who only considered a classical education as being worthwhile

(Jovanovic 2016). Jerome Bruner

(Bruner 1961) saw experiential learning as an opportunity to allow students to construct their own world view, constructivism.

David Kolb

(Kolb & Fry 1974)

(Kolb 1984) added the idea of a cycle of stages through which experiential learning should go; active experimentation, concrete experience, reflective observation and abstract conceptualisation. It did not matter where the learner started or how often they went around, merely that they cycled through these stages until the scaffold had been constructed.

Boswell and Elison

(Bonwell & Eison 1991) defined the concept of active learning in which students are presented with new concepts which they explore in a tactile way. For example, they might design a database using cards which have tables they need to link “correctly” using pieces of string and paper clips to show the “many” end.

Situated Learning was described by Lave and Wenger

(Lave & Wenger 1991) felt that learning was primarily a social process where participants in a group help each other. They applied their theory to a wide range of groups such as midwives, butchers and recovering alcoholics. This view has echoes of connectivism discussed below.

### Identified good practice

The constructivist view which underpins experiential learning has little representation in many of the TEL products available today. In fact, some seem to make collaboration difficult by heavily proscribing what can and cannot be presented to the student. The points to be learned from here are:-

1. Tests which do not count towards grades would allow students a hands-on experience of their grasp of the subject matter.
2. If the coursework is linked directly to the learning materials then there is another opportunity to put the learning into practice.
3. The system should allow networking so that students can help each other.

### Role Play

Role play, as described by Edward de Bono

(De Bono 1989), requires active student participation and would be difficult to reproduce on a computer. Video conferencing could be used, but why use that when classrooms are available and students can interact directly? There might be a need for video conferencing if students are widely dispersed geographically, but that is not usually the case. Therefore this aspect of good practice is not being incorporated in this project.

### Connectivism and the Medici Effect

Frans Johanson

(Johanson 2004) was intrigued by the way new ideas developed rapidly in places where new ideas were already growing. This critical mass of disparate intellectuals who fed off each other created new ways of looking at problems. He called this the Medici Effect because the was particularly visible in the early renaissance Venice. This free flow of ideas caused others to reconsider their view of their subject area. This is active metacognition and therefore a desirable aspect of education. A student working with another student is good because they are better able to understand the difficulties involved. However, even better would be if students could connect with others of different disciplines.

The connectivist approach suggested by Siemens and Downes

(Siemens & Downes 2005) introduces the use of social media to education. They suggest that just relying on “Miss/Sir” closes out other sources of potential instruction. A peer explaining a concept is much closer to the problem of acquiring the concept than the teacher and social media can help with that.

MacKinnon and Bacon added the concept of virtual scaffolding from their experience of social constructivism. They argue that technology is not and should not be a solitary experience of just interacting with a machine and that a social element needs to be added to make on-line learning a more acceptable experience.

### Identified good practice

There are many social media sites which would allow students to interact. They can use something as simple as email, but other written media, such as Twitter and Facebook are more immediate. There are also more visual forms of communication such as Skype and Google Conferencing. Some argue that students will just spend their time socialising, but they can do that anyway. Whilst there will be chatter, there will also be exchanges of ideas, personal support (“Yes, you can.”) and alternative sources of information passed around. This mimics what professionals do, therefore this equips them for later life. The point to be learned is:-

1. A TEL system should include social media so that help and encouragement can be found worldwide.

### Zone of Proximal Development (ZPD)

This concept was put forward by Lev Vygotsky in 1934, but only came to international attention when is work was translated in 1978

(Vygotsky 1978). It states that people will learn things most easily if they are close to things they know already. Whilst this sounds obvious, it has a great effect on how curricula should be structured. The difference between this and threshold concepts is that it works in the opposite direction, from known to unknown. But the problem areas are just the same – students may be missing assumed areas of knowledge.

Davis Ausubel

(Ausubel 1963) added the idea of teachers having to take the time to find out where the ZPD is for each student. This is an impossible task unless each student is tested on each underlying topic. Even if that were possible, the effort required to bring each student up to speed for their areas of weakness would be enormous. This is an area where TEL comes in its own.

### Identified good practice

There should be a way for the progression of concepts to be mapped. The map can then be used in the reverse direction to identify the concept causing the problem. This can then be visited, along with any subsequent concepts, to allow a more thorough and confident progress through the syllabus. The point to be taken from this:-

1. There should be links to underlying concepts which allow any holes to be filled.

## Stage 3 - Build TEL materials based on these principals.

Subject to ethical approval, these will be built on an external web server since the university is not able to host externally accessed databases.

### The Principles of Good Practice Consolodated

These can now be brought down from the Stage 2 discussion and duplicates eliminated.

1. The syllabus should be broken into atomic tasks so that all aspects of the syllabus are covered.
2. A monitoring system should exist to ensure that students are progressing and will achieve.
3. Tasks can be grouped into menus/sub-menus so that both serialists and holists can choose the method that works for them.
4. Materials can be developed in text, audio and video formats, thus allowing the student to choose their preferred form.
5. Linear forms of study will hinder metacognition, so non-linear paths should be available, e.g. a hierarchically organised menu system.
6. A lack of an appreciation of the size of the subject may cause a misunderstanding of the scope of the subject matter, so that should be clear, e.g. a hierarchically organised menu system.
7. Students need to be able to review concepts and skills as often as it takes for them to feel comfortable with them. A variety of computer-based materials is likely to be more flexible than, say, a text book.
8. Feedback and encouragement should be available quickly and easily.
9. There should be safety nets in place to provide alternative routes to success.
10. Give students an opportunity to try for themselves (helping them become independent learners) and then use the classroom to fill in the gaps. TEL needs to provide a variety of ways learners can explore.
11. There should be links to underlying concepts which allow any holes to be filled.
12. Tests which do not count towards grades would allow students a hands-on experience of their grasp of the subject matter.
13. If the coursework is linked directly to the learning materials then there is another opportunity to put the learning into practice.
14. The system should allow networking so that students can help each other.
15. A TEL system should include social media so that help and encouragement can be found worldwide.

### What should be included?

1. Each syllabus should be broken into separate, atomic tasks. (From item 1)
2. There should be a progress review page which can be accessed by both the student and the teacher. (From items 2 and 8)
3. A structured menu covering the whole course is needed to ensure the students can work in either serialist or holist mode, understand the scope of the subject area and can progress at their own speed. (From items 3, 5 and 6)
4. Materials should be presented in four formats; as a web page, as a PDF, as an MP3 file or as a video so that students can choose the format they prefer. (From items 4, 7, 9 and 10)
5. There should be hypertext links to tasks on underpinning knowledge. (From item 11)
6. Tests should be included both as a re-enforcement tool and as a tactile method of learning. (From item 12)
7. There should be the facility to have sections of coursework formatively assessed so that students can get quick and supportive feedback on their progress (From item 13)
8. There should be links to common social media sites so that students can communicate with each other and those outside their class to discuss aspect of learning. (From items 14 and 15)

## Stage 4 - Statistically analyse the results to assess how each identified item of good practice performs in a TEL environment.

Testing must be both ethical and rigorous. The ethical constraints are not a burden to this study. However, trialling the web site with one group whilst prohibiting another would be unethical. Either one group or the other could be disadvantaged. Therefore, a different method of analysis is needed. This study would also look to develop a statistical technique which focusses on the relative position of a course within a year. If an intervention, such as the proposed web site, were to work then the relative position of the course on which it was trialled should improve. This would eliminate differences between academic years.

**This is where the paper on learning dissonance would go.**

# The Research Gap

As can be seen from the discussion above, there is a need to tie educational theory to the practice of TEL materials.

The method to potentially to fill this gap has also been described as well as testing the result in a statistically rigorous manner.

# The TurnItIn Check

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1. According to Google Scholar [↑](#footnote-ref-1)
2. Page 220 of Visible Learning, Hattie, 2009, Routledge [↑](#footnote-ref-2)
3. Page 170, ibid. [↑](#footnote-ref-3)
4. Page 171, ibid. [↑](#footnote-ref-4)