University of Sunderland

BREAKING THE FAILURE CYCLE:

THE OPPORTUNITIES AND CHALLENGES OF ADOPTING MASTERY PEDAGOGY TO DEVELOP MATHS COMPETENCY IN FURTHER EDUCATION.

JOHN B COOPER.

A thesis submitted in partial fulfilment of the requirements of the University of Sunderland for the degree of Doctor of Philosophy.

24th February 2021

PhD   **2021**

Contents

Abstract

This research aims to critically evaluate the impact of deploying mastery pedagogy to the teaching of maths on learners, teachers and organisations, specifically in Further Education (FE) settings in England. Ideas from the pragmatism school of thought, particularly those of the American philosopher, John Dewey, as well as the 'second wave' pragmatist Richard Sennett, are explored alongside concepts proposed by Csíkszentmihályi, Boaler, Usher, Nuthall and Hildebrand among others.

The 'Essential 8' maths mastery programme is examined with regard to eliciting positive effects in learner experience and results. Quantitative details regarding assessment data from around 2000 students are supplemented with extensive qualitative accounts from learners. Plowright's structured mixed methods approach is adopted.

Three main themes for further debate emerge: 'Managing cognitive load', a 'teach less to learn better' concept and a proposed theory of 'collateral growth'.

This study proposes that the experience of the learner as a result of the situation enabled by the teacher, acts to improve learner perception of success. The evident continuing increase in exam grades of those studying with the programme is interpreted as a by-product of meaningful learner experience. Evidence from learners, educators, exam grades and the relationships between these data are presented in support of this theory.

A 'teach less to learn better' concept is offered to act as a catalyst for further debate between stakeholders in teaching maths with a mastery approach.

Key terms: Further Education. Maths. Pragmatism. Situation. Tacit learning. Learner voice. Cognitive load. Less but better. Collateral growth.

Research Question

The Question the study seeks to address is "what are the opportunities and challenges associated with using mastery pedagogy when teaching maths in a Further Education setting?"

The research assumes that the learner experience in UK secondary maths education varies wildly. This is borne out by many years of talking with learners and discovering their reasons for not achieving a GCSE pass grade in maths at the end of their secondary education.

The wide variety of different learner experiences is resulting in different outcomes from the same process, the effect of learner experience is considered and hence Dewey's account (Dewey, 1938) makes it possible to consider multiple truths alongside a mastery programme.

This table details the research questions the study sets out to answer:

	Research Questions	What answers this question
Main question:	What is the impact of a mastery approach to teaching maths on Further Education re-sit students?	The nuanced effect it has on the confidence and well-being of the learners on the programme. Interviews and the mass survey suggest that learners find the approach less stressful and more enjoyable than their previous experiences.
Sub question:	What is the current experience of learners and teachers regarding learning/teaching maths?	In the mass survey, learners report there is a difference between their past experience of maths education and that which they are experiencing in the FE maths classroom. In interviews, teachers claim to appreciate the structure offered by a mastery approach.
Sub question:	What impact does a mastery method of teaching maths have upon learners' experience and achievement in maths?	Numerical data shows a 5% per annum increase over a 3 year period. Beyond the fact that 4 times more young people are passing with the mastery approach than those in other FE settings, the effect it has on their perception of learning and self-esteem is evident from the narrative enquiries made within the study.
Sub question:	What are the wider impacts on learners of adopting a mastery approach to teaching maths in FE?	The grade boundary system is engineered by OFQUAL to ensure a 40% failure rate. This means teaching more and teaching faster is actually futile. Teaching less and teaching it slower offers learners collateral growth, far beyond any maths problem solving skills. Critical incident analysis of student feedback suggests learners are recognising the approach as a progressive means to achieving success – in and out of the maths classroom.

Sub question:	What are the challenges and limits of adopting a mastery approach to maths?	During conversations, a common reason students give for their lack of school maths success is the frequent changing of teachers in their final year. Dewey's continuity of experience may well be at play here. Mastery demands teachers have an unambiguous knowledge of their students' abilities. Sadly, FE colleges have no way to enforce attendance which means teachers may lack continuity of students. Educators and managers must be brave and take a leap-of-faith when they commit to teach less to learn better.

CHAPTER 1: The current landscape of GCSE maths in FE

In this chapter the landscape in which this study resides and the research setting are established. The three domains of learning (cognitive, affective and psychomotor) are introduced along with the concept of mastery pedagogy. The English education system is expalined with consideration of the roles of external stakeholders such as OFSTED and the Department of Education. Finally the social and economic factors surrounding maths in FE are presented for discussion.

This thesis is concerned primarily with the efficacy of mastery to FE mathematics with the overarching philosophical tradition being the corpus of John Dewey. The presentation and nature of this research should be considered within this context. Dewey's pragmatism pervades this study and consequently the experience of the learner, as perceived by the learner, is prevalent throughout.

Background

I am a lecturer in GCSE Maths in a Further Education college situated on the South Coast of England. Our college welcomes learners each year who have not quite managed to pass their GCSE at secondary school or in their previous place of learning. As learners can be with the college for 3 years, some have 2 or 3 attempts at GCSE and some complete functional skills exams at college in the years prior to attempting GCSE. As a result, around 750 learners (aged predominantly between 16 to 19 years old) attend GCSE maths classes provided by 6 full-time and 2 part-time teachers.

In 2015, my own learners' situation (I refer to the learners entrusted to me) was somewhat bleak as the college had little in the way of a curriculum beyond that of secondary school, which had already been unable to help them to succeed. Exam results of less than 11% achieving a grade 4 or higher, indicated change was required. With permission from my managers, I secured some Department for Education (DfE) funding and brought in an inspirational teacher-educator from the local university to advise us what to do. After spending a considerable amount of time observing our lessons, he decided that we "*needed better students*". Fortunately he went on to explain that whilst we were all teaching maths, we were seldom offering any advice on how to learn maths. What we needed was to replace their perceived failure with success,

breaking maths into manageable, achievable parts that could be learnt as a whole group, with everyone learning together – a shared positive experience. As a result, my colleagues and I developed the 'Essential 8' maths mastery programme and steady improvement in many areas of our learners' experiences (not just assessment grades) has been forthcoming.

We have developed a teaching resource which has led to us adopting a mastery style of pedagogy which other colleges have shown an interest in and are using. There are over 10000 of our workbooks in circulation (Cooper, J and Kazimierczyk, L. 2017) and in excess of 27000 free downloads of our 'Essential 8' resources from the TES web site (TES. 2020) (as at December 2020).

 The Essential 8 maths mastery programme is simply sets of eight questions that learners complete in their printed workbook every week. The topics are in a set order and never deviate. Posters in each room correspond to the topic of each question (1, is always transformations, 2 is area and perimeter, 3 probability etc). It has been designed to offer post 16 re-sit students a taste of success and a mastery of mathematics they may not have encountered before. The scheme of work (Appendix 1) repeats the eight topics in order three times over the 33 week term with assessment at the end of each cycle. This study examines the success of the programme and the effects it is having on learners, beyond that of improving grades, which although was the intention, has become secondary in importance to the more profound changes young people are associating with the programme. A mastery approach is adopted with an accompanying ethos that no learner is permitted to be left behind the others. The concept of creating communities of learners lies at the centre of the approach.

This study sets out to assess the phenomena surrounding the apparent success of our mastery approach and attempts to frame mastery pedagogy in FE maths within accepted theory. It examines the ideas and theories of educational, philosophical and practitioner based traditions to give credibility to the role of mastery in FE maths and perhaps improve the experiences of those learners within colleges of vocational learning in England. Possibly colleges in other countries where maths is learnt in such establishments may benefit from some of the methods and ideas presented.

A personal perspective:

This research is value-laden and contains personal truths. It would be remiss not to declare such at the outset of this thesis so that readers may draw their own conclusions within an appropriate context. Having taught maths in secondary schools and seen first-hand the practices that are widespread, I came to question the very purpose of education. I always wanted to be a maths teacher since a conversation I had with my own teacher, Des Donovan, in 1981. Thirty years later I trained accordingly at university and qualified. It is difficult to pinpoint when my journey in education started however but the more I ponder the question, the more I am convinced that my teaching is heavily influenced by my own childhood experience of school and subsequent issues surrounding my time in compulsory education.

During teacher training, we were all instructed on how to embrace differentiation as well as engineer curricular opportunities for 'stretch and challenge' of students. These two elements of teaching became the criteria which were most frequently used to critique our lesson plans and lesson observations. It was around this time that I realised that these were indeed effective *teaching* strategies but possibly not particularly effective *learning* strategies. It appeared that differentiation made able students more able – and less able students less able. And yet this was offered as a 'good' strategy. In my desire to gain the necessary judgement to progress and qualify as a teacher I ensured all my lessons obeyed the rules and I quickly realised that any paraphernalia remotely connected to Black and Wiliam's 'Assessment for Learning' drew instant praise and positive feedback from my teacher trainers.

Once I started in my post in my NQT year it became very clear that Assessment for Learning was about making teaching and grading teaching easier. Moreover the classroom control techniques and behaviour strategies I had been told to practice were not conducive to learning but were conducive to teaching. All in all, I was very disillusioned and I did have to take counsel from professionals outside the education sector as to how to best address my own misgivings and my personal state of well-being.

Once I had taken the chance to complete my MA in education, it became evident that there were other ways to teach and learn. It was through reading the literature of more enlightened and learning focus commentators that I found the vocation I had been seeking could be practised in a way which allowed young people to experience positive interactions with their teachers and with each other that would stand them in good stead to pass on a positive message regarding education to the young people they would encounter both at school or college and far into their future.

FE college offers me the opportunities to connect with those I was told to 'forget about' as a new teacher by school leaders; the hopeless cases on the desks nearest the door who were told to make posters whilst the star pupils on the other desks practised trigonometry. It is through the stories of those learners and the accounts of their experiences, that a way to teach and learn has emerged which gives learners as good, or better, chance of academic success at GCSE as any other approach whilst maintaining their integrity of spirit, self esteem and mental well-being and health in general. The health of young people often seems to be overlooked in education's predilection for ever improving grades.

I had entered teaching with a wholly positivist viewpoint which I then had to quickly and somewhat painfully change once I had witnessed the effects that secondary teaching practices were having on young people. To a lesser extent I entered into designing a curriculum and a pedagogical approach with the view of improving GCSE pass rates for our learners, only to then discover that it was the experience of the learners that was actually behind the rationale of everything the mastery style approach was evolving into.

This background is offered to put this study into context as it too has evolved over the time it has taken to fully understand that traditional research question of "what is going on?" Therein lies the issue with the nature of this type of study as practitioner / researchers can find themselves responding to the feedback they get from the learners and in turn the state of the 'things going on' evolves. Over time, the literature informs the practice of the teacher and the sterility of the research laboratory becomes forsaken for the wonderful unpredictability of the classroom. Every reaction of a student is recognised as a reaction which changes the situation and the students are part of the

picture, along with the teacher, the managers, the policy-makers and society at large. All stakeholders have their part to play and the research becomes accordingly nuanced and informed; it starts to appear as a huge, yet familiar, landscape to explore; picking up artefacts of data as the journey through the lesson progresses.

It is similar to an experienced palaeontologist strolling along a Jurassic coastline; they will spot footprints of ancient dinosaurs where others see rock-pools, prehistoric ammonites where laymen see pebbles and evidence of fantastic creatures in seams of rock where towels have been placed to dry in the sun. Such are the artefacts of learner data in the classroom; the naughty one, who is in fact overcome with anxiety, the quiet ones under hoods, who rarely engage and yet soak up new facts like a sponge and the eager ones who actually crave affirmation and value it far above remembering anything that they may learn. To the casual (or official) observer these learners may be misinterpreted either through naivety, ignorance or pre-conceived expectation.

I cannot imagine researching learning away from the classroom for it is only in the classroom that one can discover and interpret the emerging data in the context of the moment. Every artefact that is collected informs and assists the collection of more clues to what is happening. It is a subtly changing landscape as generations pass on their experiences to their younger counterparts, the teaching profession changes its views and policy forces sands to shift. If we are to accurately assess, responsibly improve and genuinely care for the experience of learners then educators must engage and evolve with the morphing surroundings and evolution of learning. There are many 'truths' and they are the subjective truths of individual experience. Numerical data can point to anomalies of deduced perception but they do not necessarily identify cause but merely represent effect.

The truths of experience, the 'real truths' that Dewey discusses are the domain in which my study in the role of researcher and my practice in the role of educator lie.

Mathematics in UK Further Education colleges:

In 2013 the UK government passed a law (The Education and Skills Act made education or training compulsory until the age of 17 from 2013, and 18 from 2015)

which effectively raised the age at which young people can now leave education in England to 18 years old (In Scotland and Wales, the leaving age remains at 16). There are various schools of thought regarding the political motives behind this decision which are not addressed directly within this study, although the role of education as a method of social control is discussed as it is identified as an evolving and pervasive factor in maths education.

The expected qualification upon leaving secondary school is the General Certificate of Secondary Education (GCSE) in each subject the student has studied. Attempting English and Maths GCSE is compulsory. Any learner leaving secondary education (aged 16 or 'year 11') without a GCSE in English or Mathematics must carry on studying towards the relevant qualification until they reach leaving age. This necessitates GCSE provision to be in place for 'post 16' learners (who have not achieved Maths or English) in colleges and schools. This study is limited to considering only mathematics.

College versus School maths education in the UK.
Many schools have provision in place (most commonly referred to as '6th form') for post-16 students wishing to take A' levels (a pre-entry requirement for most universities) and some cater for students who may have not achieved GCSE Maths. This means schools can allow their most able students to stay with them, sometimes refusing entry to those who are unlikely to achieve their maths GCSE, leaving them no other option of full-time academic study other than attending a Further Education (FE) college, such as the one where I work as a lecturer in GCSE Maths.

The widely used website "The Student Room" have developed the "Which? University Guide" into "The Uni Guide", a portal of comprehensive answers to questions from those entering further and higher education. They suggest that:

> "Entry requirements for school and college sixth forms vary – ranging from four to five C grades (that's between a 4 and 5 under the new GCSE grading system), with perhaps Bs in the subjects you want to study, through to at least six GCSEs at grade A for the most selective colleges." (The Uni Guide. 2019)

Many FE colleges (including the 3 where I personally work) have no entry requirements in terms of qualifications whatsoever for many courses.

This has effectively created a two tiered system where schools and 6th form colleges cater for GCSE maths students who are studying for A' levels alongside their the GCSE maths and FE colleges that cater mainly for students who are looking to achieve a vocational qualification in a practical subject (perhaps hairdressing or carpentry for example).

This creates a problem as the two tiers can be compared to each other and seen without context by parties who stand to benefit from the disparity. As a consequence, the problems facing FE colleges are somewhat specialised and this tends to be at the epicentre of the research I engage with.

Improving practice through research.

When practitioners in any discipline try to improve their efficacy and skill it is often necessary to dissemble their craft to see exactly how it works. My interest in playing the guitar stems from repairing guitars in my youth. I needed to play to find whether the repairs or adjustments I had made were successful to make music with. Similarly, many racing drivers and riders (Fangio, Barry Sheene, more recently, Carl Fogarty and Guy Martin) were themselves talented engineers and mechanics in their own right. This enabled them to succeed in their pursuits using an underlying knowledge which supports and informs their practice. The work of Richard Sennett, a self-proclaimed 'second-wave' pragmatist (Sennett, R 2008 p287) (he views pragmatism in terms of two distinct, chronological, phases) is considered later in this study to tackle how we translate practice into craft.

The craft of educating is many-faceted; it can be very difficult to grow one's sphere of influence, in order to confidently implement a new curriculum or learning programme, without a convincing body of theoretical knowledge and associated qualifications. It is vital however to see as much of the whole picture as possible and not fall into the trap of merely 'cherry-picking' the attractive parts of a pedagogical approach and suggesting it is therefore justified through secondary research.

"A little learning is a dangerous thing" *(Classical poet, Alexander Pope.1704)*

Caution should be exercised when adopting practices because they are popular or widely practised. Blindly following headline opinion may not be the best for the students of such educators. Conversely, protesting when questionable processes are employed is often viewed as simply a reaction to change or reluctance to try new ideas. It is vital to assume a credible, informed position through research and experience. By engaging with current research, understanding academic thoughts on specific issues and having an in-depth knowledge of one's own personal teaching and learning environment, it is possible to enter into a discourse surrounding the problem from such an informed position. This may be the most effective measure a practitioner can take to safeguard the learning of his or her students and the future course of teaching in their respective field. When presenting the 'Essential 8' research (Cooper, J. 2017) to the EAPRIL 2017 conference in Finland, there was strong emphasis on affecting informed change by becoming teacher/researchers with frequent reference to the term 'tesearchers'. The BERA blog article regarding this (Jones, K 2015) issues a warning of *faddism* and cites those teachers and teacher trainers that based lessons on learning styles (the visual, aural and kinaesthetic styles) which are now largely discredited (Willingham et al 2015).

Avoiding fads and thus basing teaching on sound academic theory is not as easy as one might imagine however. The aforementioned 3 learning styles have sometimes been confused (including in my personal experience during a conversation with a head-teacher) with the 3 domains of learning. The understandable misconception may arise from the classification the psychomotor domain often being simplified to the kinaesthetic domain – a term usually associated with learning styles.

The importance of educators engaging with sound theory and refreshing their knowledge may be at the heart of improving the experience for learners. Most trainee teachers have been introduced to the three main domains of learning, "*first developed and described between 1956-1972*" credited to Bloom and Kratwohl *"and all teachers should know about them and use them to construct lessons"* (Wilson L,O. 2018). They are pertinent to this research and provide good ground in which to root this study.

Three domains of learning.

A brief review of the three domains might help to pinpoint where this study resides in the educational landscape using a possibly familiar landmark for many educators. The domains traditionally are suggested as a basis for lesson planning when teachers are training towards their PGCE (Post Graduate Certificate in Education) which is the most common way to enter the teaching profession. Much is made of the 'Cognitive Domain' as it is possibly the most easy to understand, easiest to measure and easiest to cite whenever hard-edged assessment, rote learning or dogged hard work is proposed. The 'Affective domain' is concerned largely with emotions (although not in a particularly altruistic sense) and the 'Psychomotor Domain' deals with the actions and fine motor skill required to actually perform a task.

It may be prudent here to ensure an awareness of the differences between the pragmatists' approach to the experience of the act of physically doing something and the classifications in Bloom's Taxonomy (Bloom B.S. 1956). There is subtlety at play here which should not be lost by virtue of the limitations of our language. Sennett (2008 p288) eloquently explains this using the German words 'Erlesnis' and 'Erfahrung'; respectively, how it *personally feels* to do something and how that thing is *outwardly perceived*.

Sennett states he is concerned more with the latter but these are the two sides of the same experience coin, inseparable in their existence but never-the-less, providing more insight into the link between the domains of learning and the pragmatist interpretation of experience. Looking more closely at the domains allows some parallels to be drawn with this study of the Essential 8 mastery programme.

Cognitive

This is probably the most widely discussed, researched and subscribed-to domain. (A search on Google scholar returns 3.6M hits as opposed to 2M for affective and 0.1M for psychomotor). This is where learning with the brain leads to knowledge (in a very traditional sense) to be retained by memory and generally where most over-simplified teaching approaches can find refuge and justification. Blooms taxonomy (Bloom et al 1956) can be cited to quell any dissent and everything is well in this binary existence.

Black or white, good or bad. Work hard, learn more, know more. This is the gross positivist view of learning and requires little empathy or experience to understand.

Affective

The affective domain deals with the idea that learners may have feelings which can have an effect on their learning. Less obvious than the cognitive domain, Krathwohl champions this domain (Krathwohl studied alongside Bloom and in 2001 redesigned the taxonomy that he originally co-authored in 1956).

Considering emotion, feelings, attitudes and self perception; this softer, less tangible, domain is where much of the thinking behind the Essential 8 mastery programme can find some theoretical roots. If we start to value success, achievement, personal self-esteem and confidence, gains in the cognitive domain may occur as a by-product of allowing learning to happen in an emotional environment which is likely to increase recall and long term retention of skill (Boaler 2017). How we may interpret the term 'emotional reaction to learning' today, may be different to the way in which it was proposed back in 1956. Receiving, responding, valuing, organising, characterising; is the order in which Bloom suggests the progressive hierarchy occurs but true emotional reaction can be far more extreme, far more visceral when dealing with young peoples' experiences of maths learning.

Psychomotor

The 'doing' part of the trinity. Here we are getting into territory that deals with physical acts being part of the learning process. Reading a book on how to swim, then assuming one could swim with no prior practice is obviously unrealistic. Sennett tackles this at some length in his book, The Craftsman, (2009). In a summary chapter he states:

> *"... progress occurs in fits and starts. But people can and do get better. We might wish to simplify and rationalise skills, as teaching manuals often do, but this is not possible because we are complex organisms."* (Sennett, R. 2009 p238)

That complexity is where the core of this study lies. Of course there are many factors at play with learning maths, one which is frequently overlooked lies in the psychomotor

domain and is inherently linked to mathematical success. Expressing the purely social construct of mathematics using graphical representations of amounts is at the core of mathematics. Simple numerate operations require correct place value positioning and the Gelosia lattice multiplication method taught in the majority of secondary schools needs precise drawing skill to execute correctly.

The act of writing digits (graphical representations of physical amounts) in ordered lines is key to the understanding of the whole of modern mathematics. In western cultures 'place value' is everything and place value (literally giving value to something by virtue of its relative place in a calculation) is a skill which goes back to the very inception of the application of using quantities to solve problems, back to the very heart of mathematics.

This study lies firmly in the Pragmatists' view of experience and action, the proposed 'doing' and 'response' belonging to the same set of practical actions that combine to result in learning and growing in skill. Crucially, this study is approached from John Dewey's position; whereby a learner is subject to having 'something done to them' when they 'do something'. All action is interaction and the transaction between the learner and the situation in which the learner exists are all affected by the process. It discusses the holistic appreciation of a learner's entire approach to learning mathematics and the outcomes, foibles and lasting effects of the experience of an education in mathematics. This is research which examines the actual occurrences, the real effects and the genuine influences that maths has on its students.

Nuthall examines the *"common sense and widely held theory that learning is the natural consequence of actively engaged minds"* (Nuthall, G 2007 p24) noting that his research indicates that actually detecting learning occurring using engagement as an indicator may be less than reliable as learners get to know how to give the appearance of being engaged; *"research shows that students get very good at playing the reciprocal game. They are excellent at knowing what signs the teacher is looking for, and making sure the teacher sees those signs"* (Nuthall, G 2007 p24).

To overcome this inherent flaw in observation, the experiences and conversations of learners are analysed via their own feedback and unsolicited comments, which occur throughout the everyday actions of teaching and learning maths. The 'doing' is examined not purely in the sense of doing maths, but doing everything; whether that be pretending to be engaged, talking with others or saying nothing. The psychomotor must be viewed as the act of 'doing' in its entirety.

Conceptual versus physical comprehension.

There is a simple phenomenon I can relay to describe what happens to learners as they leave the physical realm of comprehension and move into the conceptual understanding of mathematics:

When I am teaching in a primary school, with learners at the beginning of the education, if I raise my open hand and ask learners to tell me what I am holding up, they will usually respond "it's your hand".

When I do exactly the same in a secondary school, I most commonly receive the answer "five".

Albeit a simple example, that difference sums up what maths education in the UK is and how it morphs from the practical to the conceptual without prior warning. As soon as educators introduce infinity, negative numbers or even simple algebra, we are expecting a blind 'leap-of-faith' from our learners. It is a leap some will never make and they may pass on this reluctance to further entrench maths anxiety in future generations.

The fundamental nature of that leap is what drives this study, for the experience of doing, even doing conceptually, must still be recognised as an act; a physical response to a problem. It is about this point that this study starts to push at the boundaries of Dewey's tenet of 'action being interaction' (Biesta and Burbules 2003). In order to cement the conceptual response to a mathematical problem, the learner is being asked to repeat a process, a mental, physical and conceptual process combined, many times.

Mastery and the Essential 8 programme requires a student to 'repeat many times'. Is this simply an excursion into rote learning, simply mindless repetition? If that is the case

it is unlikely to work for a summative assessment (the GCSE) which is designed to present problems in contextualised settings. Perhaps an examination of the differences between rote learning and mastery are necessary.

What is the 'Mastery' pedagogical approach?

It is important to dispel myths surrounding the concept of mastery. It is not a panacea for education in every circumstance. To suggest that every learner can achieve success given unlimited time is a ridiculous premise in the real world, as is to prescribe to the view that a simple series of steps can be taken to magically transform classroom practice. Mastery is a small step toward a whole pedagogical approach in which groups of learners and teachers can share a common set of ideals and beliefs.

In terms of what the core concepts are, this brief list gives an overall outline of what mastery in a maths classroom should have at its core (National Centre of Excellence for Teaching Mathematics 2016):

- *Maths teaching for mastery rejects the idea that a large proportion of people 'just can't do maths'. All pupils are encouraged by the belief that by working hard at maths they can succeed.*

- *Pupils are taught through whole-class interactive teaching, where the focus is on all pupils working together on the same lesson content at the same time, as happens in Shanghai and several other regions that teach maths successfully. This ensures that all can master concepts before moving to the next part of the curriculum sequence, allowing no pupil to be left behind. If a pupil fails to grasp a concept or procedure, this is identified quickly and early intervention ensures the pupil is ready to move forward with the whole class in the next lesson.*

- *Lesson design identifies the new mathematics that is to be taught, the key points, the difficult points and a carefully sequenced journey through the learning. In a typical lesson pupils sit facing the teacher and the teacher leads back and forth interaction, including questioning, short tasks, explanation, demonstration, and discussion.*

- *Procedural fluency and conceptual understanding are developed in tandem because each supports the development of the other. It is recognised that practice is a vital part of learning, but the practice used is intelligent practice that both reinforces pupils' procedural fluency and develops their conceptual understanding.*

- *Significant time is spent developing deep knowledge of the key ideas that are needed to underpin future learning. The structure and connections within the mathematics are emphasised, so that pupils develop deep learning that can be sustained.*

- *Key facts such as multiplication tables and addition facts within 10 are learnt to automaticity to avoid cognitive overload in the working memory and enable pupils to focus on new concepts.*

Rote learning in a mastery technique approach.

Rote learning is easily confused with mastery technique, mainly because it suits educators that believe that if we return to 1950s techniques, we will get 1950s success rates; with 21st century learners, that logic has to be deemed questionable at best. Rote also appeals to decision makers in education, who tend to be over 50 and therefore were exposed to rote learning (as was I) and 'it never did them any harm'. The media have latched onto mastery (Hurst, G 2016) as rote because, again, it will validate the views of the demographically largest sector of their readership that is that rote is best and all the 'soft' approaches have been indicative of a failure of liberal tendencies that they believe should now be rejected.

I defer to Helen Drury whenever considering matters of mathematics mastery as her approach is all-encompassing, focussed on UK education and offers practical activities to engage learners in mastery which are clearly not rote (nor traditional) in their design. I am a regular contributor to the Society For Education's periodical, 'inTUITION'. In this publication she writes:

"Maths teaching across the country is being transformed by the mastery approach. Whereas traditional methods often focus on rules or procedures, mastery teaching emphasises students' understanding of mathematical concepts" (Drury, H 2018).

She continues on to suggest the use of pictorial representations, physical manipulatives and diagrams to help learners to visualise the conceptual elements of maths to further their understanding. The Essential 8 programme has at its heart an ethos of moving forward together; a collaborative learning model – far detached from the multiplication tests league table I was forced to participate in some 40 years ago. Hopefully, this is example enough to side-line the 'mastery is rote' misconception and dispel it from any further discourse within this study. The repetition of the Essential 8 is about building familiarity and confidence to tackle 8 carefully sequenced areas of maths, not about mindless repetition of rote.

The criteria of effective teaching and learning.

It does take time and courage to adopt an approach designed to encompass the needs of the whole learner, across all domains of learning. Courage because to find the extra time, some curriculum may have to be forsaken to allow for the implementation of a pedagogy that is truly focussed on enabling the learner to understand, accept and execute the necessary skills to complete the maths problems that will occur in the GCSE summative assessment – for that is the purpose of FE maths resit and that must remain the watchword of this study to ground it within practical, effective practice ...

*"Taking the time and resources needed to design effective learning activities means covering a lot less of the curriculum. To justify this, we must make sure that the outcomes of these learning activities are really important not only in the official curriculum but in the lives and interests of the students" (*Nuthall, G 2007, p37-38)

Note how Nuthall uses the term 'design' in the above quote and the reference to covering less of the curriculum. This resonates with the philosophy of the eminent German product designer Dieter Rams of *"less but better"* (Rams. D 2014). In terms of the Essential 8, that is exactly what we have set out to do and is at the centre of our mastery pedagogy.

Teaching less for better learning is one of the recurring themes which occur throughout this study, along with Dewey's 'conjoint community' (Dewey 1938, 52) and Van

Maanen's 'verisimilitude' (1988), the apparency of truth having more meaning than the truth itself.

The Further Education Landscape

It should be noted that in FE, there has been chronic underinvestment which has often resulted in senior positions being filled by staff that may have little or no experience of teaching young people academic subjects the average annual spend fell by £244 million between 2010 and 2016 (Whieldon, F. 2020).

Bear in mind that compulsory GCSE Mathematics has only existed in FE since 2013. As a consequence, this is a sector of education which is frequently governed by leaders who have little experience, qualification or awareness of the pressures facing mathematics today. For this reason alone, an informed classroom practitioner may be the only hope a disaffected learner may have of gaining the qualification that is preventing him or her from moving forward with their vocational studies. Many vocational students are prevented from finishing their course to a level suitable for employment, unless they can enter their final year with a GCSE in mathematics.

It should be noted that as this thesis is being created the awareness and importance of FE education is increasing and the situation is improving through maths courses becoming better established and leaders starting to understand the position FE commands within the larger GCSE maths setting.

Context and Problem.

Having presented the specific foreground of this research, it may be prudent to consider the more general landscape of further education, the pressures upon it and the way in which it might be able to be improved for the learners within it. Note this is about improvement for *the learners within it*. Other parties (parents, schools, colleges, employers, governments, OFSTED and society as a whole) exert huge force upon the experience for our learners and yet are, arguably, the least qualified to do so: schools sometimes portray further education college as a last resort and use it as a veiled threat to make students work harder to pass exams.

Improvement as a concept should be seen in context and from the viewpoint of the respective stakeholder. This is a highly nuanced, complex set of relationships, each with their own agenda and the distinctions between each are often hard to define. To further confuse the issue, different individuals within each stakeholder body will exert their own

influence, depending upon their personal reasons for being involved in further education. Just as Dewey alerts us to the different agendas of the participants involved in a horse sale (Dewey, J 1910 p227) the discourse here will inevitably be different to that of an article written for a different audience or from another perspective. Whilst I can attempt impartiality, my experience and passion for the subject, may result in opinions that seem biased or unfounded. Whilst my position may appear at times inequitable, it is, I hope, not uninformed. I am an educator of young people and they occupy my central focus.

A brief history of maths in FE:

The education reform bill of 1988 was the biggest overhaul of UK schools and college for decades. Along with establishing the new National Curriculum, the creation of a new body to inspect and rate schools and the publishing of grade league tables was initiated. That body was The Office for Standards in Education (OFSTED). Inertia was eventually overcome and by the time of New Labour and the Blair victory of 1997 (it should be noted that this study harbours no political affiliation or preference beyond the improvement of education in FE) wide ranging new powers were granted to increase the remit of OFSTED in order to further pressure schools into higher performance in terms of grades.

Colleges:

Put bluntly, there exists an uncomfortable premise that Further Education colleges receive the learners that secondary schools do not want. Stated even more brutally, colleges often get the learners schools have rejected. That may be considered an inflammatory statement but it is honest and based on fact. I have spoken to learners who were warned at school they may end up in a college if they did not try harder. Read any school prospectus and it will talk about league tables, stretch and challenge, achievement awards, sporting success – not about the 40% of young people that will leave completely devoid of core subject qualifications.

FE colleges must take those disillusioned learners and attempt in one academic year of two lessons a week, what schools have failed to do in eleven years of four lesson weeks. This has to be done without sanctions, detentions or even attendance

repercussions available to educators. Who in a college is responsible for taking decisions about academic success however? How do they arrive at their decisions?

Educational establishments have coined the term 'senior leadership team' or SLT. In schools, these are teachers who have made conscious decisions to leave the classroom, (a job for which they trained, practiced and in a subject in which they were secure enough to teach others) to enter into a position of management of adult teachers (in which they may have little or no experience) for increased personal financial gain and status. In colleges, the same situation exists but appears to often be populated with individuals from a less academic background, often with experience only of teaching adults vocational or linguistic subjects. These same individuals are now in a position to form institutional policy on academic core subjects such as maths and English. Therein lays a problem. Who will decide how well they are doing? Well, OFSTED will grade their college accordingly.

OFSTED.

OFSTED are a politically neutral organisation. That is to say, they are individuals who have not been elected and are therefore in post through no democratic process. That being said, OFSTED is not above being used as a political football; Professor Viv Ellis resigned from an OFSTED advisory group in April 2019 due to his perception of OFSTED being aligned to the right of party political spectrum (Staufenberg, J 2019). The Guardian reported that Jeremy Corbyn announced plans to scrap OFSTED should the Labour party enter government. (Savage M and Helm T 2019), copying the Liberal Democrats pledge to do the same in March 2019. Neither party came to power in 2019.

OFSTED inspectors are often ex secondary school SLT personnel and therefore may have no subject knowledge within the lessons they are inspecting. Anecdotally, and in my personal experience, around 50% of inspectors visiting maths classrooms have a maths background. Some profess to having post 16 experience but this is usually limited to 6th form environments, with their carefully selected, high ability students and A' level curricula. Inspectors look for key points during lessons and are sometimes guided by the college SLT on what elements of lessons to focus on depending upon the outcomes the SLT desire. OFSTED want to see various things in classrooms,

regardless of the setting (FE, secondary, primary etc) as they are advised by government policy. They have definite areas in which they expect to see evidence of the practice they deem suitable. Their inspectors are not necessarily in possession of specific relevant experience or qualifications in relation to the setting they are inspecting. OFSTED costs the taxpayer the equivalent of around 5000 teachers in the UK (Teaching Times 2019). This fee payment is administered by the Department for Education.

A policy review of OFSTED in the 2019 inspection framework has been favourable towards the different needs and requirements of FE and it remains to be seen whether inspectors will adhere to the new policy and be more understanding to the differences between secondary and FE education.

The Department for Education.

The Department for Education (DfE) are an elected body, formed by the governing party and led by a minister aligned to that party. They have to pay for OFSTED from their budget. There is often confusion here; in a 2017 panel discussion to which I asked a question of the OFSTED and DfE representatives, it appears that the DfE has an interesting relationship with OFSTED. Whilst they may interact on policy and procedure, neither is beholden to enforce or uphold the decision of the other. This disparity of common vision basically means that the DfE may champion a pedagogical approach which OFSTED are reluctant to agree with or factor into inspections. The losers in this counter-productive battle are the learners and educators. The DfE have even gone so far as to publish an online paper regarding myths surrounding what OFSTED are looking for in lessons (Crown Copyright 2017). It could be argued that the intended audience is as much OFSTED inspectors as it is educators. It is certainly the case that many inspections are still berating schools and colleges for the very things listed within the government paper as myths.

Government.

Some might claim that the 2013 decision to pass legislation dictating that education finishes at 18 rather than 16 was merely to reduce unemployment and associated state benefit liability. However, surely there should exist some credit in a nation wishing to

ensure its citizens start their adult life with at least a GCSE grade in maths of some sort? The problem is linked to the investment for that provision though and the funding surrounding each student. The government do not stipulate how much of the learner payment given to each college needs to be spent on the actual provision of maths or English. Given that colleges receive funds per learner, the quantity of money spent attracting learners through advertising may well eventually reduce the available contact time for maths. Were the government more stringent on how the finance learners attract is spent then outcome may well improve. Whilst governments allocate and distribute funds to regional bodies, those education authorities have to redistribute to the governing bodies of colleges and schools, which, in-turn, redistribute to specific areas (infrastructure, student welfare, advertising, management salaries and finally teaching) where, often unqualified, faculty directors redistribute to a subject, possibly GCSE maths.

Hopefully this illustrates the extent of the issue and why different areas of the country experience very different sets of issues arising from investment (or lack) of available funding. The concept of colleges and schools repurposing funds intended for education to create an advertising budget is morally questionable.

Regional variation.

Whilst not wishing to limit the discourse to a single geographical area and just highlight the myriad issues surrounding the region in which I teach, it may provoke a similar assessment of factors in those respective regions in which readers of this may hold a vested interest. It is imperative that affluence variation is considered when comparing areas as private maths tuition tends to be less prevalent in deprived areas.

My college exists in the relatively densely populated South East of England in an area which suffers from a significant level of increasing deprivation (ESJNSA 2019: 5).

When colleges publish their results, there is an inevitable desire to compare their success with that of the National Average. Figures vary wildly as to what the genuine national average is and that is at the root of the problem with the current monitoring and transparency policy; it is easier to lay blame at the door of a college than look closely at

the wider issues surrounding a region or area. Thus starts an inevitable decline. It should be imperative that local communities are also placed at the heart of decision making with FE colleges as the citizens it produces will often be those serving the local community and forming the ongoing social structure of the region.

The situation was neatly encapsulated by Stephen Ball in 2013, just after the decision to extend compulsory education to 18 when he wrote in an article regarding free-schools and academies but the sentiment applies equally to colleges.

> *"We need to reconnect education to democracy and work towards a relationship between schools and their communities. We should recognise the centrality of education to larger projects of democracy and community building.*
>
> *This is about communities, parents and students having a say in deciding what, how, and by whom they are taught – and whether, how, and when they are tested, among other things.*
>
> *It is time to think seriously about what is the purpose of education and about what it means to be educated, what schools are for – and, crucially, who should decide these things."*(Ball, S. 2013).

Secondary Schools.

As mentioned earlier, it may be the case that some schools tend to only allow entry to sixth-form learners who are likely to get their maths GCSE at resit. However, sixth form colleges are included within the overall national average and skew the figures greatly. As is often the case with numerical data, it is possible to calculate a national average in very different ways. Data can be manipulated to meet whatever ends one requires.

For instance; after introducing The Essential 8, 60 learners passed their GCSE compared to the previous year when just 40 passed. Every year we had around 400 learners. If I am trying to attract more funding to further the investment levels in the Essential 8 programme, I claim that a meagre increase of just around 5% occurred (from 10% passing to 15% passing). If I need to attract more funding basis the

incredible success of the programme I claim a 50% increase occurred (60 being 50% more than 40).

Similar slight-of-hand may be used when publishing results for sixth-form colleges. For instance, entering a learner for a GCSE in maths may be deferred a year whilst they have extra tuition or a re-sit may not be offered to a learner who is unlikely to pass. Moreover, schools still have a degree of control over their learners. Often, dress codes, attendance requirements and sanction-systems are established and used to alter the behaviour of their learners. Extra lessons may be compulsory and the parent-school relationship has already been established over the previous five years. Not all post 16 maths settings are created equal. Sadly, not all put the interests of the learner above the interest of the school or college.

FE Colleges have no such sanction systems available and there is no established relationship with parents as learners are treated more as adults than children. Worst of all, attendance is generally around 70% in FE for maths. In the relatively small amount of contact time available in FE maths, further degradation of that time occurring, often due to poor timetabling of vocational subjects which may clash, the pressure of having to attend work experience and the full-time demands placed upon students in the less time-structured disciplines, such as music and art.

All that aside, there is a possibly insidious practice that lies at the heart of secondary education; an issue which is priming learners to fail; managing learning expectations in such a way that their fate is sealed from the day they enter the secondary classroom. That practice is target-setting based upon entry ability when learners leave primary school. If couched in brutal terms, learners are split into thirds; the third that will get great grades regardless of their secondary schools experience, the third that will pass with considerable input from teaching staff and the third that will fail.

It is a simple task to match relative learner maths ability upon entry to secondary school and the same upon exit. If a learner is put in a bottom set upon entry, the chances of ever achieving a maths GCSE are greatly reduced. The maths experience in primary

schools varies greatly and is often down to individual teachers rather than whole-school policy

Primary Schools

Whilst not wishing to berate what is occurring in primary schools (the government have recently invested £42m into mastery pedagogy practice in primary education), there has been a long standing issue whereby teachers have often been drawn from a demographic which has been traditionally under-supported in maths and have little or no affinity with the subject. The knock-on effect from this has been an inability to raise the overall level of maths attainment in transitional primary/secondary learners. This has meant that families and parents (and expensive independent tutors) have often had the greatest impact on their children's self-evaluation of their maths skills. Sadly this has disadvantaged families from the lower socio-economic sectors (Impetus 2017) and single parent families where time may be at a premium. These families may have their low-aspirations confirmed when, at 16, learners are awarded grades which are deemed not to be a pass at GCSE level.

Exam boards and grades.

Young learners missing out on their GCSE maths by just one grade can immediately enter GCSE classes in FE. Learners missing by two grades, i.e. grade 2 and lower, are not admitted to GCSE lessons until passing a Functional Skills exam, putting them back yet another year. The history of exam boards is of just a little interest here, all but one (Edexcel is owned by the US publishing giant Pearson) are not-for-profit. However the practice of setting *grade boundaries* is somewhat perplexing when considering the importance of these qualifications for young people.

Grade boundaries are basically the raising or lowering of the levels which dictate whether a learner has passed or failed. It is the metaphorical equivalent of asking high-jump competitors to clear an invisible bar, waiting until they all have and then telling them which ones have failed to make it because the organisers couldn't be bothered to measure it correctly in the first place.

Exams are set by exam boards' subject specialists, once the exam has been taken; the results are used to set grade transition points. The Office for Qualification and Examination Regulation (OFQUAL) state:

> *"exam boards wait until most or all of the marking is complete so they can see how difficult students found the paper, and individual questions on the paper, and take that into account when setting the boundaries."* (OFQUAL 2018)

Whilst this all sounds quite acceptable, take a moment to fully understand what is actually happening. Around 4 in 10 of all GCSE maths students must fail their maths GCSE; every year, 40% must fail.

I have attended secondary school celebratory events where there is much mutual back slapping for getting two thirds through maths when perhaps they should rather be hanging their heads in shame for failing a third of our young people. This statement is somewhat unfair however as the policy of grade boundary setting historically prevents any more the 60% passing overall.

If employers are looking at GCSE success, A' level courses are using GCSE success as entry requirements, vocational courses require GCSEs to access the Level 3 qualifications that are meaningful to employers then one third are being denied that access. One third of young people will be entering the labour market unqualified. One third will take minimum wage positions, offered by huge corporations, just to survive. One third will effectively enable the other two thirds to prosper. Year on year, order is restored.

I stated earlier that this is not a politically biased study, and it is not, however, it would appear that the free-market economy we enjoy in our capitalist society (and I can neither recommend nor subscribe to an alternative system) requires an exam system to be in place that is, at its heart, corrupt. At its heart, it is designed to produce young people to exploit. Normative as opposed to criterion assessment ensures this occurs.

Despite an often alleged Machiavellian capability, I have to admit that changing this situation is beyond my sphere of influence, as it may be for many teachers. However, it would appear that there is a loophole where something can be done to redress the injustice of the discarded third; Further Education is capable of putting a positive spanner in the unjust works.

That loophole has been created by the 2013 decision to put everyone who fails a maths GCSE into FE. Suddenly, those learners have become under the auspices of a system that has not been subject to conditioning of years of cynical manipulation. Suddenly, learners find themselves in small classes, with individual attention from teachers and are free of the regulations (uniforms, draconian sanctions etc) they have found ridiculous and incongruous to a meaningful learning environment. Suddenly, teachers can change the arguably unjust situation.

Consider school uniforms, conforming to an unnatural stereotype, having to have a certain haircut, belonging to fictional 'houses', calling adults Sir or Miss, all manner of bizarre rituals and conventions that have nothing to do with their perception of how a centre of learning should exist. Obviously, there are elements within college SLT who are too frightened to abandon rules (there are still curious directives regarding wearing hats and coats in FE classrooms for instance, OFSTED can downgrade colleges for the presence of coffee cups or drink cans) that have absolutely no purpose other than stamping authority and undermining learner confidence. But once in the classroom, we are able to create a positive learning environment, where we move forward together and change learner perceptions of their own abilities and skills. This is the place where teachers can engineer a 'situation' (Hildebrand. L 2018 p288) for learners to experience meaningful learning.

The Essential 8 programme.

In my role of mathematics GCSE lecturer, it is my responsibility to identify areas where my learners have failed to engage with mainstream education, often not through the fault of any one party but a range of influences arising from long-standing secondary education issues. There is little value in raking over what has been, but there is a possibility that change can be facilitated and the future improved.

36

As previously mentioned, I sought advice from a university lecturer and mentor of mine, using some government funding to ask him to visit our college and assess the situation. Having observed our classes and seen the time constraints we face, he suggested we concentrate on 8 main topics of teaching. The decision as to which topics to include were made by my colleagues and me. Over the last two years that programme of the Essential 8 has formed into a series of workbooks, corresponding poster set and online resources which are proving popular amongst UK colleges, schools and learners across the whole of the UK. 10000 workbooks are in circulation and 27000 free resource packs have been downloaded. The subsequent and ongoing research into the programme has led to presentations at European conferences in the UK and Finland (Cooper, J 2018) (Appendix 2) and various publications in the education sector press.

The Further Education Dilemma:

GCSE re-sit maths is not an open ended qualification in terms of excellence and developing a lifelong love of mathematics. I have a specific job as an educator which is to get a GCSE for those that have been failed by a system which is deliberately designed to fail over one third of its participants. My learners are unable to achieve more than a Grade 5 (1 is the lowest, 4 is a pass) as the exam they sit (foundation GCSE) precludes a grade higher than 5.

Later, when discussing Flow (Csíkszentmihályi, 1975), experience and advanced learning techniques, it is necessary to remember the context in which this study exists. It is not set in a world of ultra-high achievement, nor with cohorts who desire to seek a career in mathematics. This is a necessity, a qualification that is merely a hurdle, an obstacle. Using a high-jump analogy, there would be little point in teaching Fosbury Flop high-jump techniques to an individual who just needs to climb over a fence. As an educator, I am limited to helping my learners achieve a goal, a set target. Put metaphorically; the fact that the fence may as well be a high-jump in their relative perceptions, means my focus has to be on the practical needs of each learner. Perhaps this is why Pragmatism resonates more in FE Maths than any other area of education I am aware of.

I will endeavour to identify existing research and educational theories that are relevant to getting learners the GCSE qualification they deserve in a manner which suits their skill set and crucially differs from what they have experienced at secondary school – as that clearly did not work for our learners. There are theories proposed by proponents of experience based learning (Dewey and Nuthall in particular) and I offer this study to further inform the stakeholders within FE maths with relevant and practical concepts so that the abandoned third may have another bite of the GCSE cherry, another chance to escape the destiny which had been engineered for them from the day they left primary school.

Social, cultural and political factors

The account offered by Robin Alexander (Dialogic Teaching 2017) throws up some cultural, social and political reasons behind the apparent prioritisation of content over approach – curriculum over pedagogy. This has allowed the research question emphasis to lay firmly with pedagogy rather than academic competence or results. It has softened the nature of the research and shifted the perspective to examine the very essence of experience even more so.

Alexander notes how culturally the UK is bound by a preoccupation with curriculum being the answer to all teaching and learning woes. Despite decades of failure, the conviction that "what" teachers teach is more important than "how" learners learn, remains unshaken with the policy makers, arbiters and leaders of education in the UK.

Culture is not something that should be discounted as incidental when considering the plight of FE maths learners. Many suffer from being raised in an environment where maths is considered a mystical art that was intended solely as the preserve of the 'cleverer' students. Not just at home but also in schools, some students are ear-marked for maths failure from the start. The very fact that maths and English are valued more highly than any of the humanities, scientific or artistic subjects demonstrates that the UK perspective of maths is that it is a critical subject that should be used to determine whether a learner is allowed to access higher education or certain jobs. Such distinction does not exist in many countries where a talented artist or musician may be held in the same esteem as a literary scholar or mathematician.

Before arguments surrounding maths being a 'life-skill' and therefore necessary to become a good citizen are raised; it is important to realise that there is little 'everyday use' skill within the maths GCSE curriculum. Trigonometry, prime numbers and calculating volumes of cones are unlikely to crop up too often when building, shopping or cooking. Maths is undeniably full of beauty and wonder, but I refer back to the goal of GCSE maths in FE and that is the arbitrary passing of a national, summative examination.

Education is often used as a political football, especially around election time when promises of increased funding and more teachers abound. (Intuition: March 2019) There is a remuneration issue surrounding FE that the teachers cannot command the same salaries as their secondary counterparts. This again leads to a dilemma that impacts young people as many have not been lacking in resources and knowledge but have felt neglected, sidelined or simply disliked by their previous teachers. Investment in a pedagogical approach may pay far greater dividends than increasing teacher training and salaries which amounts to reinforcing the systems that fail many young people. Perhaps it is time to stop trying to make teaching better and start making learning more equitable and more accessible to every learner by ensuring the experience they have of maths is positive and free from the stigma and pressure that their educational career has imposed upon them before reaching FE college. How to affect such a paradigm shift is the crux of the discussion presented within this study and the questions surrounding making it happen.

The research question.

Assuming research is solely undertaken to answer a question troubles me somewhat; examining a phenomenon and increasing personal understanding and disseminating findings in an accessible and useful way, seems far more important than answering a question.

From a Cartesian viewpoint, all undesirable situations may be distilled into questions waiting for correct answers. Education however is, rightly so, a messy, nuanced balance of teaching, learning emotions, intellect and motivation. Any single question must be

couched in the very broadest terms whilst not assuming to be a panacea for a huge range of settings.

The Question this study seeks to address is **"What are the opportunities and challenges associated with using mastery pedagogy when teaching maths in a Further Education setting?"**

The research assumes that the learner experience in UK secondary maths education varies wildly. This is borne out by my many years of talking with learners and discovering their reasons for not achieving a GCSE pass grade in maths at the end of their secondary education.

The 'Further Education setting' part of the question cannot be overstressed. Commentators on education often choose to present their theories in widely generalised terms. Primary, secondary and many other levels of education (initial teacher training especially) take on these theories as tenets of good practice and use them to assess such practice accordingly. Mastery pedagogy could become such a theory and lose impact through adaptation to suit specific settings.

When the panacea of 'Assessment for Learning' was seized upon by a government that was dazzled by a pedagogy that was cheap to implement (and crucially, indifferent to class sizes) it became twisted to suit wherever it was deployed. Its authors eventually admitted that its presentation was inherently flawed, leaving it opens to abuse:

"The big mistake that Paul Black and I made was calling this stuff 'assessment',". "Because when you use the word assessment, people think about tests and exams. For me, AfL is all about better teaching." (Wiliam.D 2013)

Whilst it is a magnanimous admission of AfL being an inherently flawed approach from its founder, it is disappointing to see that Wiliam confirms his system is designed to be "all about better teaching" when it appears to becoming evident that what is actually required is a pedagogy that is all about better learning.

This research question is not written as a vague musing, it is not concerned with anything other than learners who have failed their maths GCSE by one grade,

continuing their education as a result of the 2013 legislation demanding they continue to study maths until 18 in Further Education. It is written with precision to provide a precise analysis of the specific situation that directly affects around 100,000 UK learners each year. (about 600000 sit exams each year, 40% fail, of those 50% obtain a grade 3).

The wide variety of different learner experiences results in different achievement outcomes from the same teaching process. The effect of learner experience is considered and hence Dewey's account (Dewey, 1938) makes it possible to consider multiple truths alongside a mastery programme.

Allied to the questions and sub-questions to be answered in the introduction, the three main outcomes of the project are to be as follows:

a) Identify whether applying a mastery pedagogy to FE maths has a positive impact on learners.
b) Gain a deep insight into how learners' experience of an FE maths resit course can affect their final outcomes.
c) Place FE maths in an accepted theoretical setting, increasing awareness and understanding in the wider education community.

In order to achieve these outcomes, the literature surrounding the subjective experience of learning needs to be reviewed in order that the research questions may be approached from an informed position. That is the purpose of the following chapter.

The outcome from this study is inextricably linked to the widespread recognition and continued success of the Essential 8 programme. I co-authored a paper published in response to this research (Nixon, L and Cooper, J 2020) which presents the issues surrounding deploying a core concept curriculum to a wider audience.

The structure of this study:

This chapter has established that the thesis details the narrative surrounding the attempt to discover if the experience of young people re-sitting their maths GCSEs can not only act to enhance final grades but also improve many of the less tangible aspects

of the lives of students in this respondent group by employing a mastery pedagogical approach broadly informed by the philosophy John Dewey.

Chapter 2, the literature review, uses the pragmatism of Dewey to assess the research question from a platform which focuses upon the experience of the learner, the situation in the classroom and the extraneous factors which have created the scenario to cause learners to achieve less than a grade 4 GCSE in maths after 11 years of schooling. The works of Sennett, Wiliam, Nuthall, Csíkszentmihályi and Hildebrand are considered among others.

The literature considered is wide ranging and an emerging appreciation of a learning community moves the spotlight away from mere content and delivery, asking the reader to consider the wider implications of marking young people as failures and what may be done offer them success, which may not always be directly related to final grades.

Chapter 3 discusses the research methods that may be pertinent to a study such as this and explains how the final mixed methods approach was arrived at. The 'multiple truths' of Dewey inform the discussion surrounding the tension between quantitative and qualitative data and ensure the 'experience' of the learner is central to the eventual data collection instruments use to fulfil the faceted taxonomy of Plowright's FRaiM.

Chapter 4 goes through a sequential description of the data collection tools used and how they eventually coalesce to form the entire research data. The use of critical incidents logged over a period of months in a research journal along with a structured interview, written survey responses and simple written feedback slips are presented with their respective outcomes supported by appendices detailing the analysis of the raw data.

Chapter 5 Analyses the data and explores the interdependency between inductive and deductive reasoning using Denscombe's (2007) account of the dichotomy facing researchers. The emergent themes of cognitive load, reducing explicit knowledge transfer to improve understanding (termed as 'teach less to learn better') and the proposal of a theory of 'collateral growth' are introduced and the nuanced outcomes are arrived at for in preparation for the forthcoming recommendations.

Chapter 6 reviews to what extent the study has met its criteria and answered the research questions as stated. It goes on to address the recommendations for various stakeholders in the maths GCSE re-sit process basis the main emerging theories. The opportunities for areas that may benefit from further research are identified and an overall summary concludes the thesis.

SUMMARY

Having established the differences between the post-16 options of 6th form college or FE College, it is clear that the two sectors should not be compared in order for one to denegrate the other. They are two distinct sectors for learners with very different skill sets.

The cognitive, affective and psychomotor domains are presented and their respective place in the context of this research is established. Traditionally the cognitive domain has taken precedent in the teaching of maths, the mastery approach prioritises the domains of the affective and psychomotor, respectively in the Deweyan vocabulary of 'experience' and 'doing'.

Mastery is proposed as having more than a single definition and established as having at its heart the requirement that no person is left behind and therefore necessitating a cohort of learners to be involved. This ties in with Dewey's concept of the conjoint community. Learning may well be more effective in groups than singularly as the experience of the learner may enhance recollection of explicit knowledge.

The dilemma facing FE colleges is identified as helping learners to surmount the GCSE hurdle rather than trying to turn them into mathematicians. There is an honesty in the fact that FE maths serves as a means to an end and that should possibly be celebrated rather than denigrated.

The roles of various stakeholders are discussed and the practice which currently can decide the final outcome for a learner based on their SAT results from primary school is called into question, as is the efficacy of OFSTED in an FE setting, whilst acknowledging that its ethos may be evolving.

Assessment for Learning is held up to the light provided by the quantity of learners for whom it has not worked and the question of maths GCSE in terms of social control is raised. The Essential 8 maths mastery programme is introduced.

Finally the research question is reframed. The research aims of understanding whether the experience of FE learners and perception of the FE sector may be improved are proposed.

CHAPTER 2: Literature review introduction.

This Chapter begins by introducing the philospophical tradition of pragmatism, particularly that of John Dewey. His holistic approach of subjective reality is viewed in comparison with Descarte's dualism of mind and body and his assertion of objective truth.

Dewey's concepts of language, experience and habit are examined along with Biesta and Burbules' interpretation of Dewey's thoughts on disturbance and the concept of multiple truths is pitched against Cartesian dualism. Hildebrand's account of situation and Sennett's views on the shame of dependency are weaved into a body of academic theory which is intended to eventually support and lend validity to the approach of mastery pedagogy to FE mathematics. Dweck's work on Growth Mindset and Csíkszentmihályi's concept of Flow are examined within the context of mastery education.

Van Maanen's proposition of verisimilitude, the apparency of truth, is explored within the ethos surrounding the approach to the research data and the links between experience and narrative enquiry are broached as prelude to the next chapter which discusses research methods.

This literature review is undertaken with the purpose of exploring academic theories pertinent to examining the experience of young people carrying out a task which has been designed to positively affect their perception of their ability to learn and consolidate their skills in GCSE maths.

The 'experience' element of this requirement leads one to consider the philosophical entity of *pragmatism.* The defined mastery programme of the 'Essential 8' (a set of 8 questions, always in the same order on the same set of topics, completed by learners

on a weekly basis) is a clearly designed *action*. The skills that may be gained by this action may be considered as *knowledge*.

Pragmatism, in an educational research setting, is described by Biesta and Burbules as. *"The acquisition of knowledge within the framework of a philosophy of action"* (Biesta and Burbules 2003 p9).

That is a definition which is attributed to John Dewey's particular flavour of pragmatism (over a century ago Lovejoy suggests there are at least 13 varieties) (Lovejoy, A.O 1908) and as a starting point when exploring experience and pragmatism, Dewey provides vast quantities of interesting insight and theory. Herein lays the problem however, as Dewey's prolific output makes selecting which works to consider quite difficult. As a starting point Experience and Education (Dewey 1938) affords an accessible introduction to the position Dewey assumes later in his career. Selecting the relevant point in a commentator's career may be prudent, as some appear to change their ontological stance throughout their writing life.

Philosophy.

A potential pitfall when tackling the philosophy of education is disappearing down philosophical 'rabbit holes' and losing sight of the fact that we are here concerned foremost with education. As a result the somewhat more accessible works of Gert Biesta are used as a signpost and route map through which to navigate the, sometimes complex, Dewey philosophical maze.

Biesta and Burbules (2003) proves useful as a guide to navigate Dewey's corpus and to re-appraise the concepts and ideas in a more contemporary setting. Additionally, the subtly nuanced behaviours of classroom learners are held up to the light provided by commentators on the nature of discovering, learning, remembering, and assimilating skills and knowledge. The way in which both implicit and explicit knowledge is transferred is examined. The growth mindset work of Dweck (2006) is allied to the theories surrounding the field of tacit knowledge and an emerging principle of *'collateral growth'* is proposed.

To provide a focus and to keep a relevant thread running through the review, the concept of 'flow' that Csíkszentmihályi proposed (1992) is used as a theoretical model to represent the maths mastery programme called the 'Essential 8' that is at the heart of this research paper. Looking for evidence of 'flow' in literature and recognising where it can be seen as an emerging factor, keeps the literature on a broad, but directed course.

In an attempt to establish boundaries to frame and give structure to the available literature, 'experience' is used as a touchstone throughout; possibly most succinctly expressed by Dewey's pragmatism theory and its associated proponents.

Education.

Contemporary commentators, such as Didau, Askew and Alexander are introduced and the outpourings of UK education agencies and stakeholders, such as the Department for Education (DfE) and OFSTED, give targeted relevance to the situation as it stands at the time of writing, examining the specialised theories (and some disputed opinions) of mastery (specifically Dr. Helen Drury's work) and differentiation teaching methods are evaluated for their efficacy in an FE setting.

A valuable discovery arising from undertaking this review is the work of Graham Nuthall. As a result of some 40 years of pioneering and painstaking, intimate research into the interactions that occur in the learning environment. "The Hidden Lives of Learners" (Nuthall 2007) echoes the reportage style of Holt's seminal "How Children Fail" (1964) but on a much larger scale and with detailed data analysis and crucially important conclusions.

From this brief agenda, hopefully it is clear that this is not an exhaustive, systematic literature review but is narrative by nature. In considering how a young person perceives their own ability as a result of a prescribed set of tasks, a wide and varied set of philosophical, educational and even scientific concepts must be considered to produce a landscape in which this research can reside.

Mind and Body, separate or whole?

There is a key distinction to make from the outset when tackling issues surrounding effective pedagogy and that is the one of whether the mind is considered as the centre

of all learning, controlling the body according to intelligent processing and knowledge, as Descartes suggests (Sorrell 2005), or whether the body has a role in the learning process which is just as key as the mental processes required to actually allow learning, and retention of that learning to occur; as proposed by Dewey (Biesta and Burbules, 2003 p32) and pragmatism in general.

The question can be illustrated with a reference to riding a bicycle: If a child is told simply to balance and pedal, then in theory, the child should be able to ride a bicycle, which is obviously not the case. It requires lots of practice, pedalling and balancing, to put theory into action of the body. Therefore the body is as important as the mind in successful learning. However, the mind does not just learn to process messages from the body (the body acting as a set of motors, feeding back information) nor is it the brain that is doing all the work, the body being merely a physical set of movement and feedback devices. There is an entirety of human experience at play which is developing as a whole to achieve the desired skill.

This can sound like philosophical splitting of hairs, but the distinction is key to what is happening in our classrooms; the very essence of learning is examined in this study. Do learners have to physically do something in order to learn and retain it? How much can be learnt by demonstration alone? How highly should the act of *doing* be valued?

The concept of the mind being separate from the body has been raised here to present the human being in *dualistic* terms (Biesta and Burbules, 2003 p32). Although it will be a proposition to ponder when thoughts turn to education-specific questions of rote-learning, mastery (Drury, H 2018), practice, grit (Duckworth A, 2016 p9) and Flow (Csíkszentmihályi M, 1992).

Cartesian Dualism.

Having considered the dualistic scenario above, it may be prudent to set the psychology scene to which Dewey responded and to tackle the heart of mathematics and its relationship to these accounts of human nature.

Descartes was a mathematician and philosopher (a commonly paired profession throughout history) active between 1629-1649. He is often attributed to bringing a

scientific approach to western cultures (Magee 1998 p84). The eponymous dualism behind his contribution relied upon the accepted opinion of an existence of a divine being he refers to as God. Four hundred years ago, it should be recognised that the existence of a God was a far more widely held belief than in much of the Western World today.

Descartes was well travelled and tackled the difference between the personal experiences of people and the reality of a situation. Magee cites Descartes' example of refraction causing a straight tree bough to appear to bend when it hung into a lake (Magee, 1998 pp86-87). Descartes found certainty and indisputable proof in mathematics and claimed it was God's gift to mankind; a method by which one might keep at bay the demons of deception that plagued impressionable minds.

The dualistic nature of his theory lies in his premise that there are just two kinds of substance; minds and matter. He conjects that humans are no more than minds and that minds are open to the vagaries of external sensory deception which may deceive them (e.g. the diffraction in the lake). Objects however, must obey a true, mathematical set of irrefutable properties.

From this, Descartes declared in Latin his famous 17th Century quotation; *'cogito ergo sum'*. Translations vary but *'I think therefore I am'* does well enough. In short, Descartes establishes that an entity capable of rational thought has undeniable existence separate from the body.

Pulling this theory apart a little, Descartes asserts that the undeniable truth of mathematics is a touchstone which allows knowledge to be rooted to a maxim which is immovable and completely devoid of subjective subversion. How valuable this is to contemporary learners is debateable though.

A personal interjection.

I spend much of my time explaining to learners that I meet that maths is purely a social construct, a manmade interpretation of the world around us. Dispelling the certainty, allowing some doubt to creep in, humanises the arbitrary subject that has put the lives of my students on hold.

Knocking maths off its pedestal is an important part of letting my learners know I am on their side, working with them to succeed. Showing the vulnerability of maths is a key strategy I use to reassure learners that they are not stupid, not dumb, not an idiot. If maths is all-knowing, Descartes' ultimate truth, then my learners are deemed to never know truth, never be as good as those who have conquered and understood 'the truth'.

In fact, we can unseat maths from its Cartesian pedestal very easily, dispel the truth in a brief set of calculations, just using the fact that dividing one number by a small number results in a large number.

$1/10 = 0.1$ $1/0.1 = 10$ $1/0.00001 = 100000$

$1/0.00000000001 = 1000000000000$

From this it is clear that the smaller the number we divide by, the larger the result. Therefore if we divide by the smallest number possible, then the result must be the largest number possible...

$1/0 = infinity$ Therefore, $infinity \times 0 = 1$ Therefore: Maths is *not* infallible.

Suggesting a vast quantity of nothing will be resultant to a quantifiable amount is nonsense and yet maths suggests just that.

Relating this back to the concept of maths being an ultimate and divine truth as Descartes suggests, creates tension with the true place of maths in the everyday world. Maths allows the mind of the individual to have experience of the real world underlying the deceptive everyday world. If, as Descartes would espouse, God is maths and therefore maths is correct, then the mind of the individual is trapped in the everyday world, devoid of the freedom of experience, locked in the shackles of truth. The Cartesian view would have us believe that if we had failed at maths, then we had failed at life. The above example that asks for a subjective view of both zero and infinity contradicts this view. Success in mathematics may well be a tiny part of life success but certainly not its deciding factor. Experience is the ultimate truth of the subjective mind. Perhaps all else should be considered purely as conjecture.

Dynamic account of experience

When Dewey considers *experience* it is perhaps important to recognise that he considers it is more than just the act of remembering within a mind. A mind recalling a series of events that one was part of. If I refer to myself as an experienced teacher, I am merely recalling that I have done a lot of teaching, seen lots of different types of learning occur and remembered the feelings, emotions, results and ramifications of those events. By remembering past actions, I consider, I am experienced.

In Dewey's eyes however, experience is the transaction of our responses to external stimulus (and, crucially, our interaction with that external stimulus) that may *change* the perceived reality of the stimulus itself. This is a dynamic exchange, occurring in real time, parts of which may be open to different interpretations. Here though, lies the contentious issue; is my experience of an event different from the reality of the event? Dewey would suggest they are actually the same thing, my interaction with the event, changed the nature of the event itself and there is an *inter*action which must be seen as a whole. The opposing view is that held by dualism, whereby my perception of the event and the event itself are considered as two separate entities, the only 'true' one being the latter.

It is Dewey's opinion that our interactions with external influences are dictated by our cultural experiences. He uses the metaphor of the development of an oyster and that of a bean vine; the latter being open to external influences and he likens it to the human condition. If cultural experience shapes our interactions and, as Dewey suggests, language is the most important cultural element as it *"defines everything that has meaning"*(Biesta and Burbules 2003 p31) then perhaps this opens a window into what is happening in my maths classroom: is the language at the heart of the interactions? Perhaps that offers a starting point from where to start to unravel the complexities of how learners are interacting with the education they receive?

The role of language in Dewey's account

The language of maths appears to be English but there is an immediate issue facing learners whereby maths uses familiar terms to describe concepts that are very different

to their meaning in English. For instance the word 'similar' in maths means something very different from the same word in everyday parlance. Words like 'denominator' and 'indices' have no obvious etymology and may prove to be a barrier to learning. Immediately, there is a disconnection between learners' cultural knowledge and subject knowledge.

In a classroom dedicated to a single subject, it is often overlooked that external influences can affect learners in very unexpected ways and yet their learnt reactions have never been allowed to change the black-and-white world of mathematics. The very word "classroom" suggests a room with a certain 'class' of people in it; people wishing to learn a subject at a level required for their purpose. And possibly this single concept is where Dewey starts to offer an insight as to what might be occurring with my own learners.

Dewey sees culture at the heart of *"everything that is the product of human action and interaction"* (Biesta&Burbules 2003 p29) and views the single most important cultural product as language. Whilst recently presenting 'Essential 8' research in Finland (Cooper J 2018 p285), I was keen to try to understand exactly why Finnish maths results were so much better than many other countries. One interesting fact is the Finnish words for teach and learn share a similar root (*opetta* and *oppia* respectively). Another curious Finnish concept is that of *Sisu* (Strode,H 1940), an inherent state of being which guides their approach to learning and life. It encompasses struggle, endurance and determination in every aspect of life.

Finns endure harsh weather conditions and lengthy periods of darkness (51 days in northern parts and only 6 hours per day in the south in winter). They have developed this cultural theory of *Sisu* which has evolved through their personal experience. By identifying the cultural roots of a community, one may be better placed to empathise and better understand its underlying axiology. Perhaps this is why it is not as simple as going to a nation that is successful at maths and trying to implant their methods into a different culture. There is a dogged determination within the culture of the Finnish nation that pervades every interaction its people have with their surroundings and endeavours. That is not a trait that can easily and quickly be engendered in a group of learners who

have different cultural experiences and values. It transcends mere spoken language; it is the very essence of communication and existence.

Dewey sees language beyond the written or spoken word, as the very currency of action and interaction. Perhaps it is necessary to start to identify the words and sentiments which are acting as obstacles to learner understanding, so learners may be offered genuine meaning to their time in college, through a structured approach which allows them to find success in mathematics.

Dewey suggests that the process of hearing sounds which are recognised as words is;

> *"The most striking illustration that can be found of the way in which mere sensory stimuli acquire definiteness and constancy of meaning and are there by themselves defined and interconnected for purposes of recognition"* (Dewey 1933 p231)

Biesta and Burbules (2003 p49) interpret this to mean words are "sound events" and Dewey furthers this to encourage events to be viewed as objects which should in turn be considered as tools with which to understand the interaction with the environment, rejecting the concept that we should have knowledge about an object but our knowledge should come from how we use the object to give *meaning* to its existence. Later in this study, some spoken comments are classified as '*artefacts'* of data.

Meaning

Dewey offers an explanation of 'meaning'. His definition of language is far more than written or verbal when he proffers the phrase "*conjoint community of functional use*" (Biesta and Burbules 2003 p29). Having 'meaning' necessitates an understanding by the learner that an interaction is expected and should indeed occur. There is a desired and justifiable outcome from the education being presented. So, can we increase 'meaning' by constructing a simplified, common language? A language of shared rituals, shared procedure, shared perspectives might produce individual interactions that however have a shared meaning.

Dewey considers 'meaning' not in the way an individual perceives a concept but as a "*property of behaviour*" (Dewey 1925 p141). By this he refers to the way in which an individual makes a connection between an expected or learnt reaction to an external event. Once that reaction (or, more accurately, interaction) has been established to be suitable and correct, meaning has been established.

Can we separate this from mere reaction? For instance, my dog, Henry, doesn't like loud noises and takes refuge under the coffee table when there is a firework or similar noise. During a recent storm, he was alerted by a lightning flash which was duly followed by thunder. Now if anyone uses a flash on their camera, he goes under the coffee table. Henry has found meaning in an environmental disturbance that allows him to act in manner he finds coordinated with the event. His meaning is more than mental; it is a physical reaction to external stimuli.

Rather awkwardly, Dewey uses the term "organism" where I would use "individual" but I see that in doing so he encompasses more than just the human world and perhaps to start to appreciate pragmatism it is necessary to consider a less narrow demographic than the interactions of just mankind. There is little more pragmatic than the behaviour of nature in tooth and claw. Descartes views animals as automata, machines to fatten into food for humans, devoid of emotion or pain. Dewey uses the term organism carefully as to deny another organism's experience as valid could lead to a hierarchy of truths which is how many students end up perceiving themselves as failures; others tell them maths is easy, they think otherwise but their experience is deemed invalid in the glare of their successful peers and knowledgeable adults. This cultural poor self-perception can be challenged if culturally it is accepted that some people 'just don't get it'. It may be possible to change this perceived subjective truth if it is tackled within a culturally supportive environment.

The increase in learner confidence since we introduced the Essential 8 maths pedagogy programme may be tapping into the idea of simplifying a vast set of hitherto seemingly disparate maths topics (the secondary national maths curriculum) into a set of simplified language instruments (common topics; books; practice; timings, etc) which will allow learners to experience interactions, en-masse, that will resonate and possibly become

more memorable and easier to recall as a result. It may be that a pseudo culture is being generated by the programme which is giving meaning to interactions.

Pragmatism and its heart of not separating doing, undergoing and understanding, (i.e. a learner's perception of experience being the reality of the experience) might offer a genuine alternative to the dualistic practice of training individuals to react to events that are set in motion by external, immovable influences; an approach which clearly does not work for a section (or class) of young people currently trying to achieve a qualification in maths.

An illustrative account of the reality of experience.

Some 30 years ago I was in a busy, but very restful, vegan café staffed entirely by Buddhists. A young waitress was carrying a large tray of small coffee cups, complete with saucers and spoons. She tripped and launched the tray into the middle of the cafe. The noise was terrible, coffee and smashed china everywhere. Customers jerked into action at the sound, leapt to their feet and started to try to tidy the mess. My waitress didn't even twitch; she carried on pouring apple juice from a jug into my small glass without spilling a drop. I shared in the same *event* with the people in that café but I didn't share the *experience*. The staff did not react; they simply carried on with their tasks, just adding clearing up to their agenda. For me, this might just be what Dewey was explaining: A conjoint community who, through a common language of rituals, words and actions, calmly adjusted their interactions and successfully progressed with their work. Their interaction *with* the disturbance was far less traumatic to my reaction *to* the disturbance. Whether education can utilise pragmatism's concepts for some learners, is an intriguing question.

Habit

To expand on the idea of a person's interaction with an event being an integral part of their natural set of conditioned responses, Dewey proposes the term *'habit'* as something to describe a learnt adjustment that can be made to cope with a tension in the course of the act of simply doing. Dewey suggests that we are both 'doing' and being 'done to' at any given interaction. The act of doing things in a community with

shared languages and rituals could be seen as the way in which habits are formed to give meaning to interactions.

Unlike the accepted definition of habits; merely being a repeated action that an individual may knowingly or subconsciously carry out, Dewey uses the term to describe the predisposition in response to an external event. Habit is not used by Dewey to describe mindless repetition; however repetition may become a habit as a result. Moreover, habit should be considered as a refining process, a loop of external stimuli, interactive response and meaning. Each cycle becomes an opportunity to refine the interactive response, deepen meaning and, consequently, the reality of the external stimuli will also be altered (assuming we accept Dewey's concept of all action being interaction which will change the person's perception of the event and therefore the reality of the experience for that person). From this successful cycle of 'stimuli-response-meaning', we could imply that meaning is occurring and learners are hanging up their knowledge on their learning hook, for later use.

Biesta and Burbules select three relevant Dewey quotes that summarise the application of pragmatism to the learning landscape: (Biesta and Burbules, 2003 p37)

Regarding habit, they define *"special sensitiveness or accessibility to certain classes of stimuli".* To contextualise this, perhaps it can be aligned to the response of the learner to a request for information to solve a maths problem – as found in the exam style questions in the Essential 8 programme.

From this predisposition to interaction to external stimuli, Dewey suggests that the *"vast penumbra of vague, unfigured things"* evolves into a *"figured framework of objects"*. This sounds pertinent to the analogy of maths being a collection of disparate islands to some learners, which we are trying to change into a sign-posted collection of connected places on a single, mathematical continent.

It is important here to be very specific with the semantics; 'objects' here are the *"events with meaning."* Dewey makes it very clear that such events occur when there is an interaction between a person and external stimuli. This allows the construction of a

model which may focus on this very specific but highly relevant tenet of pragmatism, perhaps something like proposed here in Figure 1?
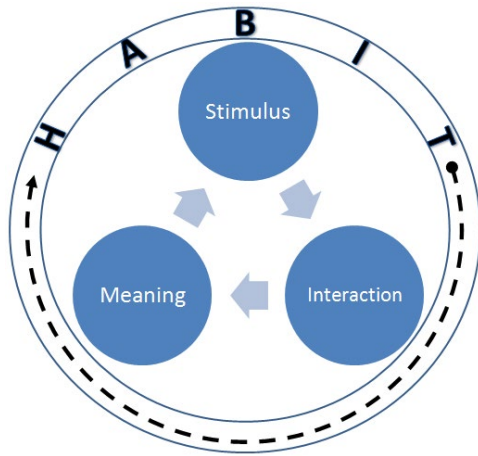
Fig1.

If we accept this as a self-contained habit, that is a predisposition to act (or more accurately, *interact*) in a certain manner as a stimulus occurs, whether that stimulus is expected or unexpected (perhaps as in the Buddhist café) becomes immaterial as these habits allow the individual to form access to an *experience*.

The more refined these habits become, the deeper the meaning, the stronger the hook that is created for the individual to hang their knowledge on. This is the process by which learners might be able to start to share in the experience of successful understanding with lasting recall abilities. The rituals and language of Dewey's proposed *"conjoint community of functional use"* (Biesta and Burbules 2003 p.29) can occur in a class of learners that move forward together in the true spirit of a mastery pedagogical approach which can claim to have pragmatism at the philosophical heart of its ethos.

Perhaps now that there is a graphical representation of a *habit*, it may be possible to use the developed habits of an individual to visualise Dewey's concept of experience. If habits (that is the cycles of stimuli, response and meaning) are the components which allow the experience of two persons to differ to the same stimuli, perhaps the individual can be seen as a collection of habits, a collection of predisposed responses that form the very essence of the individual.

In summary, if the opportunity to form enhanced, relatively successful habits (which contain maths stimuli, positive interactions and deepened meaning) can be offered to learners through a mastery based pedagogical approach such as the Essential 8, the research necessary to investigate the possibility further should not be overlooked.

Reality of Experience.

Earlier, when introducing the concept of habit, I touched upon the idea that one person's experience of an event may be different to another's depending upon the habits those respective individuals possess.

For a moment, recall the events of the Buddhist café: my experience has remained with me for many years as the habits I used to decide upon a response to the catastrophic noise, were conducive to initiating a reaction of alarm. The café staff possessed habits which were formed differently, soliciting a far less effervescent response.

In short, my experience of the event was decidedly different from some others in the café. However, my experience was no less real than that of anyone else's. Experience was the reality. Dewey calls this *"different reals of experience".* (Dewey 1905 p159)

Dewey discusses (Biesta and Burbules 2003 p44) how Zöllner's optical illusion divergent lines can be shown to be parallel, but that it does not change the fact that they appear otherwise. The appearance is the reality. The *"evidential value"* of the individual's experience is what is important, not the fact that knowledge can prove the experience to be somehow invalid or worthless.

I recently asked someone how their charity parachute jump went. They told me that the violence of being dragged upwards when the chute opened was quite alarming. I knew that they hadn't been magically propelled upwards, merely that their rapid descent had, at that moment, become less rapid. Should my knowledge of physics somehow lessen or negate their experience? I hope not.

A question of Knowledge:

As inevitably happens, philosophical discourse turns to the question of knowledge and all the colour of conjecture is washed away by the brilliant white light of fact and objective reality. Right here, is (for me) where the merits of pragmatism start to become evident: As discussed, if reality is subjective then we cannot fall back on knowledge as the maxim of all scenarios. Knowledge argues Dewey, arises from *"conditions and consequences"* (Biesta and Burbules,2003 p45). So knowledge is no longer just sewing together "*bits of cognition*" (Biesta and Burbules, 2003 pp44-45) until we can claim to

have constructed some kind of ultimate knowing, no longer do we need to reference fact to gain knowledge, we can create our own knowledge, personal subjective knowledge, through the meaning of our experience. Remember here how Dewey views words as objects; tools to give us meaning and create our own knowledge. Knowledge that is linked and embedded with meaning that can be recalled and used when needed.

Disturbance.

Dewey considers knowledge to be associated with making disturbed scenarios more controlled (Biesta & Burbules 2003 p30). It may then be possible to postulate that the habits of an individual may develop to give meaning, which may then be used to adjust to a situation in a controlled interaction with the disruptive circumstance.

Identifying such a disturbance is another matter however. If we follow the reality of experience concept, what one individual may view a disturbance, another may not. Pragmatism must allow for the spirit of the individual to be taken into account else we may be left without a reference point from which to try and improve those interactions to positive conclusion.

Such a premise could be achieved by ensuring individuals have experienced enough positive outcomes from their responses to external events to have the confidence to deploy similar *habits* to good effect.

How does Dewey integrate into the classroom?

Learners' experience of education

This research is concerned with what is happening in a maths classroom; a room full of learners who have been told they are lesser than their peers, inferior, stupid even. I asked Jenny why she always opened a packet of crisps when she was doing the Essential 8 questions. She told me that maths made her hungry; at primary school, maths was in the morning and she was always held back to finish her work when her friends went to lunch. There is a reality; maths makes you hungry. Does Jenny need to read all the existing research linking eating habits to mathematical proficiency to have the knowledge that sums make you peckish? This single example is where pragmatism

may be able to start to explain, enhance and evolve what the Essential 8 programme is doing for our learners.

John Holt and his work from the early 60s, echoes this point. Holt explains a foray with his learners into long division. *"A child that does not know what he is doing or why he is doing it, will see long division, as most children do, as a meaningless recipe that will give him endless trouble"* (Holt 1964: 107). Holt identifies early experiences (in the true Dewey sense) as shaping the knowledge, Deweyan habits and meaning for the life of the learner. Here, children learn that long division is not connected to their everyday lives and that is difficult to master. They start to nurture *habits* which classify maths as troubling and uninteresting. Dewey would suggest that this *experience* has become the *reality* of maths for this learner.

The Essential 8 workbook (Cooper J and Kazimierczyk L, 2017) and pedagogy are geared to offer small glimpses of success. The experience of the learner, the reality of the situation becomes adjusted, not through mere repetition but through the formation of personal habits that become the response to the stimulus of a maths question being posed. Every one of the topics has an associated number (6 is always ratio, 7 always algebra etc) and there is a corresponding wall poster to assist with the completion of the question. Consider Dewey's habit theory here. Can a learner change the nature of the stimulus, the reality of the situation? Well, a glance toward a wall poster offers immediate help; familiarity of topic sequence removes some of the unexpected nature of the next question; knowing the correct answer will soon be given and that they will be allowed to correct their answer accordingly for reference will allow them to record a transcript of a successful experience, so enhancing the habit they will rely upon to meet this stimulus when it next occurs.

Learner Language.

It cannot be overstated that maths GCSE exams are evolving into something very different from an assessment of mathematical ability. The 'non-calculator' paper of the 2017 summer exam (Edexcel, 2017) contained less than half of questions which required arithmetic competence. As the following 2 out of the 3 papers allow calculators, less than 14% of the questions in a maths exam actually require a secure level of

arithmetic competence. The remaining 86% require maths knowledge, tacit understanding and most importantly, language.

To illustrate a point, which diagram below shows a pair of angles which should be called "vertically opposite"?

If you decided upon B you are correct.

However, if you decided upon A you are also correct. 'Vertically opposite' in maths means of opposing sides of a set of vertices (or corners) and yet we culturally know 'vertical' in a north-south sense.

Bearing in mind that in 2019 around 20% of my learners do not have English as their first language and another 20% do not have an English qualification, then the problem starts to become evident: UK government policy is changing the maths GCSE into a test of English language rather than the universal language of numeracy, geometry and algebra.

That, in itself is not necessarily a bad thing however. Champion of common sense and pragmatic solutions to teaching maths, Jo Boaler states

"We no longer need students to compute fast (we have computers for this) we need them to think deeply, connect methods, reason, and justify."(Boaler J, 2017)

She then offers this advice to educators:

"Tell students you don't value fast work. Mathematical thinking is about depth not speed. Don't use flash cards, speed competitions, timed tests, instead value depth, creativity, different ways of thinking about math, and different explanations." (Boaler J, 2017)

If we no longer need to solely teach numeracy and rapid computation, then all that is really left, is *language*. Dewey suggests *language* is the single most important cultural element. When educators start addressing the cultural elements of maths education, perhaps educators can start having a more positive impact on the learners within that setting.

Can learners develop habits and find meaning?

If we accept that Dewey's "different reals of experience" (Dewey 1905 p159) mean each learner must find meaning from their own interpretation or reaction to an event (perhaps the answering of a question) we expect them not only to construct appropriate interactions but to do so for a wide set of differentiated questions which are designed to test them to their respective limits.

In which case, how does the purported educational maxim of differentiation sit in this model? Each learner is given an individual path, individual targets, individual experiences that offer no common language (Dewey's 'language', not just written or spoken). For the learners I see, for whom differentiation has been the sole pedagogical approach, could the mastery concept of moving forward together with a common language (Dewey's "conjoint community of functional use") be a valid approach?

The *'meaning'* of interactions could be aligned to what is happening in my classroom. Young people often see maths topics as a disconnected set of islands, each demanding a separate set of rules to be learnt and remembered. To allow them to have some *'meaning'* I try to teach holistically, allowing exploration of a metaphorical continent of maths, allowing learners to construct something that they may be able to recall more readily than a *meaning*less procedure.

At this juncture, (where the concepts of meanings, habits and recall have intersected), it may be worth mentioning that when asked to assess what was happening in my classroom, visiting university teacher-educators, suggested that the single most problematic event occurring was my learners' lack of ability to retain and recall information. In response, learners are now offered a metaphorical *'hook'* to hang their learning on. That hook is the Essential 8 programme and all topics can be related back

to those therein. Delving deeper into Dewey's *'habits'* may be pivotal in understanding exactly what our programme is providing to learners and whether their own habits are being affected by offering them a place to hang up their knowledge, so they might remember where they left it when the exam requires them to find it. Is it then possible to liken this 'hook' to Dewey's 'meaning'?

Disturbance of assessment.

When considering disturbance and the habits deployed by individuals to adjust to it, I would like to tackle the concept of assessments as a disturbance to meaningful learning, not of knowledge but of interactions with external stimuli – like an exam might represent to some learners.

Thousands of trees have been felled to contain the amount of words written on the subject of testing learners and this is not the focus of this research. However, when a demand was made for my lessons to contain a 5 minute test of arithmetic computation skills, I had to attempt to counter the damage I considered it may cause to some of my learners. To this end, I asked them to carry out the timed assessment then write down how the test had made them feel on the reverse of the paper.

Bear in mind here that such learner feedback (often referred to as 'student voice') has had its value questioned: In a recent LSE blog (Boring et al 2016), close examination of various research data revealed that students' evaluation of teaching (SET) *"significantly correlated with students' grade expectations: students who expect to get higher grades give higher SET, on average"*

Deweyan alarm bells should sound now as my learners who found the test easy, liked the little test, those that struggled, hated the feeling of failure. Common sense should preclude any real surprise at this result but again, experience of the individual is the reality of the situation. Worryingly, it was a teacher-educator from a respected university, responsible for forming the teachers of the future and suggesting an approach for improving FE outcomes, who suggested this strategy. Against the vast majority of emerging academic opinion, an influential individual is falling back on a rapid assessment method to improve learning. Here is the problem; encapsulated in a

seemingly innocuous addition to a maths lesson. We are still setting up learners to fail, just as Holt discussed over 50 years ago.

Differentiation in schools

Be sure here though, that the reality of experience is different for each learner, not a uniformed response of identical answers, arbitrarily assessed and recorded without the option to correct a misconception. Now let me turn to differentiation and how it has effectively become a prerequisite of 'outstanding' teaching and learning. Every new teacher is given Black and Wiliam's 'Inside the Black Box' (1998) as a guide to teaching with an expectation of almost biblical reverence. At the centre of this cleverly marketed paper is the need to intimately know each learner through records of prior assessment and *"ways of formative assessment that work with the assumptions of untapped potential to help all pupils learn and can give particular help to those who have previously struggled"* (p9).

Here is why Dewey's brand of pragmatism might need to be re-appraised in a contemporary context as 20 years of differentiation and formative assessment have proved to be of questionable benefit to society and even less to learners. Perhaps it is no coincidence that one of the items left intact in the wreckage of secondary maths education in the UK, is Wiliam's Black Box.

If differentiation lies at the infra-red end of the spectrum of pedagogical approach, then mastery is the ultra-violet. Playing Devil's advocate; one could say that differentiation is geared to ensure under-achievers keep under-achieving, whereas mastery allows everyone to move forward together. The risk of 'Assessment for Learning' is that it underestimates the role of shared experience of success, pushing forward together. That same risk lies in educators and observers of education caring more for 'Assessment for Learning' than they do for learners' learning.

So what of Dewey and the concept of subjective reality, if differentiation actively sets out truly different stimuli (i.e. easy questions for the less able, hard questions for the over-achievers) where is the room for subjective reality? The reality of stimuli has been tailored to allow each a predetermined piece of cognition. Mastery promotes the learner

to form their own reality to a given stimulus and adhere to Dewey's "conjoint community of functional use" to achieve meaning and therefore retention and recall. Knowledge can be built by the individual in frameworks they constructed themselves and hung on the hooks they have made themselves.

Rather than completely savaging differentiation and its associated methods, it may be prudent to acknowledge that the mastery approach to education and formative assessment share a common father; Benjamin Bloom (he of the well-known taxonomy). It is therefore necessary to look at the evolution of these two siblings; although which is the errant twin, I will leave to for you to consider.

Formative assessment

Dewey has the experience of the individual at the centre of his arguments for pragmatism. Therefore, differentiation in the accepted educational sense of teaching in secondary schools, means tailoring tasks to a degree of difficulty that will challenge a learner to reach their full potential. That sounds superb and a definite 'magic bullet' to ensure every student is full to the brim with explicit knowledge by the time they leave school. However, to ensure educators know they have been successful in filling every last part of a learner's anatomy with knowledge, the students must be tested to check whether there is still a vacuous region of the brain just waiting for another formula to be crammed into the void.

Enter formative assessment. In a backlash to summative assessment, formative assessment is supposed to reinforce learners' performance through three main tenets; a focus on students, instructionally informative and to be based on outcomes. Teaching is aligned to regular tests and feedback is delivered promptly whilst assessment is embedded within content. The concept existed in various forms from the early 70s but when Black and Wiliam (1998) released "Inside the Black box" formative assessment became the mainstay of 'outstanding' teaching for OFSTED when it was formed in 1992.

The focus on learners goes so far as to require a teacher to know each student's history and their prior learning in depth and possess sets of records that chart a student's

success. This is where an issue arises: Once again, highly organised adults are assuming that young people should possess the same traits as themselves and be able to organise their learning into retrievable facts, what Dewey terms *"bits of cognition"* (Biesta and Burbules p44) when called upon to do so in an exam. This positivist view is where things possibly start to unravel for formative assessment.

A useful metaphor for teaching maths to a certain proportion of young learners may be the painting of the Forth Bridge: Unless the process is continually maintained then gaps will form and learnt maths skills will flake away like paint from rusty girders.

Creating an environment suitable for learning to occur without anxiety or unpleasant learner experience necessitates the correct situation to be created by the leader of learning in the classroom. Hildebrand explores and illuminates the notion of *situation* to useful effect.

Hildebrand on 'situation' within education.

When considering the role of pragmatism within mastery pedagogy, the work of Dewey presents so many ideas and intriguingly pertinent issues that the work of another commentator can help to bring relevance and clarity to a contemporary setting that may have not been so obvious at the time of Dewey's writing.

Undoubtedly, there is a true 'pick and mix' in Dewey's body of work, so much so that it can be difficult to navigate the application of his work to a classroom setting, specifically a classroom full of disillusioned, disheartened learners, such as one sees in a maths FE setting. Heading down irrelevant avenues of enquiry is a constant possibility when researching the practical application of a philosophical tradition; however some texts naturally dovetail with this study.

David. L. Hildebrand (2018) casts his 21st Century eye over this in his consideration of *'situation'* within Dewey's book Democracy and Education (Dewey, J 1916). He makes a point of considering how *situation* is the cradle in which *experience* resides and how the two concepts are entirely interdependent.

He holds out the possibility that teachers might facilitate situations that enable learners to challenge their habitual forms of experience in order to open up new possibilities of experience that maths is 'alright'.

Situation within FE Maths

Situation may be pivotal to understanding the essence of how a mastery pedagogy might shape the learning experience for young people in a way that they have not previously witnessed in their learning journey. It is the situation that is being created within the FE maths classroom that is enabling young people to have the time, the freedom and the security of a whole group moving forward together, without a differentiated outcome agenda being imposed upon them. Of particular interest is Hildebrand's assertion that meaningful education cannot exist without educators' *"conscious, intentional and imaginative deployment of experience and situations"* (Hildebrand, L. 2018 p288).

Consider that in the light of how teachers are judged in the UK educational landscape and it soon becomes apparent that the mantra of 'progress at all costs' may be, at best, misguided. If meaningful education is indeed dependent upon the creation of a safe, motivating environment; then consideration should be given to Hildebrand's idea that educators should eschew Cartesian positivist beliefs and instead concentrate on *continuities.* Happiness and safety are words all too seldom used by education policy makers but appear often in my students' responses to impromptu surveys and in conversations. A pre-requisite in Maslow's hierarchy of needs (1943), the hygiene factors of well-being and safety play key parts in a mastery pedagogy that is free from the fear of 'dropping a set' or other competitive pressures that may have an adverse effect on the meaningful learning of some students. Hildebrand summarises this when he ponders;

"For, if we could relinquish dualisms that pretend to be 'ultimate' – authoritative beyond experience – and think, instead, in terms of continuities, we might re-dedicate our practical energies toward particular situations, problems and people struggling to find safety and happiness in a changing world." (Hildebrand. L 2018 p288).

That short excerpt succinctly qualifies the purpose of this study. As the role of mastery pedagogy in FE maths is examined, it's ethos of a community moving forward together with common goals, objectives and culture has resonance far beyond that of mathematics. Perhaps teaching maths in order to pass a maths GCSE is not always the best method for all learners. Perhaps, for some, achieving a GCSE in maths occurs as a by-product of positive learning experiences facilitated by a safe, happy situation?

The dualism of which he comments may indeed be the heads-or-tails nature of success and failure. The mutual exclusivity by which our learners are schooled. Everything is grade dependent rather than happiness dependent. This is no frivolous premise as health can be adversely affected by failure in learning. A brief correlation I carried out (see Appendix 7) of the countries who score highest in maths plotted against their national suicide rate might be offered as evidence to bear out this hypothesis but with so many variables at play in such cases to make such a claim may be spurious. Nevertheless, the significant correlation would make for an interesting topic of further research.

Hildebrand makes a theoretical categorisation of types of experience (although it is fair to consider that every learner experience will contain a mix of some or all of these types). I prefer to think of them as the elements that form a blended experience; just as a pot of paint will be made from a mix of the 3 primary colours; perhaps each experience is a mix of (i) experimental (ii) direct and caring (iii) social and moral. These are considered in the following few paragraphs.

By experimental, we can infer (in Deweyan terms) that the experiment occurs as a learner forms habits from the two part act of doing and undergoing. Having performed a task, the learner then sees the outcome of their efforts. This feedback is at the heart of Wiliam's ubiquitous Assessment For Learning (Black and Wiliam 1998) but the 'experimental experience' considered here is far more intrinsically linked to the learner's well-being than the somewhat arbitrary act of waving a scribbled answer in the air on a mini-whiteboard to publicly declare what is hoped to be the correct answer. Dewey recognised that, in that moment of doing and undergoing, the consequence of an action

is *"reflected back into a change made in us, the mere flux is loaded with significance. We learn something"* (Dewey, J 1916, p146).

By 'direct and caring' Hildebrand refers to the moral obligation a teacher and learner have to each other as they live in that moment. This is the experience which transcends the mere exchange of fact or knowledge but constitutes something that is *felt* by the learner (and hopefully the teacher) which manifests itself as a memorable moment which may contain a piece of knowledge which may be permanently attached to that moment in time. This is an occurrence in the present, a split second where knowledge and emotion fuse together to form an experience which may last far longer than a memorised formula or method. This too, offers learners a hook to hang their learning on; somewhere to hold something special for future use.

Caution when creating 'eventful' learning.

There is a caveat here that is well illustrated by a story that a senior lecturer, author, teacher-trainer and inspirational teacher and personal friend, Emma recounts: During an OFSTED type observation early in her teaching career, Emma used a clip from the film Terminator to provide a speed-time-distance activity for her class. Some months later, she met a student who said how much she had enjoyed the Terminator lesson. Emma asked her if she could remember what the lesson was about, and her student replied "Yes of course. It was about the Terminator". And that is where the danger lies; if the situation is falsely manufactured the dignity of the learner may be diminished and the forced connection between teacher and learner is meaningless. There is no shortcut. Without honesty, experience is worthless. Emma uses this example when she highlights the importance of balance between fantasy and academic rigour when using metaphor in the classroom. It can create shared experience however which should not be overlooked.

The 'social and moral' element of experience is mainly concerned with the acknowledgement of the learner as a person in the present, the now, at the point of learning and their right to interact with an educational setting that allows them to make choices regarding their learning, to deliberate regarding their decisions in the learning environment, which inevitably contains other learners. Hildebrand is of the opinion that

the shared experience, the empathy and participation in joint experiences goes to form the whole experience for the individual and therefore the situation itself is also affected.

Again, this aligns perfectly with the idea of a community that is at the core of mastery pedagogy. Again, reference to Dewey's *"conjoint community of functional use"* (Cited in Biesta and Burbules 2003 p29) comes to the fore and Hildebrand asserts with reference to this axiom of community:

"For only an interacting community can provide the situations in which direct experience can help students develop moral character." (Hildebrand. L 2018 p290)

The Essential 8, an allusion to mastery.

Whilst the Essential 8 scheme is not the whole of a mastery pedagogy it is the maths content element and as such integral to the pedagogy. The Essential 8 meets the three elements of the experience blend head-on. It lends itself to simplifying the nature of experience within a very measurable, manageable and motivational programme. The notion of a simple resource influencing a whole pedagogical approach is possibly radical but it does create an opportunity to engineer a situation of shared experience in an interacting community.

Experimental

It is experimental by nature and its participants are encouraged to be willing, engaged and enthusiastic members of its execution. They have an innate interest in its progress as they see their peers benefitting from their involvement and are part of something much bigger. The experiment is changing the status quo somewhat too. When they discover that grade boundaries as designed to fail 40% of GCSE candidates, they see that they are in fact in competition with the other 2 million young people set to simultaneously open the exam paper. If my learners pass, they are putting a spanner in the works of a system that is designed to fail them. This subversion appeals to many young people as they potentially become empowered by their own efforts.

It is carefully controlled with data, both hard and soft, becoming available throughout the year and they see small, measurable success as they tick off their competencies in each of the 8 topics. Best of all for me personally is witnessing their joint sense of

belonging and achievement. Bear in mind many of my learners were not the 'popular kids' at school, not in the football team, not prefects, not award winners. In society terms they were being prepared for becoming the drones of the UK's beehive. Slowly, they see their worth as an individual in a community and play their part accordingly. Just as Wiliam added in his defence of AfL in 2013, it relies on students working as a group, not just in a group. The Essential 8 is undoubtedly a collaborative, team event.

Direct

It is a direct link between teacher and learner because it is designed to promote success by getting correct answers in a little book that records something being wrong, being corrected and therefore being right. It is a little book of misconceptions that can be seen to be undone without risk or fear of ridicule or humiliation. When the Essential 8 was on weekly worksheets they soon filled the recycling bins but now the books become personal belongings of individuals and their property. It is evidence (not necessarily in the OFSTED sense) of progress that has happened, not through rote regurgitation or online explanation but through human interaction with someone (a teacher, a peer, a learning support assistant) who wants them to succeed for the right reasons. Because success is a by-product of their participation rather than a result of their effort, the Essential 8 programme can be considered to possess a caring element.

Caring.

Without apology I am willing to stand up and say that I care for my learners. That may be unpopular with some commentators and even some of those employed in the training of new teachers, but it is central to my belief regarding the essence of education. Despite the fictional computer 'Deep Thought' proclaiming that the meaning of life is "Forty-Two", I think it might actually be simply to 'help each other out a bit', regardless of our relative situations.

The Essential 8 was borne out of a desire not for personal gain (the programme is free for anyone to use and has proved popular with thousands of learners) but to have an effect on a system that could be construed as being designed to harm young people so their contemporaries may benefit. Aside of my personal experience, I have no political affiliation, religious ideals or grand plan for the pedagogical approach I advocate. I just

want more people to have a positive experience of maths so they might not carry any consequent negativity with them in the future. If the by-product is a swathe of learners not fulfilling the establishment's model of "four in ten must fail" then so be it, although that is probably far beyond the sphere of influence of this thesis.

It is impossible to implement the Essential 8 without learners caring for their progress and teachers caring for their learners. I also think it may be misplaced to deploy the programme in a secondary setting as it may discourage those who wish to learn and master 135 GCSE maths topics as opposed to 8. In FE however, it promotes caring, something which some of our learners may be experiencing for the first time.

Crafting situation in the classroom.

Hildebrand defines the term *situation* as providing educators with a *"justification (a logical, psychological, pedagogical and moral rationale) to reconstruct curricular and methods to be radically experimental, interpersonally caring and socially relevant to actual students."* (Hildebrand. L 2018 p290)

This resonates with the process my colleagues and learners have been developing with the Essential 8 mastery pedagogy approach for the last 3 years. The nature of the process has been radically experimental, its delivery is interpersonally caring as each learner gets to record their own progress and discuss it with their peers and teachers. The socially relevant element needs to be examined with a more critical eye in maths however.

There exists an uncomfortable truth that the maths skills we assess at GCSE are highly unlikely to ever be of use to our students in their working and social settings. That is possibly a provocative statement and it is easy to immediately rebut it with examples of bricklayers multiplying and hairdressers calculating ratios but, in reality, nearly everything that requires maths skills has been replaced by software, machines, containers or other devices that are there to negate costly human errors and for reasons of operational efficiency.

Social Relevance

It may be prudent to consider exactly in what context 'social relevance' should be seen however. My learners realise they are there for one reason only; to pass a GCSE in maths. What transpires throughout their learning journey however is that some find a new way to accept the demands of tricky concepts and processes and re-learn how to tackle them. I use the term re-learn because there is often a conversation that goes along these lines...

Learner: "What. So that's the right answer then? I've got the right answer?"

Teacher: " Yes". That's perfect. Why are you surprised?"

Learner. "I thought it was really difficult. I always dodge those questions in the exam. That's not all there is to it though is there? I mean, it's not really that easy is it"

Teacher. "Well yes, that method will always work for that topic. As long as you remember that process you can solve any questions of that sort"

Learner. "Why didn't they show me that at school then? Why did no one just sit down and show me that before? This is so annoying. Why didn't they show me that at school?"

There is social relevance. Of course, the students have been shown this at school but class sizes and a pedagogy steeped in differentiation did not allow them to experience being shown something that worked, a method that resulted in success. Instead they were offered the chance to fail, duly failed and then were given something to do at which they could succeed – leaving them devoid of the skills they needed to pass a GCSE.

Social relevance is perhaps offering learning in a way that is socially acceptable. I am always at pains to ensure my students are aware that I am highly unlikely to be the most intelligent person in the classroom; the probability is usually around 1 in 20 or 5%. Many learners speak English as a second language with more eloquence than I do with it as my native language. Many are highly skilled at engineering or in the arts. The social acceptance is borne from a pedagogy that recognises that we are designed to progress

socially and learn in groups of like-minded people with similar goals. For me – the social relevance is in the teaching and learning rather than the curriculum.

Motivation: the teacher's responsibility.

In considering motivation and student interest, Hildebrand notes that Dewey talked not in terms of student attitude but educator ignorance. This movement of focus away from the learner and back to the educator harks back to Coffield's question regarding whether student centred learning is the way forward.(Coffield F 2008).

If we start to look more to the teacher's role in the teaching and learning process, we deal with something possibly less volatile than the emotions of disillusioned teenagers. By concentrating on the situation teachers can construct rather than reactions of learners (which we can view as interactions) we can actually analyse and adapt something within our control rather than merely bemoan the state of that which is out of it.

Hildebrand goes on to opine that *"cultivating such situations requires planning"* (Hildebrand. L 2018 p290) adding that the personalities and emotional traits of learners should not be overlooked and must be considered on a par with curricular content. He then considers the value of externally administered learning, online mediums and questions their value when it is the depth and breadth of situation that might have far more meaning than the mere transmission of knowledge.

Tacit knowledge transfer

This is where my own interest of tacit knowledge transfer is piqued. Since my first degree in 2000 I have been fascinated with the field of tacit knowledge transfer. Particularly the work of Prof Clive Holtham, who I interviewed in 1999 regarding the use of email and the effect it was having on business. His belief that communication without interaction was of far less value than personally conveyed messages was because tacit knowledge transfer happens only in face-to-face communication, was very telling.

Although that was in a business setting, the situation was no less relevant in an education setting. I need my learners to instinctively see through the tricks and

misguidance that may purposefully be added to GCSE questions in maths (the use of confusing scenarios or the addition of dimensions irrelevant to the question in calculating triangle area etc). More than transmission of maths facts, I need to allow my students to *"know that which I cannot tell them"* (Polanyi M 1958). The more they think they know, the more they will know. They can build their confidence, their ability and their resilience through experiencing the carefully constructed situations in our classroom.

Hildebrand reiterates that *"creating genuine situations requires profound care; conditions must reflect participants' individuality or pedagogy fails"* (Hildebrand. L 2018 p290). Without question, in many UK secondary schools and FE, maths pedagogy has failed and only profound care in creating suitable situations in our classrooms can right that wrong.

A conclusion of Hildebrand's account and its relevance to this study.

Dewey's belief was that education should go beyond the delivery of facts that are deemed to necessary for future generations and rather to *"liberate the young from reviving and re-traversing the past"* (Dewey 1980 [1916] p79). For me personally, that is why we need to recognise the evolution of learning and seek pedagogies which themselves are able to evolve in unison. I hope the mastery-based maths pedagogy delivered by the Essential 8 mastery programme goes some way to achieving this goal.

Mastery

Bringing Dewey and Bloom right up to date, Dr Helen Drury is at the forefront of pioneering mastery in UK maths and has this to say:

"Some teachers get frustrated that a child who, having 'learnt' to round decimals in one lesson, appears to have entirely 'unlearnt' this skill by the end-of-term test, or in class the following week or even day. This happens when the focus is on 'learning' mathematics in unconnected chunks, rather than on 'mastering' the subject over time." (Drury 2015 p8)

So over a hundred years on, a leading light in education is still trying to get educationalists to understand Dewey's argument against knowledge simply relying of *"bits of cognition"* (Biesta and Burbules 2003 pp44-45).

Returning to the Essential 8 programme, can it be acceptable to claim it hangs on the coat-tails of mastery and pragmatism? The theory of the programme does fit with the ethos of mastery, the moving forward together ideal. Pragmatism does appear to provide a lens (an overused metaphor but useful nonetheless) through which to view what is going on with those learners on the programme. However, it needs to be noted that it is also borne from a desire to explore the effectiveness of *flow* (Csíkszentmihályi 1975) with influences of Vygotsky (one of Dewey's contemporaries with whom he however differed in many areas) and the almost inevitable doffing of the cap to Maslow (1943).

Flow, zones and frameworks.

As any 'get-rich-quick scheme' or 'lose-a-dress-size-in-a-week' programme, recipes for educational success are just as incredibly attractive to anyone wishing to pursue a path of least resistance. This is where pragmatism offers a reality check (a subjective reality check, obviously).

Flow in sport is well documented (Susan A Jackson is a key commentator) and its founder, the irrepressible Mihalyi Csíkszentmihályi, often uses musicians to demonstrate his theory. In short, he believes that an individual may reach a Nirvana-like state when performing a demanding task in which they are highly proficient. At this point they will be in a state of "*optimal experience*" (Csíkszentmihályi ,N. 1975) wherein time passes faster, concentration is utmost and new learning is accelerated.

Note the use of the term "optimal experience"; Csíkszentmihályi uses this as a subtitle to the concept of flow and uses it as a title of his 1975 book and it has become a subtitle to the concept of flow. Dewey's focus on experience is still at the fore here but it is important to temper flow with what Dewey stated in 1938. It is all too easy to select argument and counterargument with prolific auth. ors but I hope this quote is in context and illustrates Dewey's reluctance to view anything in isolation. He talks about how the

"educative process can be identified with growth" (Dewey 1938 p35) but issues a caveat that proponents of flow should possibly bear in mind when considering practicing well versed situations:

> *"Does this form of growth create conditions for further growth, or does it set up conditions that shut off the person that has grown in this particular direction from the occasions, stimuli and opportunities for continuing growth in new directions?"* (Dewey 1938 p36)

Referencing this back to our Essential 8 mastery programme, does encouraging a learner to become an expert at a certain topic, eventually stop his or her learning and further comprehension? If conditions for Flow are indeed present (high skill, high proficiency task in a zone of optimal experience) is that actually conducive to passing a summative assessment which will cease at a certain difficulty level, predetermined by a curriculum?

The end of the previous chapter discussed the educators' dilemma of learners needing to reach a certain level and no more (the foundation maths GCSE is limited to a grade 5). Is flow necessary, even desirable in this context? Can it be used in conjunction with other approaches to offer learners a leg-up out of the GCSE trap they have landed in?

The concept of 'grit' is proposed in a counter argument to Flow (Duckworth et al 2007 p1087). Grit is about dogged repetition, Flow may be viewed as an elusive state of personal optimised learning. Of course, the talent needed to experience flow may well be as a result of a preceding 'gritty' process but there is no emotion in Grit, mere effort. As an analogy one might consider that a bird must flap its wings many times before it can soar in the air. Perhaps suggesting that grit is in fact an integral element of flow. Didau (2013) now often uses both grit and flow in his learning models and both may be seen as relevant to a successful maths learner.

That term 'successful maths learner' needs to be carefully considered in this experience-focused context, however. It is imperative that the learner's perspective is a prism through which we refract the white light of success. Success needs to be examined in its component parts, the elements which will resonate with the individual

experiencing their version of success. Discovering which colours success takes on for the individual learner is a highly nuanced task, it is a dialogic process, discovering stories of experience is where narrative inquiry needs to be considered. An opportunity to sense success occurs to learners as they practice their maths skills to ensure they are prepared for the summative exams.

Sennett's "The Craftsman" (2009) tackles the question of guiding toward success at length and in intricate detail. Three 'expressive tools' are offered to provide about the sense of practice as a whole. Their relevance to the concepts explored so far is clear: (Sennett 2009 p238)

- Sympathetic illustration identifies the common problems learners facing new subjects can encounter.
- Scene Narrative, which places the learner in a certain situation.
- Instruction through metaphor, requiring imagination to be used by the learner which will aid retention of the associated skills or facts.

Furthermore, Sennett talks of 'dynamic repair' where learners use their imaginative use of these tools to adapt the skills they have to solve the problems they face.

The 'emotional reward' referred to may be the success learners need to improve their confidence and assist in their continued engagement. The value of a 'teaching manual' that imparts skills and knowledge is also addressed:

> *"No one draws on all these resources all the time, and in labour as in love, progress occurs in fits and starts. But people can and do get better. We might wish to simplify and rationalise skills, as teaching manuals often do, but this is not possible because we are complex organisms. The more a person draws on these techniques, the more he or she plumbs them, the more will that person gain the craftsman's emotional reward, the sentiment of competence."*

"In order that a learner may make use of guidance they must first be able to ask for it and accept it without fear of ridicule from peers or teachers."
(Sennett 2009 p238)

Sennett (2002) tackles this dependency of shame and examines how it can affect those subjected to such a dilemma where help is needed but is too painful to accept.

Sennett's commentary on the shame of dependency.

Sennett uses his account of Cabrini, a housing project in Chicago built just after the Second World War, to set his discussion of the shame of dependency. He uses the authorities' simplistic, intensive-dwelling construction response to the necessity of housing people that could not afford to do so themselves. He explains that it was the sort of place that welfare reformers believed to "embody the evils of dependency". It is important to not be too concerned with the location or details of Sennett's narrative; it could easily be one of the estates in South London where I used to repair televisions in the early eighties. It graphically plots the cycle of providing a solution which makes people dependent to the eventual backlash of the acceptance of the dependent party turning to shame, lack of self-esteem and finally rejection of socially accepted behaviour. I have vivid memories of my 18-year-old self, dodging burning mattresses which were being thrown from the balconies of a housing estate as the police attempted to evict families that refused to pay rent for flats which were damp and vandalised.

Fig2:

Cabrini Project. Chicago 1980

Aylesbury Estate. South London 1980

This is a useful metaphor for the maths education thrust upon the young people I teach as links between their experience, dependency and personal emotions emerge in the light of the government decision to invoke mandatory education until 18 years of age. Herding thousands of learners into FE colleges to have another go at passing a maths GCSE is the hurried construction of identical high-rise apartments to which young people are consigned until they pass a GCSE and are no longer educationally dependent souls. The way the 'outside world' views my learners in the same way some homeowners might view those in social-housing accommodation; lazy, useless, inept. It is this insidious misconception that studies such as this might be utilised to challenge. It may be the case that we are creating shameful experiences for our learners to punish them into achieving more. I sat in my daughter's school with hundreds of other parents whilst the head-teacher warned how lack of exam success could result in being banished to vocational study in FE.

It is key to Sennett's piece that he starts out by clearly acknowledging that there is nothing wrong with dependency, that it is good, normal and necessary to feel empathy, compassion and accept help when it is needed. Whilst that exists within the private lives of individuals, he goes on to explain how in the public realm "dependency appears shameful". He finishes his essay by concluding that

"Dependency has appeared like a coin with two faces, one private, the other public; on one side the need of others appears dignified, on the other side shaming." (Sennett 2004 p153)

Good to be poor but not to be needy.

In an attempt to further explore the connection between dependency and shame, Sennett cites welfare reformer Patrick Moynihan; *"Being poor is often associated with considerable personal qualities, being dependent is rarely so."*(Sennett,R. 2004 p.103) There is doubtlessly some kind of admiration attached to those who toil yet remain poor and yet often contempt for those that accept handouts or other offers of help. He goes on to consider Moynihan's 'infantilization thesis' whereby the dependant might be considered a child and the independent an adult. This can be equated to the whole attitude surrounding our maths learners in FE; there is a sense that they are there

through their own volition rather than as a result of a secondary education system that is designed to ensure just over one third of students fail. Sennett makes this distinction between the views of Locke and Kant the former recognising how society itself can produce individuals that lack the maturity to be self-sufficient. He adds their agreement that people should be questioning of authority to gain the mutual respect of others. By doing this, they are exercising the Deweyan tenet of undergoing something being done to them, whereby all action is reaction. Consequently, as communities are formed through the mutual respect, parallels may be formed to Dewey's *"conjoint community of functional use"* (Cited in Biesta and Burbules 2003 p29) and the pertinence of using mastery pedagogy in FE maths can again be realised.

Just as Sennett points to Kant and his view that all dependents were lazy and needed to be forced into work to alleviate their shame, there exists a similar notion within education. In UK schools, failure to do schoolwork at home (incidentally, Finland has a highly regarded education system that has no concept of homework) is met with punishment of forced work, or worse; idleness, during detention periods, often sat in enforced silence or isolation, sometimes for whole days. Staufenberg (2018) found 68% of UK schools use isolation rooms: *"the bleakest sign of an institution giving up"*. Such a widespread practice in 2020 must surely be viewed as tantamount to child abuse in any civilised nation. Sadly, it is a punishment used by many UK secondary schools, even though it is widely reported that the Children and Adolescent Mental Health Service, has rapidly growing waiting times and is under considerable strain from the quantity of referrals as the number of adolescents seeking help doubled between 2017 and 2019 (Shraer, R 2019).

Shame as punishment.

Nasim is one of my students. He was late to an exam and arrived devoid of a pen. The elderly female invigilator publicly berated him for not being on time, he remained unconcerned in his attitude. His request for a pen went unanswered until the invigilator remarked that it was no wonder he had failed his exams with such an attitude. Once Nasim had bowed his head and shrunk back into his chair, the pen was issued and he started his exam. He had become dependent and his shame was the signal for the

handout pen to be issued. Sennett does not tackle the question of whether shame is a prerequisite for help to be issued or occurs only as a result of the charitable act but I am convinced the former may often be the case.

The invigilator is an ex-secondary school teacher who was merely doing as she had always done; beating down an apparent lack of desire to work until the individual publicly displays shame and remorse at his dependency. Locke would have seen this as his world in action, the education establishment suppressing young people into a state of shame. This could controversially be interpreted as differentiation in action, shaming of those less able or willing in front of their peers, a blatant attempt to exclude a learner from the pen-holding, punctual community.

It would be churlish to blame the invigilator in this scenario for she too is a product of a system that relies on punishment to induce shame, shame to induce failure. It is a systemic factor of secondary education and one which is perpetuated through the avarice of those individuals, organisations and societal sectors who use education to further their own ends and uphold a flawed system designed to promote selective failure.

Nasim is a superb student who has faced horrific personal challenges in his life prior to coming to England. He has learnt a new language, made a new country his home and helps those around him by bringing positivity with him wherever he goes. He is a true catalyst for learning to occur in a classroom. And yet a broken down bus and a missing pen is used to destroy him before an exam which he would pass immediately were it in Arabic rather than his hurriedly learnt new English language. There can be no excuse for a system that wants me as an educator to differentiate in order to alienate.

Shame is complete when it is public

This is a useful juncture in Sennett's account to consider Dewey's 'situation'. The invigilator created a situation to induce shame, to expose an interpreted desire to be idle (by forgetting a pen), to be dependent and shamed in that dependency. Had the invigilator been devoid of a captive audience (of around 40 learners in a large room) would Nasim's shame have been so complete? Did the invigilator whisper her

admonishment? Not at all, it was a public humiliation and conducted with a degree of ridicule. This was the metaphorical displaying of a student's head on a spike to act as a warning to other potential pen-less souls.

Sennett addresses the role of culture in dependency and shame and prompts consideration of the Japanese tradition of '*amae'* whereby adults offer their dependency to others in expectation of assistance. The only shame that can occur in this scenario arises if the person receiving the request for aid refused to help and Japanese culture would have the shame upon them for denying the needful party. This provides a useful parallel to our learners' experience of secondary school where many were treated as stupid amid their peers if they asked for help, whereas now they know their FE teacher is not professing to be the most intelligent person in the room but merely a colleague who may be able to help them with their maths, the embarrassment is all upon the teacher should they miss a request for advice. The two approaches are as diametrically opposed as the cultures of East and West. It is society which dictates how dependency is interpreted and society which decides whom shame should be heaped upon, the learner or the teacher.

Hildebrand asks us to consider the difference between dropping a dinner fork in our kitchen to dropping a dinner fork at an important function. It is not the physical setting but the societal setting that makes the difference and induces shame and dependency. The fork dare'nt be picked up and used but a waiter must be summoned, dependency occurs. It publicly occurs. Exposing an individual's deficiency is an unpleasant practice that is used in education to humiliate learners into compliance and industrious endeavour.

Public assessment

Wiliam's (Black and Wiliam, 1998) 'assessment for learning' (AfL) remains the mainstay criterion which all 'outstanding' lessons must contain. Secondary education clings to this ideal despite secondary education getting arguably steadily worse since its inception. AfL may be viewed as easy to standardise, easy to evidence, easy to understand and easy to practice. The fact that it may not have been wholly successful as a learning strategy (although measurable as a teaching strategy) is largely overlooked, because it

provides a rubric from which to score educators and education establishments. It follows the same logic as assessing the suitability of a candidate to be a US president by how much hair they have – it has no bearing whatsoever on their efficacy, but there has not been a bald president elected since 1953 - so never in the television age. Therefore, presidents must have hair.

In the interest of an equitable account, it is right to point out the success of AfL also. It has served the middle-ground achievers very well. The stable, willing, secure and fortunate learners that need little more than structure and instruction to succeed have thrived on its approach. Their success however has been at the cost of those it excludes.

Denigrating the "Inside the Black Box" work of Black and Wiliam (1998) is an unpopular pursuit. Didau elicited a response from Wiliam following his blog post "Why AfL might be wrong and what to do about it" (Didau 2014) and Wiliam produced many caveats to defend formative assessment and AfL, including stating how students should move forward as a group, and yet the AfL package is more concerned with peer-group shaming to prevent an individual from thinking it acceptable to let his group down or hold them back.

AfL promotes the apparently revolutionary use of mini whiteboards (as opposed to mini blackboards that my mother used in the 1930s) to allow the teacher to immediately assess and feedback on all the answers that are flashed up by the eager students. Compliance must be mandatory for the AfL to work so slower and less-able students also have to hold up their boards for all to see. And right here is where the humiliation begins for the slowest learners, destined for maths GCSE failure and a subsequent low-paid job. This is differentiation by public humiliation and where secondary learners are earmarked to end up in FE. It is judgement and the shame of dependency in full public glare.

There is a definition of rare clarity in a quote by Erikson that Sennett cites when summing up the true meaning of shame as it occurring when someone is rendered *"visible and yet not ready to be visible"* (Sennett 204 p.111) . I want to explore this

further against the backdrop of current expected, recommended pedagogy in maths classrooms.

Visible to all

This is my concern over the widespread use of mini-whiteboards, the randomisation of names for questioning on lolly sticks and all the other AfL paraphernalia which is so easy to employ. It panders to the most able, the quickest, the most confident learners and offers an easy route to 'outstanding' for inexperienced or uninformed teachers. It is differentiation at its most brutal and yet it remains the aim of so many educators and arbiters of education. May it be the case then that it is designed for judging teaching rather than improving learning?

By forcing a learner to be exposed to the glare of their peer group and compared to them for the arbitrary judgement of right or wrong, we place them under enormous pressure to perform and to outperform their rivals. In Wiliam's 2013 response to Didau he cites Slavin's comment on collaborative learning and blames teachers for the shortcomings of his theory.

"The problem is that few teachers ensure that the two criteria for collaborative learning are in place: group goals (so that students are working as a group rather than just in a group) and individual accountability (so that any student falling down on the job harms the entire group's work)" (Wiliam 2013)

This is the central tenet of mastery pedagogy and yet there is little mention of how AfL empowers the individual learner beyond the fear of within his or her group. Note how Wiliam talks of a student 'falling down on the job' and 'harming the group'; this is the language of accountability, blame and exclusion that is rife in secondary classrooms. AfL is superficial enough to ensure the confident, able, learners are assured exam success, but it does little to address the needs of those who don't always carry a pen and sometimes miss the bus; those normal people who have gone through school being told they are less than their peers. The policy makers in education have an unhealthy pre-occupation with differentiation that is powered by shaming learners. Test results are public, whiteboards are public, and answers to randomly directed questions are public.

Learners may not be ready to be visible yet are forced to be so; and consequently, their shame is guaranteed.

Wiliam has done so much to cause educators to become accountable and reflect upon their practice and he is often venerated as a force for good within UK secondary education but his theories have been twisted and distorted, cherry-picked and adapted; until they suit the ends of whichever stakeholder can use them to their advantage, seldom for the good of the learner and nearly always at the expense of the richness of education. It has distilled the complexity of teaching and learning into quantifiable criteria, a 'tick box' exercise by which judgement of 'good' and 'requires improvement' may be handed down.

Just as J.W.M.Turner controversially painted into the light rather than with it behind him, perhaps as educators we should seek to free ourselves from the teaching-by-numbers approach; Nuthall (2007 p14) is *"deeply suspicious"* of such recipes for good teaching. We must apply diverse pedagogies to diverse learning communities with bold intent. The dependent have a right to education, teaching to the existing ability of a learner is a shame that should exist within the educator practising differentiation in order to appease the self-appointed arbiters of 'outstanding' education. Teachers using mastery pedagogy must be prepared take responsibility for learners as a whole cohort, moving forward as a group. In doing so we must be prepared to reject student-shaming as central to our art and instead consider teaching into the light. It is through the learner's experience that they find learning success, educators must take responsibility for the nature of that experience and ensure they are able to assess the quality of that experience. Listening to students own accounts is a good place to start; through necessity, teachers become researchers.

Experience and narrative inquiry.

 Connelly and Clandinin (1990, p2) state that narrative inquiry is increasingly used in educational experience and note its long history both in and out of education. Clandinin et al (2016) suggest that it's not enough for researchers to highlight the phenomenon of experience but also to have an interest in the process of narrative inquiry as a research method; *"All researchers, despite ontological and epistemological assumptions, share a*

view of research as searching again, a search for deeper understandings of particular phenomenon." (Clandinin et al 2016. P13)

Using the distinction of phenomenon as being the *story* and the inquiry into that story as the *narrative*, the narrative researcher describes the life experiences of the group being studied and writes narratives of those individual's experience.

Berk (1980) is cited by Connelly and Clandinin (1990, p3) as the question shifts from *"what does it mean to educate a person?"* to *"how are people educated in general?"* This elicits stories from students and educators rather than the former question which takes no account of experience, merely considering a philosophical point.

Those stories become the data for the narrative enquirer, thus forming the methodology for the study itself. Moving from 'what is education?' to 'how are people educated?' allows a critical review of mastery pedagogy to take place, as the pedagogy is the 'how' in the question.

As narratives emerge (not just stories but stories that have been enquired into), they can be translated into metaphors for teaching-learning relationships. Recalling Dewey's tenet of pragmatism, students are not having education 'done to' them, they are not reacting to education; they are interacting with their education. Those metaphors can be used to adjust pedagogy to be the most effective it can be in a given setting.

So narrative inquiry is established as qualitative data in the pragmatism tradition. Connelly and Clandinin (1990, p3) cite as follows:

> *"Eisner's (1988) review of the education study of experience implicitly aligns narrative with qualitatively oriented educational researchers working with experiential philosophy..."*

They go on to consider the relationship between researcher and their respondent group and consider that the collaborative nature of narrative inquiry allows the researcher, practitioner and participant to see themselves as part of the research community, having value for both theory and practice.

Hogan (1988) talks in terms of empowering relationships that are caring and have mutual purpose. He also talks of equality for stakeholders in the process. Noddings (1986) notes how unfamiliar this very considerate language has become in educational research. As this study continues its investigation into a pedagogy that takes experience seriously, narrative inquiry in a collaborative setting, provides a solid foundation from which to collate and analyse the research data.

If narrative inquiry is further distilled, the concept of voice can be broached. Not purely in the audible sense but in the sense as proposed by Britzman (1991 p23)

"Voice suggests relationships: the individual's relationship to the meaning of her/his experience and hence, to language, and the individual's relationship to the other [as in other people], since understanding is a social process."

The researcher must listen to the voices recounting experiences so those voices are granted the time and space that their stories attain the same high level of *"authority and validity"* (Connelly and Clandinin 1990, p3) that the entire research story has.

It is vital to remember that a narrative enquirer cannot realistically expect to have no effect upon the research being undertaken, even more so for the insider researcher. Rather than accepting this as a negative consequence of practitioner research, it can be viewed as a positive autobiographical account which adds authenticity as teachers tell their stories in a very focussed way.

Connelly and Clandinin (2005, p5) use the term *'active recording'*. This is where the researcher's participation in the events which will go on to form the phenomenon of the narrative enquiry actually allows emphasis, surprise, even revelation; to be entered into the account and finally become the qualitative data that shapes the outcomes of this study.

The accounts of John Holt in 'How Children Fail' (1963) and more latterly, Jo Boaler (The Elephant in the Classroom 2005), use this to good effect. The use of their accounts as metaphors for occurrences in teaching-learning encounters can be used as a reference to identify patterns of success, failure, response and interaction in such

circumstances. Active-recording lets educators and learners realise they are not alone, not struggling where others haven't before them and investigate ways to improve their situation. Building accounts for others to base further research upon has inherent validity.

Returning to Dewey's account of experience, it may be claimed that a person needs to experience an event for that event to have true relevance. That does not mean that we need to live other's lives vicariously but the accounts others offer may be used to frame a situation, to give it a position in theoretical landscape.

Van Maanen (1998) talks of the importance of apparency of truth and the concept of 'verisimilitude', both concerned with the way in which a narrative inquiry takes on the appearance of that which is authentic, truthful and real. He values these criteria above reliability and validity. Again, Dewey's multiple truths concept can be drawn upon when considering how true something appears to the reader. No universal truth is sought but a general impression of honesty and truthfulness can allow an account to have increased resonance and impact.

Additionally, a word of caution arises when looking at the causality of narrative inquiry and inventing links between what had happened in the past to what is happening in the present and hence what will happen in the future. Rarely are such correlations so simply explained away and the temptation to impose cause and effect where none may actually exist should be guarded against, or at least borne in mind. Similarly, Connelly and Clandinin (2005, p10) highlight the danger of the *"Hollywood plot"* scenario developing where everything *"works out well in the end"*. Here is another point where narrative inquiry aligns with Dewey's multiple realities as the researcher is asked to contemplate the idea of multiple "*I's*" whereby the critical-self must be separated from the researcher-self and the practitioner self.

 Connelly and Clandinin (2005, p12) discuss how the researcher becomes the gentle narrative enquirer, re-storying the accounts they collect in active-recording of experiences and how that research becomes one of *"learning to tell and live a new mutually constructed account of inquiry in teaching and learning"*.

Verisimilitude

As proposed by Van Maanen (1988), verisimilitude, is an intriguing and possibly vital factor in improving a learner's experience. Its definition is *"the appearance of being true or real"* (Oxford 2018).

Two pieces of highly successful marketing have already been discussed within this discourse: Firstly Descarte's brilliance of proclaiming mathematics (and thus science) to be the only genuine truth and therefore the divine invention of God. Secondly, Black and Wiliam's 1998 flawed but ubiquitous "Inside the Black Box" report that has reached biblical status with education leadership and policymakers, as it offered an effective counter to the complexities of creative, inspirational, dialogic teaching. Coupled with research which suggested effective teaching and learning had no link to class sizes (their equivalent to the Cartesian masterstroke which suggested assessment-for-learning was an invention of the fiscal Gods and therefore indisputable), this single document has been the mainstay of measurable, formulaic methods of teaching for the last 20 years.

The factor that links all popular and therefore effective (so far as it has 'an effect') educational theory is Van Maanen's 'verisimilitude'. Its Latin etymology is 'truth-like' and it is this 'appearance-of-truth' which strikes a chord with the entire ethos of this study. It is the effect of this research that is paramount; it must appear to have credibility in addition to actually being credible. It must appear honest in addition to being honest.

Honesty in narrative inquiry.

This is where the students that offer to tell their stories can give depth and meaning to the study through their personal accounts of what maths means to them as young individuals. Getting honest responses has to be the aim of the research process, avoiding the 'Hollywood plot scenario' (Connelly and Clandinin 2005, 10) is something that Jean McNiff broaches with considerable eloquence (Clandinin 2007).

She highlights that firstly, people must be told about the research to lend an air of potential significance through the research becoming a story of real life. Secondly, that story must be listened to by people:

"This means telling a story that is acceptable in terms of normative conventions, what people expect to hear as part of the orthodox canon"(Clandinin 2007 p308).

She talks of how getting a story accepted requires a degree of cultural, as well as editorial politics. Very bravely, she goes on to consider whether her work and account will be judged as 'good' and questions whether her responsibility is to do good, or merely to tell a good story. This is when she presents a set of criteria which possess such clarity that a researcher cannot fail to adopt in order to achieve that single purpose of 'doing good', conducting research not for popularist consumption, approval and convention but (in this case) with the purpose of making things better for young people in education. As a researcher; this concept is heady and intoxicating, whilst at the same time being refreshingly simple. Her criteria are brilliant in their simplicity, academically rigorous and undeniably attractive. These criteria are the cornerstones of validity and credibility but cannot exist without the verisimilitude of the stories being recounted. There is truth, the appearance of truth, the justification, desire and result of narrative inquiry research – all wrapped up in these six simple (paraphrased) criteria: (Clandinin 2007 p310).

- What is the concern?
- Why is there concern?
- What experiences can be used to demonstrate the reasons for this concern?
- What can, and what will be done about it?
- How can the educational influence of the work be evaluated?
- How can the validity of that influence be demonstrated?
- How can further concerns, ideas and actions be modified in the light of the study?

Note how the third point is all about experiences and how they might be used to demonstrate the concern which is the reason of the narrative inquiry research. Dewey's work on experience synergises well with narrative enquiry and the critical incident techniques used in this study. Early in Chapter 2, it can be seen how Dewey indentifies language as the first important role in establishing 'meaning', one of the three

requirements (along with interaction and stimulus) for 'habit' to exist and therefore shape individual experience.

Returning to pedagogy, it is vital to examine the role of dialogue within the single act of teaching and learning. This study is concerned with just how a mastery pedagogy, where everyone moves forward together, can impact the experience of maths learners. By association, Dewey's identification of the importance of language implies verbal or written communication is vital to forming meaning. This suggests dialogue (my deaf students converse with me using non-verbal dialogue) and yet the starter-main lesson-plenary, plan that is bizarrely still widely prescribed (despite its apparent lack of any success beyond enabling teaching to be homogenised for inspection) actively seeks to cut down on teacher/student talk time.

In my limited experience and from my enquiries it appears that self-proclaimed teaching experts in quality departments all over the nation's colleges have quality teams with few or no academic qualifications nor experience of teaching 16-18 year old learners. Pedagogy must evolve as our learners evolve, repeating the same mistakes in the hope that somehow things will magically start to improve because the 30 year old national curriculum says it will, is ludicrous in a contemporary setting, especially one as specialised as FE.

Talking and discussion is widely held to be an effective and necessary part of meaningful, long-term learning. Dialogue is the lifeblood of experience and experience is what may shape the ability of young people to recall information and pass exams.

Alexander (2013) comments upon dialogue and speaks of the two distinct types of dialogue that are needed; that which concerns itself with the business of education itself (as we are engaged in here) and that which forms the classroom practice when the mutually dependent activities of teaching and learning are taking place. Both of those dialogue types are central to this study; the wider, policy driven business of providing an evolving, engaging and nurturing experience of education for FE maths learners and the right of learners and educators to engage in rich dialogue without ill-informed restriction

by decision makers that are ignorant of the complexity of compulsory, post 16 maths delivery

This excerpt sums up what is at the heart of education and the lack of foresight (bearing in mind this is from a speech Alexander delivered in 2006) which plagues decision the decisions made in the FE sector.

> *"Dialogue requires willingness and skill to engage with minds, ideas and ways of thinking other than our own; it involves the ability to question, listen, reflect, reason, explain, speculate and explore ideas; to analyse problems, frame hypotheses and develop solutions; to discuss, argue, examine evidence, defend, probe and assess arguments; and to see through the rhetorical games that people play in order to disguise their real intentions or deny access to the truth. Dialogue about education is a prerequisite for social and economic progress. Dialogue within the classroom lays the foundations not just of successful learning, but also of social cohesion, active citizenship and the good society."*
> (Alexander, R. 2013 p122)

Alexander sums up how decision makers outside of the classroom form flawed policy to serve their own ends which translates to flawed practice inside the classroom. It could be argued that the hierarchical nature of schools and colleges promotes those who blindly follow flawed policy to positions of decision making and thus the uninformed continue to peddle ineffectual pedagogy in the name of observation and inspection. Ill informed teachers become obedient observers and move to being dictatorial inspectors, rewarding those who subscribe to the flawed pedagogy of the past 30 years. The value of dialogue is all but lost in FE as non-academic ex-teachers construct an ethos of fear which precludes open and honest discussion. Anecdotal evidence from personal conversations and online forums suggests this appears across many learning organisations.

The Essential 8 maths mastery programme has offered up an unforeseen opportunity to network with many other educators in FE and the ensuing dialogue is enlightening but somewhat depressing as it so often has the common thread of the above synopsis. The

flawed pedagogy deployed throughout the UK formed part of a keynote paper by Askew (2013) when he discusses five necessary conditions (Diversity, Redundancy, Enabling constraints, Neighbour interactions, Distributed control) for new pedagogies to emerge (Davis and Simmt 2003) here abridged.

Diversity: Classroom observations before the introduction of the National Numeracy Strategy revealed a wealth of practices, which could provide rich opportunities for teachers to share, debate and build on—to have a dialogue about. After the strategy was introduced, virtually all the lessons had the same 'three part' structure, thus reducing the opportunities for innovation.

For emergence of new ideas, redundancy is helpfully thought about in terms of proscription—what we do not do round here—rather than prescription—we only do it this way.

Exploring ways in which students have to work in pairs on a problem imposes a constraint (paired work) that enables ways of working to emerge.

Neighbour interactions means more than simply teachers working together. In schools and networks of schools it means the sharing of ideas, hunches, questions, records of teaching practices. It means having more dialogue about the outcomes of teaching, the evidence for these and what we value, than planning the inputs of teaching.

Distributed control: Local, distributed control is essential; else the dangers that Paolo Freire (1996) warns of may emerge: "Leaders who do not act dialogically, but insist on imposing their decisions, do not organize the people—they manipulate them. They do not liberate, nor are they liberated: they oppress." (Askew 2006)

This is a powerful and resonant endorsement of what this study is examining; whether a change to mastery pedagogy can establish a link between experience and breaking the cycle of repeated failure and thus explore the opportunity to construct a pedagogical

approach that does not marginalise, stigmatise and debilitate young people in the way the current system of FE education in the maths sector does.

Recipes for brilliant teaching.

Possibly somewhat misleading in its heading, this section requires the consideration of whether it is at all valid to engage with the step-by-step guides on what good teaching should look like. FE colleges have individuals employed to form 'quality teams'. These are the college's in-house inspectors that periodically drop in to make classrooms to make scheduled observations and comment on them accordingly. The background, experience and qualifications of the staff which comprise these quality teams is varied which is also the case for university lecturers who lead initial teacher training courses such as the Post Graduate Certificate in Education, which leads to Qualified Teacher Status after the first year of teaching.

The checklists of those making observations in lessons are designed as an aide memoire for the observer so they might record all the elements they need to witness throughout the cut and thrust of a lesson to decide on what judgement to pass down upon the classroom teacher. Designed to be supportive and collegial, anecdotal evidence suggests this is not always the case.

I have personally had advice to 'get the kids moving about' from observers who are ex sports teachers for instance. A teacher with only experience of teaching English as a foreign language to adults, suggested that times tables were a ludicrous thing to be discussing in class as small children know them long before they leave primary school. This lack of understanding of teaching a conceptually demanding subject such as mathematics to learners who have experienced great anxiety and frustration already in secondary education is far from helpful or supportive.

The fact that many FE quality departments use observation checklists with a single tick box for 'assessment for learning present' shows the level of understanding of the people making and using such lists.

When it comes to teaching methods, the 40 years of meticulous observational education research of Graham Nuthall makes his work have a relevance and honesty that places

him firmly in the company of Boaler and Holt. His corpus embodies Van Maanen's 'verisimilitude' (1988); the apparency of truth that may be of more practical value than the truth itself.

In his Hidden Lives of Learners (Nuthall. G 2007) his introduction talks of the danger of prescribed teaching methods as authorities may use such recipes to tell teachers how to teach without regard for their students or the circumstance in which they are practising. The role of learning peers is always at the forefront of his account and the need for teachers to understand how peer influences work in order to be effective is seen as paramount.

The act of lesson observation is called into question as the tick box entitled "are all learners engaged?" suggests that a brief glance around the room can answer such a complex question. However, Nuthall notes how learners become adept at feigning engagement through nodding or whispering to themselves when the teacher passes by them. He discusses how...

> *"many of the quality assurance systems used to evaluate teachers are based on the belief that we can tell by looking whether the teaching is effective and the students are learning"*

He concludes that...

> *"For all the insights that direct observation might provide, we should not base our evaluations of teaching on some universal model or set of models of good teaching". He emphasises: "we simply cannot tell by looking".*
> (Nuthall.G 207 pp25-26).

Nuthall cites research which reverse-engineered the 'good teaching' model by looking at good teachers from different countries and distilling their best practice into 6 of the most important characteristics. They are a refreshing antidote to the quality assurance checklists:

1. A passionate commitment to doing the very best for their students.
2. A love of children enacted in warm caring environments.

3. Pedagogical content knowledge.
4. The use of a variety of models of teaching and learning.
5. A collaborative working style with other teachers to plan, observe and discuss one another's work.
6. A constant questioning of, reflecting on and modifying of their own practice.

Bear in mind this is not a recipe for good teaching, this is a list of the things that the most effective teachers exhibit and practice. These are personal attributes that are unlikely to be immediately apparent within a 20 minute observation. This was the result of at least 20 hours with each teacher across 10 different countries.

Nuthall concludes his thoughts on classroom observations by tempering his enthusiasm for any prescriptive list by arguing that unless an observer knows what good teaching looks like they cannot interpret what they see in classrooms. His opines that...

> *"the result of these studies of "best" teachers is usually a picture of what experts currently deem best. Whatever is fashionable at the time determines what researchers look for and what they see."* (Nuthall.G 2007 p29).

This is of great interest to me personally as I have fallen foul of quality inspections through criticisms of pace (refuted by Boaler 2017) and teacher talk-time (refuted by Nuthall 2007). Because the perception an observer gets of a class may not be what they want to see, it should not make that teaching inherently 'wrong'.

The same criteria of 'good' teaching that failed our FE maths students at secondary schools is being employed by quality assurance systems within FE colleges. This relates directly to the 'failure cycle' examined by this study as it sets learners on a course to get the same negative outcome time after time.

It is not only the observations that are lacking in depth and comprehension and rigour, it is the observers themselves. This is not to denigrate those involved in performing lesson observations, they have chosen a career whereby they will perform a prescribed task of watching a lesson and tick boxes on a prescribed list to decide whether teaching is 'good' or not. In the same way a dispassionate, detached and unbending demeanour

is demanded of a parking attendant or scientist, the same objective criteria must be used by the observer. If the box is ticked the teaching is 'good'. The learning is never really assessed, as that would be impossible within a 20 minute observation.

Over a sensible period of time it is of course possible to talk with students and teachers in order to obtain a whole picture of lessons rather than assess a teacher on a single, always engineered and disingenuous, snapshot of a lesson observation. Nuthall makes the point that interview is far superior to assessment when really finding out what students know (Nuthall G. 2007 p52) and perhaps that notion should be applied when assessing teachers too.

Nuthall found from his research *"that a student needed to encounter, on at least three different occasions, the complete set of the information he or she needed to understand a concept. If the information was incomplete, or not experienced on at least three different occasions, the student did not learn the concept"* (Nuthall 2007 p63).

This influenced the Essential 8 programme to adhere to a scheme of work in which learners experienced the same set of 8 topics, in the same order, 3 times over a 33 week academic year, plus practice from the workbook. The weeks in between each cycle are allocated to assessments and catch-up week for absentees and admin activities.

Nuthall's account is purely driven by his extensive research and lines start to blur between where commentary on the nature of learners experience ends and the way in which that experience can be captured as raw data ends. Exploring the philosophical and practical nature of how learning happens in classrooms requires an in depth assessment of the scope available to the practitioner/researcher. Scott and Usher (1996) provide insightful opinion regarding the relationship between research and practice.

Their paper pulls together the many strands of researching learner experience literature reviewed for this study. It provides a useful bridge between this literature review chapter and the next chapter which broaches the research methodology used for this study.

Ideas of the main protagonists

When considering Cartesian Dualism in contrast to Dewey's pragmatism it is prudent to view a classroom as a set of real truths rather than referencing everything to one ultimate truth. The subjective, holistic experience of dynamic interaction with the stimulus at hand is at the epicentre of this study.

Dewey's ideas around language, meaning, habit and situation are dependent on a community of learners supported by a leader of learning who is prepared to take the leap of faith necessary to allow a cohort of learners to have their independence and make mistakes, find their level and learn more than that which is being taught .

Hildebrand's extrapolation of Dewey's commentary on 'situation' allows an appraisal of one of the elements that a classroom practitioner can carefully deploy on a local level and gently ease into, allowing a set of individual learners to slowly transform into a learning community.

Learner performance in exams, when displaying mini whiteboard answers and during assessments, may be considered in relation to the 'disturbance' put in the spotlight by Biesta's account. The way in which students react to that disturbance is something that can be addressed by classroom practices that reduce anxiety and produce a calmer response to disturbance, perhaps allowing good results to develop as a by-product of learning in a community rather than a goal of learning in intense isolation.

The concept of promoting the optimal experience of 'Flow' in the classroom must be carefully considered; how desirable or advantageous it may be to aim for Flow during practice rather than in the performance of an exam must be questioned. Perhaps engineering Flow should be reserved for not for learning or practising but for assessment. Merely practicing that which is known, even highly demanding skills, may lead to an inflated view of ability, both by student and observer. Perhaps the learning environment needs to have the focus shifted away from the individual learner to the individual with a group of learners.

Ideas surrounding tacit knowledge and the formulation of the concept of collateral growth are explored in the light of the possibility that learning in a suitably created

environment may produce a situation whereby more than maths skills are learnt. The whole experience of learning may put the maths facts in a context of experience where learners can associate their newly gained explicit knowledge with inherently more 'sticky' implicit knowledge of social interaction, confidence and security.

Sennett's views on the shame of dependency could be applied to what has happened to learners in their past and how their experiences have taught them to see dependency as a reason to feel embarrassed rather than the prerequisite for growth as Dewey identifies it.

The account of Connelly and Clandinin proves to be an effective base from which to examine learner experience through a narrative enquiry approach. Nuthall's conclusion that more can be deduced regarding learner understanding by interviewing than by assessment lends further credence to such an approach.

Scott and Usher's wide-ranging theories on practitioner research provide a useful bridge to lead to move from this literature review into the subsequent Research Methods chapter.

Social research in education.

Scott and Usher (1996) tackle the issues surrounding the very nature of social research and proposes that research as a scientific process may not be best served by attempting to remove all subjective influence in favour of a completely detached and objective appraisal of the subject under research. They set out by declaring that they find it *"impossible to adopt the orthodox stance of complete neutrality and impartiality."* (Scott and Usher 1996 p9). This is true also of this study as my own, value laden, approach is declared from the outset, as it must be if the study is to have intrinsic value within the contextual situation it is setting out to examine. In short, they see research into social sciences as a social practice; one which, by necessity, requires the researcher to acknowledge his or her place within the research.

In analysing the role of data within empirical research and how it becomes overshadowed by the descriptions, explanations and generalisations. He considers these to be good way to view the scientific research process of stating the purpose of

the research, determining a cause for the phenomenon under scrutiny and finally proposing all-curing panacea that may be applied regardless of context or setting.

For me personally, this holy-trinity approach to applying research findings lies at the heart of the issues surrounding how education is subjected to wholly inappropriate suggested practices and counterproductive recommendations. For instance, best practice in a sports lesson is unlikely to be best practice in a maths lesson but this is not a popular view with those forming educational policy.

There is however a slowly growing academic school of thought that is starting to recognise that much of the guideline material issued by the likes of OFSTED and quality teams throughout the UK is at best ill-informed and at worst, ruining the opportunities for young people to learn. One of the recent frequent OFSTED criticism points of maths lessons is the lack of pace in lessons. This is based upon the drive for assessment-for-learning on all subjects. Jo Boaler has dedicated all her efforts to try and reverse the 'math madness' (Boaler, J 2017).

Scott and Usher go on to set epistemology against ontology and the inevitable question of Cartesian dualism versus the tradition of pragmatism arises. Just as Dewey would have argued that separating thought from the effect on the matter around it was bizarre when considering experience; they raise the same concerns regarding empirical research, citing how the assumptions of a positivist epistemology gives rise to research that holds tenets such as determinacy (as per Descarte's ultimate truth) and how impersonality is used to remove all context. He goes on to discuss the research language of the natural sciences becoming the same as that of the social sciences. Just as Dewey identifies language as defining everything that has meaning, Usher sees language being used to negate the value of social research.

Kuhn is cited at length as the concept of 'normal science' is introduced where a paradigm shift occurs which allows researchers to be free from the empirical bounds and rather subject to cultural bounds. This is argued as being due to the act of research itself becoming the subject of debate, the idea of research communities wielding power also may be considered.

In a recent exchange of views with a lecturer from a local university, the reasons I gave for not wishing to engage with a certain classroom practice they were promoting was immediately rebuffed by means of citing quantitative empirical research which somehow 'trumped' and negated my learners' experiential research.

The interpretation of research within education is governed by numerical data, pass rates, grades, percentages – that is the flesh of maths research data. Usher introduces the concept of a hermeneutic epistemology whereby data may be considered in context and exist perhaps in a framework which would allow analysis of human behaviour whilst retaining the interpretive element, perhaps just as in Plowright's FraIM (2011) model used in this study.

If the formation of knowledge does indeed become an evolving set of ideas rather than a singular truth (as is happening for instance in the world of natural quantum physics) then the 'big-picture' epistemology may be allowed to entertain a degree of cultural context. Hermeneutic circularity is introduced to allow a framework to provide an understanding of what epistemology is relevant and what may be considered of less importance. By removing the 'one-set-truth' knowledge is allowed to become individualised and pertinent to relative settings. This pertinence has been sadly lacking in FE for many years and finding that relevance is a task which falls in some small way to the account I am presenting within this study.

Scott and Usher (1996 p.17) cite how Gadamer argues that the social sciences need the researcher to become part of the hermeneutic circle to engage from an ontological standpoint with those being researched. He dubs this the 'fusion of horizons'. The point they are missing, and indeed focussing on as a negative aspect, is the interactions I have with my students as we work together. They conclude:

> *"Hermeneutic understanding is therefore a learning experience involving 'dialogue' between ourselves as researchers and that which we are trying to understand"*

This echoes the work of Robin Alexander (2017) and his major research project that is currently underway to explore further the value of classroom talk. Bear in mind this is

set amidst a backdrop of OFSTED including "too much teacher talk time" within their common inspection framework.

The work of Habermas and the Critical Theory tradition is examined as it rejects any notion of entirely objective knowledge as all knowledge has people at its inception and those people would have their own ontological position and social setting. This is fascinating in the context of this study as many of the problems facing the learners in FE stem from the wisdom of secondary education and its central tenet that around a third must fail. The knowledge around those controlling secondary education is perpetuated by those with a desire to maintain that status quo. FE is a spanner in the works of the sausage-factory ideology of secondary education as it empowers those deemed to fail to have a real chance of success.

Habermas looks for four validity claims when considering the *validity claims* of dialogue: meaningful, true, justified and sincere. He then seeks *ideal speech situations* where we *warrant* what we claim to be true in our dialogue. This study uses an approach to research methodology which is the most likely to produce a 'warranted account', presenting a narrative designed to uncover the underlying nuanced developments occurring as a result of a new pedagogy.

The problem is, Critical Theory ends up setting itself a paradox as it continues with its theme of ideal situations for communication, deciding that arguments in dialogue must be logical. Critical Theory looks very much like Mr Spock of Star Trek fame; it is at odds with itself, fighting to remain a logical Vulcan whilst desperately desiring to be seen as interpretive, hermeneutic human. This is a crude analogy but no less pertinent for being so.

In a surprising coincidence, a research study entitled "Staying dumb: Student Resistance to Liberatory Curriculum" is cited by Habermas (Lather 1991). This resonates with this critical incident within this study when Katie proclaims *"I'm not the dumb one anymore"* in one of the critical incidents which form this study's data. There is no certain knowledge as our learners are evolving. Teaching and learning is affected by so many variables that trying to set tick-box criteria can only harm the process.

There is an anarchic streak that courses through the centre of postmodernism as it challenges what we have been told is the gospel of education. Bravery is not however a trait that all research can lay claim to. That which cannot lay such a claim may be of no more value than that from which its dated epistemology tried to perpetuate. Education is changing because learners are changing. If research is to keep pace with the curious twists and turns of issues surrounding maths in FE, it must assume an ontological position over the epistemological and dare to question that which is set in stone and instead deal with the experience of learners and the ways in which they can be improved for future generations.

The essence of the featured literature:

Capturing learner experience is at the heart of this research and Plowright's (2011) mixed methods framework does a sterling job of ensuring many different types of data capture are undertaken and can be organised in a coherent fashion. The actual methods are detailed in the following chapter but the concept of capturing experience needs to be addressed in this literature review as interpreting learners' responses incorrectly is an ever present risk.

Dewey is placed at the forefront of the literature reviewed here but this decision needs to be qualified. Exactly why Dewey's account is relevant over a century after it was published, has to be broached as it may be construed that the use of such outdated material is retrospective or even simply sentimental. Partly it is an attempt to deconstruct the generations of revolutionary ideas that have all been as damaging as they are transient. The positivist ideals of control and corporal punishment of my school years became incongruent with enlightened thought. The introduction of the National Curriculum in 1988 wrested much of the freedom away from educators and led to less inspiring lessons, potentially encouraging poorer behaviour. The blind faith, which is still to be found in differentiation as an effective teaching tool, is at best questionable, at worst divisive and prejudiced. The only thing all those educational fads have in common is learner experience. When it comes to experience, the later distillation of Dewey's corpus into the concentrated 1938 work Experience and Education has resonance in the context of a changing society. As the UK was staring into another world war, the US

was undergoing a transformation of prosperity and opportunity and yet much of its education was failing. Huge change was about to be heaped upon the world as many of its students left playgrounds and entered battlefields. It was a time where the experience of young people was to be brutally affected by war.

Dewey's commentary in his later work captures that zeitgeist as he clearly identifies the changing attitudes towards education from the old way to the new way. FE in England is undergoing a similar metamorphosis in 2020 as it is emerging as the driving force behind ensuring the nation has a ready supply of highly trained individuals with the vocational expertise and training to ensure the UK has a suitable personnel skill set to take its products and services to the rest of the world as it prepares to leave the European Economic Union.

The concept of experience shaping a young person and enabling them to succeed where before they have failed is not bound by the shackles of chronological order; Dewey's commentary forms the source which enlightened educational commentators can trace their theories back to. It is the intrinsic essence of how learning happens and the indisputable, yet subjective, truth of the individual. It is the individual learner that this study focuses on. The aims of identifying ways in which a mastery approach can improve experience, and consequently wellbeing and exam grades, benefit from Dewey's singularity of nurturing care that is devoid of the corruption of the celebrity commentators and self-appointed arbiters of 'outstanding' teaching. Dewey is the champion of the experience of the individual and it is that learner experience which should be at the heart of FE education, because for FE GCSE maths students, secondary school was possibly negligent in providing a situation in which they could succeed.

Capturing learner data.

It can be difficult to capture learner data from young people as a direct question may well elicit a generic answer, usually of one word and most often not particularly helpful; "alright" tends to be a common response.

The data of most value is that which is collected in the context of what is happening at the time. Reactions to scenarios, peer to peer comments and even outbursts of despair or anger are often much more telling than structured interviews.

It is imperative to understand that it is these very interactions which shape learner experiences however. There is some narcissistic arrogance surrounding some teachers' accounts of learner experience during the many discussions which have arisen from this study; often educators place more value on what they say as teachers to provoke a response than what learners say and the response they receive from the teacher. This may be because of the incessant demand to be reflective rather than consider their students' experience. Perhaps rating the value of the transactions that happen within a classroom should not be based upon who initiated the exchange. The most valuable, thought provoking and sometimes troubling interactions are often apropos of nothing, seemingly innocuous and yet the direct result of a situation which the teacher may not even be aware of. When students react angrily to successfully answering a question it may be that they perceive themselves as being 'dumb' prior to finding out just how straightforward a method actually is once it has been correctly explained (this happens frequently when working with the inequality symbols of < and > for instance.)

Sometimes the teacher must accept that the past experiences of their students will need to be played out in the classroom before they can be replaced with new, more positive ones. If this is stifled or discouraged, the learner may never replace the experience and instead remember the often more potent feelings of negativity and shame above those of satisfaction and success. Sennett's commentary on the shame of dependency (2002) is at the forefront of this assertion and that dependency must be accepted by educators as the responsibility and privilege which is placed upon them as a teacher who may assist in not cementing dependency as shame but instead as Dewey suggests, a prerequisite for growth. When not knowing how to do something is viewed as an opportunity to learn rather than a reason to fail then the landscape may be viewed from a different perspective. It can be difficult to distinguish sunrise from sunset unless you know which way you are facing. The role of the educator must become one of 'creator of situation' rather than simply fount of knowledge. The way in which learners exist

within the classroom, whether they see a sunrise or sunset, will form the basis of their experience.

It is the capturing of the data from learners that the following chapter is concerned. It details the methods and approaches used to try to understand the underlying issues of learners of mathematics in Further Education. Rather than searching for revelations this research attempts to make sense of the overall picture of the locus held by maths GCSE in FE. Only GCSE English holds a comparable position in FE and yet so often the criteria and rubric used to assess A'Level and vocational classes are awkwardly pressed into service when looking at GCSE maths which inevitably is to the detriment of teachers and learners within those maths classrooms. The following research methods are not proposed for any other purpose than investigation into the hidden machinations of GCSE maths in FE; they may however be of interest to researchers attempting to examine compulsory academic education in largely vocational settings. Teachers and commentators within the primary and secondary sectors should be aware of the limitations of adopting a core concept curriculum and the threat is poses to exchanging high attainment for a merely 'good enough' level of achievement. The learners revealing their thoughts and experiences are learners who have been told they have failed and as such had their lives put on hold. The approaches taken in understanding their stories must not be confused with those of learners who find maths easy or have been successful in their prior study of mathematics. Essentially this research presents the views of individuals who have been let down by a system to which they were entrusted and their sense of disappointment, both in the school system and in themselves, may emerge as their personal barrier to academic and social competence. The story of the wider implication of that disappointment is contained within the data collection made possible by the methodology presented in the next chapter.

SUMMARY

This chapter presented Dewey's brand of pragmatism as a foundation to present a literary landscape on which to layer the aspects of mastery education which are later identified as having links to the way in which the FE maths students in this study perceive their learning.

The stark contrast between Descartes' ultimate truth and Dewey's multiple truths are given form by examining the fallibility of mathematics and couching the subject in terms of a social construct rather than indisputable fact.

Examples of multiple truths of experience and the concept of meaning, situation and experience are broached and it is proposed that learning in a group may be give rise to more efficient learning than learning alone. The whole experience gives rise to more meaningful, and therefore memorable, learning.

A graphical interpretation is used to offer an insight into meaning, stimulus and interaction forming habits. These habits are then seen as the individual's holistic response to situation. In an FE maths context the learners' habits form the basis of how they will respond to the disturbance of summative assessment.

The ubiquitous deployment of formative assessment and differentiation is called into question, along with the inextricably linked 'Inside the Black Box' of Black and Wiliam. Mastery rejects the notions of each-for-themselves for a more learning-community oriented mastery ethos of leaving no one behind.

The three experience elements of direct, experimental and caring are aligned to the Essential 8 mastery programme and Hildebrand's thoughts regarding situation are explored in conjunction.

Social factors surrounding learning maths are examined by the use of Sennett's account of the dependency of shame which lead into a discussion around the very culture of Western education, contrasting dependency shame to the Japanese practice of *amae*.

The chapter primes the thesis to start considering methods that have been well documented to begin to interrogate the data that arises from trying to link theory to practice, academic writing to classroom experience. Connellly and Clandinnin are held up as the main proponents of narrative enquiry and the extensive research of Nuthall provides an impressive and inspirational body of work to begin to answer the 'what is going on in the classroom' question that Chapter 3 sets out to document.

Chapter 3: RESEARCH METHODOLOGY

This chapter discusses the process of deciding upon the most suitable methodology to adopt for the purpose of this study. It is semi-narrative in its presentation as it describes the process of appraising and selecting the mixed method approach that is finally chosen.

The ways used to collect the data play a role in the final decision yet the mixed methods frame of Plowright then go on to inform the collection methods creating a cyclical relationship that allows for a wide variety of data to be put forward for later analysis.

The main data collection instruments used are recordings from a reflective journal, student questionnaires, a formal interview and many informal discussions. These are examined alongside the relevant numerical data corresponding to the respondent cohort.

Dewey's account of 'experience' threads through the decision making process whilst the mastery tenet, of no one being left behind, frames the overall discussion as the responses, interactions and asides, whether conscious or subconscious, of each individual member of the response cohort are allowed to retain intrinsic value and be given consideration by means of the careful selection of an appropriate mixed methods methodology as proposed by Plowright.

Chapter overview:

This chapter discusses the selection process used to arrive at a suitable research methodology to deploy in constructing this study. At its heart, lies experience – the tenets of Dewey, Nuthall and Sennett. The action of doing something lies in the doing itself. Dewey's concept of all reaction being interaction and the subjective perspective of the individual being the only reality one need concern oneself with, eschewing Descartes concept of ultimate truth, espousing the concept.

The research methods for this study are not arrived at easily. There is struggle within the research method choices to be made as they will shape the entire character of this account. The options, struggle, decisions and justification of method is discussed at length because they form, the very essence of this attempt to explain a small element in a specific sector of maths education.

Saunder's at al (2007) research onion is introduced later in the chapter to offer a visual representation of the path that this study has taken through the research methods minefield. It is with no flippancy that I use the term minefield either. Having previously fallen foul of allowing prescribed research methods lead me to finding the answer to a research question I had absolutely no wish to answer, I am cautious of blind adherence to research methods whilst appreciating the academic rigour that such a structured, recognised approach offers to the wider academic community and the associated further research opportunities that accompany such an approach.

After consulting with the academic team at the University of Sunderland, it became clear that a wealth of data already existed from the regular data collection I use as part of informing my classroom practice. My penchant for the works of John Holt, Graham Nuthall and Jo Boaler (and their specific focus on the teaching of maths) also meant that I needed little persuasion to embrace a Critical Incident Technique (CIT) approach to this study to pinpoint the pivotal path the research has taken.

The founder of CIT, (Flanagan, J.C. 1954) is introduced and a brief explanation of the history of CIT ensues. More latterly, Tripp (1993) brings CIT into education, exhibiting many similarities to the style of Holt's (1963) book, which was pivotal in my personal decision to enter the teaching profession.

This use of CIT achieves two main goals: It allows the narrative of the mastery pedagogy and Essential 8 programme to be revealed and it upholds the pragmatism watchword of 'experience'. This is about the reality of a situation; this is about a programme that is designed as a means to an end which is achieving that end but by largely yet unexplained means. The dissection of the critical incidents might allow an appreciation of what is happening in our classrooms, and now in classrooms across the nation as increasing numbers of learners are buying into this very simple, yet effective programme.

It may be unwise to underestimate the tension between collecting qualitative and quantitative data. Simply claiming mixed methods as a methodology carries with it the danger of the method lacking rigour and associated credibility. To mitigate the issue,

Plowright (2011) offers a structure and format which encourages unambiguous categorisation of data whilst establishing a comprehensive appraisal of the entire study.

Plowright's FraIM (Framework for an Integrated Methodology) gives structure to the data. This goes some way to ease the qualitative vs quantitative dilemma and ensures the integrity of the study without its aims being compromised in the effort to constrain the research to a prescribed research method.

Employing narrative enquiry techniques from Connelly and Clandinin allows for the experience of learners to be captured and analysed within Plowright's FraIM.

Structuring the methodology.

Referring back to the research questions set out in the first chapter offers a clear rationale to the suitability of the methods eventually employed to conduct this study and allows for the selection and rejection process to be conducted with a singular purpose of answering each of the elements within the question array.

Moreover, a methodology 'production line' is established as a machine to effectively process the data so it assumes a form which is ready for analysis. Whilst this is far too much of a generalisation to express the true nature of sometimes highly nuanced data, the production line metaphor offers a hierarchy of process which may assist in explaining the way in which the data is collected, processed and combined in order to arrive at a set of conclusions that go some way to addressing the research questions described at the outset.

- What is the **impact of a mastery approach** to teaching maths on Further Education re-sit students?
- What is the **current experience** of learners and teachers of learning/teaching maths?
- What impact does a mastery method of teaching maths have upon learners' **experience and achievement** in maths?
- What are the **wider impacts** on learners of adopting a mastery approach to teaching mastery maths?

- What are the **challenges and limits** of adopting a mastery approach to maths?

From the emboldened words, it may be ascertained that a singularly quantitative approach will only cover those data pertaining to the pass marks of achievement and that any impact would be limited to considering grade changes and possibly attendance figures or a simple questionnaire analysis.

Capturing qualitative data can be a daunting task at first but when a research has developed a feel for identifying what artifacts are true glimpses of experiences rather than affected displays for the benefit of peers or teachers, the process becomes quite natural. Processing such data requires a compendium of techniques in order to fully explore and analyse the data in an appropriate and meaningful manner.

Using surveys, noting the comments, frustrations and general outpourings of students and asking direct questions have all helped to capture learner experience but none of these techniques are without their potential pitfalls.

Using Likert style surveys are of some use but they are constructed by adults, with adult sensibilities and they also assume that a respondent is capable of holding opinions that 'strongly agree' or 'strongly disagree' with anything – let alone their experience in a maths classroom. Many learners, will simply click through each question with the same response, whilst not actually reading what is being asked of them. Trialing the initial questionnaires with around 20 students soon revealed that the questions contained too many words and were generally not fit for purpose. Asking the students to re-word the questions was of great help and produced less unread, repeated responses than the first attempt. The version used, as amended by students is in Appendix 13.

There is a danger with Critical Incident Technique that one waits for a monumental event (for Flanagan (1954) this was an air crash) before deciding it was pivotal in the development of a pedagogical approach. However the true enormity of an event may only become apparent when one sees it in hindsight or realises just what a catalyst for change an incident actually was. Practically the entire Essential 8 programme and the exploration of our mastery pedagogy hinged on the moment when a young lady called

Katie said, "If I can do maths, I can do anything". I remembering laughing with her at the time when she said it but it was only later that I realised that in that brief exchange was the true essence of our mastery pedagogy which ensures that no one gets left behind, no one is given easier work merely to keep them occupied and no one is left feeling that they can't 'do maths'.

Collecting CITs in a journal is sobering experience; it brings to light just how much of the minutiae of student feedback and valuable information gets lost in everyday interactions. Choosing which of the many recorded incidents to class as critical is an iterative process of assessing which are most pertinent to the research and only using those which genuinely have been responsible for changing the course of the study.

Narrative enquiry must also be carefully approached if the potential for misdirection is to be avoided. There is a danger that learners will either be inclined to recount feelings and emotions to suit their desired mode of working (or not working) that may be simply designed to fool their teachers or delude themselves. This is an always-present concern with asking learners directly to describe their feelings or experience of a particular activity as they may take the opportunity to mislead the enquirer to meet their own ends. Some may seize the opportunity to gain favour with their teacher or their peers, others may genuinely have a distorted recollection or perception of their own state of being. Echoing with Dewey's multiple truths, that which the learner believes to be his or her personal truth may actually not be the case at all but merely what they would like it to be or that best serves their intent.

This is why the artifact analysis of narrative enquiry is sometimes best achieved by a researcher who has developed a 'nose' for a critical incident, artifact or piece of data in whichever form it presents itself. Direct questioning has an inbuilt danger of simply hearing answers that the respondent assumes he or she should provide. Far more telling are the whispered comments, muttered asides, doodles, reactions, excuses and behavior anomalies which may occur and subsequently be picked up as pertinent by the skilled researcher. When Anita asks "why don't you ever teach us anything" of her teacher, she is providing a vastly more honest account that might be gained from a

questionnaire or interview. It is within those spur-of-the-moment interactions that the real truth of learner experience lies.

Plowright's FraIM (2011) (section shown abridged below) is employed to order the data and ensure a good spread of data types are achieved. It must also be noted that the questions Plowright suggests as a taxonomy for a comprehensive mixed methods approach have a natural affinity with the research questions to be found in this study.

Plowright's model also offers a method of ensuring a fully rounded set of responses so that as many stakeholders in the process (in this case post 16 GCSE maths) who are influencers in the wider research support for the mastery approach.

Discovering local and government policy regarding post 16 education has been an enlightening experience for the informed researcher and the national and theoretical are not omitted, thus giving an altogether more inclusive and rounded set of results than otherwise might be the case.

Selecting a hierarchy of techniques:

Using a series of techniques allows for qualitative data to be collected and processed in an organised manner. This is a somewhat over-simplified statement, but it suffices at the outset of this chapter.

Flannagan's Critical Incident Technique (1954) is used to identify the vignettes of each of the learners which form the heart of the very personal stories which offer fleeting visions of the subjective truths of the people this study is concerned with.

Connelly and Clandinin offer such a refreshing approach to collecting narrative data as they realise that the true narrative lies in the actions, the doings, of the subjects at hand. Understanding that stories are not made solely of words is crucial to this study as it wholly synergises with Dewey's view of the visceral nature of experience. It is the whole

package, the thoughts deeds and intentions of an individual at that time, in that situation.

Plowright gives the permission to cast off the ligatures that accompany the distinction between quantitative and qualitative types of data. The 'Q' words, as Plowright calls them, have strangled my own attempts to present research in the past. Prior to the work of Plowright this was actually very difficult to achieve without criticism from some less progressive sectors of the academic community. It was something of a revelation to discover his mixed methods framework and it was a huge factor in arriving at a suitable methodology for this study.

Using the Plowright FraIM has given this research the room it needed to breathe, filling its lungs with the air of the learning environment and capturing the moments that make up the subjective experience of the learning community that this study owes its existence to. Each and every learner in the classrooms within this research group are contributing to a pool of general understanding that may improve the way in which young people interact with their maths for generations.

What is the size and nature of the research group?

The research group consists of around 2000 learners (over 3 years), all of whom are between the ages of 16 and 19 and are sitting their GCSE maths exam for the second or third time. The 2017/2018/ 2019 cohort consist of some learners in their second year with the college and some who have come from secondary school. Those from schools will have a grade 3 (equivalent to a D) or a Functional Skills 1 qualification (achieved post 16) and have been deemed not to have passed a GCSE (grade 4 or above). Learners with less than a grade 3 go straight into Functional Skills and do not comprise this study group.

The vast majority (95%) are studying a vocational subject, the remainder are studying for A' Level qualifications and are required to work towards maths GCSE. Learners have been offered the option to have their anonymous results excluded from this study. None accepted the available choice opt out.

Research methodology and values: A personal perspective

When selecting suitable research methods, it has been necessary to consider my personal values in relation to the largely constructivist, paradigm within which this research is structured. This research is borne out of a belief that in every learner there lays an inherent ability to improve their perception of their ability, give greater depth to their understanding and achieve a sense of personal satisfaction.

I approach this research having witnessed the, sometimes negative, effects that largely instrumental teaching can have on young people.

The positivist notion of the researcher being entirely detached from the research results (Pring 2000 p47) cannot be readily applied to this research. The assertion that positivism is merely "naive realism" is challenged (Pring 2000 p52) as Pring suggests a common truth must exist in order for individuals to perceive it differently. The Descartes/Dewey conflict is a thread which runs throughout this study. Frequent reference is made to the effect brought about by the researcher/practitioner,

Insider research.

The question of the insider research must be addressed at this point. Earlier in this thesis it is already established that this study is not entirely free from bias, as I do harbour a belief that maths can, in some cases, be a pathway to increasing self-esteem and is often the root cause of anxiety in some young people. This study however is aiming to ascertain exactly *how* the programme is having a positive effect on learners and, should that hypothesis be the case, *why* such a simple approach is paying dividends in terms of learner self-perception?

Rather aptly, Blaxter et al use a decidedly Cartesian heading of "Truth, power and values" to frame the following thoughts around research often being less than wholly objective, suggesting it is...

"a social activity powerfully affected by the researcher's own motivation and values. It also takes place within a broader social context, within which politics and power relations influence what research is undertaken, how it is carried out, and whether and how it is reported and acted upon." (Blaxter et al 1996. p14)

Part of my research is designed to question the validity of decision-making being the preserve of, often under-qualified, senior-leadership-teams in Further Education. Asking whether the academic subject specialists in department leads roles and classrooms would be more suited to the role. Partly it is to encourage such subject specialists to take part in their own research and further understand their learners. Partly it is to challenge my own understanding of teaching and learning, in the ever-changing search for the best way to meet the evolving requirements of learners.

The insider/researcher has validity and credibility that may actually exceed that of the purely objective, apathetic observer but this should not preclude the credible researcher being aware of their influence and how to engineer their analysis accordingly.

Again, Blaxter et al summarise this succinctly (1996 p198)

"At the same time as recognizing and asserting your own perspective on your data and anyalsis, it is important not to get too embedded and bound up in this view... stand back for a time and attempt to view your research from the more dispassionate perspective of an outsider"

This is easy to state but can be far harder to achieve. However, crucially, one of the aims of this study is to identify where the Essential 8 programme has exhibited limitations, just as Csíkszentmihályi has detractors (Didau for instance) citing legitimate concerns regarding the optimal experience of flow, our programme is not without such concerns and they are voiced accordingly within this study with the goal of improving our evolving mastery pedagogical approach. As Winston Churchill stated when interviewed (1939) "*Criticism may not be agreeable, but it is necessary. It fulfils the same function as pain in the human body. It calls attention to an unhealthy state of things.*" There is both criticism of the Essential 8 programme as well as that surrounding the stakeholder concepts within this study. Much of maths in FE is in a decidedly unhealthy state which should command attention.

Having established the bias, personal agenda and limitations of this research; transparency may serve as a foundation upon which to build the body of the study.

What exactly is the nature of the data being collected?

The data covers a wide range of different types as the collection period has allowed gathering of in-depth quantitative test results and qualitative feedback from Likert scale surveys, written text response, critical incident analysis and personal interviews.

In addition to this tangible material, the verbal interactions, casual observations and learner comments that have proved pivotal in the development of the Essential 8 programme are considered and analysed with a critical-incidents evaluation.

The following table explains research group approximate size and the nature of their responses.

Data collection tools	cohort size (proposed)	Explanation
Experience survey	400	Learners use a Likert type scale to rate their experience of school and college and their ability in 8 topics
3 words feedback	150	Simple feedback from my own students
Learner feedback survey	400	Learners write freely and submit their experiences
2017 data	400	Learner perceived ability mapped to their actual. Originally presented to EAPRIL conference Finland 2017
Critical incidents	2000 over 3 yrs	Selection of pivotal entries from my personal journal
Personal interviews	Varies	Discussions with groups and individuals regarding the programme
GCSE results issued	400	Grades are correlated to the E8 assessments

The data collection tools used in the research include Online and paper-based surveys, assessment data, written learner feedback, critical incidents journal recording, personal interviews, and GCSE results analysis. In total over 2000 students and 8 classroom practitioners have contributed to this study over a 3-year period.

Ethical considerations.

There is an inevitable concern regarding the Essential 8 programme and the mastery approach that is inescapable; we have changed the balance of a well-established curriculum for thousands of learners. That is not to say that they are being denied an appropriate level of instruction in the topics needed for their courses, but the 8 topics they will see most have been dictated by the programme being researched in this study. It is given greater importance now that other colleges and institutions have adopted our programme.

The Essential 8 programme can be warranted in its approach by the conclusions from the extensive research of Nuthall (2007) and by more contemporary work that focuses on the post-school sectors. A summary of curricula and pedagogy is offered here:

"Young people benefit from engaging approaches to teaching and learning where the pedagogical practices build on their own experiences and aspirations. Approaches to curricula and pedagogy that have proved successful include:

- *Use of collaborative group work*
- *Active contributions from young people to establishing their own curriculum offer*
- *Effective use of informal learning to re-engage students, held in community or outdoor settings*
- *Interactive approaches to using technology that are rooted in the way young people use technology in their everyday lives*
- *Authentic contexts for learning that relate to the world of work, particularly for the students who need support in developing maths and English"*

(Rogers, L 2016 p129)

Whilst evidence seems to indicate that the programme is 'working' (in whatever sense an organisation or individual wishes to interpret that term, most often in terms of exam success) this research sets out to ensure that the mechanics of the programme can be given sound theoretical foundations. This research is being conducted in-part to allow further scrutiny of the Essential 8 mastery programme, identify any immediate or long-term effects it may have on those stakeholders engaged with it and allow the educational community at large to better understand the aims, outcomes and potential benefits of allowing educators to inform practice through research and exploration of their chosen field whilst ensuring that the well-being of the learners entrusted to their stewardship remains at the centre of their research at all times.

This study is not sponsored by any commercial organisation. The college which employs me have kindly made a contribution to academic study costs.

BERAs 2011 "Ethical Guidelines for Educational Research" has been used as a reference for this research paper and the necessary permissions have been sought where appropriate. Whilst this study spans an age group of learners between 16 and 30 years old, every precaution has been taken to avoid any identification of individuals or compromising of privacy. Where artefacts are offered in appendices, necessary precautions have been taken to remove any identifying elements. Names of learners have been changed in order to protect their anonymity.

All numerical and qualitative data have been made anonymous within this study. The original data are stored securely as raw data in the same format, using the same security and electronic applications as stipulated within the policies of each respective college or organisation.

Children and young adults.

Working with young people, especially those whose experience of school had been poor for a variety of reasons, necessitates a clearly defined set of policies to be in place and further education colleges have safeguarding and well-being personnel in post to ensure the policies are adhered to and that all students are able to study free from anxiety or harm.

The research/practitioner has to be even more rigorous when studying the effect of that education may have on young people as there is so much at stake whilst young people are in such a formative state. I vividly remember actions and comments of some of my schoolteachers from over forty years ago; the PE teacher who called me a 'pansy' for not getting muddy enough whilst playing rugby, the maths teacher who warned me that hard work could never be a substitute for innovative risk taking, even mannerisms of my music teacher when she conducted. The detail of what we experience can often outlast the overall experience in our memory. It is in those details, a smile instead of heaped praised, a raised eyebrow as opposed to spoken admonishment; these casual asides may carry far more meaning than public statements in front of peer groups.

Those very same details are the lifeblood of this study as the data are comprised of students who are being asked to reveal their experiences of education, often for the first

time. There is a disclosure element which must be considered whereby if a young person shares something that puts them in danger or involves criminal activity then their right to complete confidentiality must be waived to ensure their safety. It is not uncommon for a young person to disclose personal information when they discover an adult they trust; whilst maintaining their dignity is vital, ensuring their well-being and safety is paramount. Add to this dilemma the typical FE classroom consisting of students ranging between the ages of 15 to 20 and awareness of safeguarding is necessarily further heightened. BERA tackle the issues surrounding the difference between young adults and adolescent teenagers in a practical manner that serves the researcher/practitioner well:

> *"The Association requires researchers to comply with Articles 3 and 12 of the United Nations Convention on the Rights of the Child. Article 3 requires that in all actions concerning children, the best interests of the child must be the primary consideration. Article 12 requires that children who are capable of forming their own views should be granted the right to express their views freely in all matters affecting them, commensurate with their age and maturity. Children should therefore be facilitated to give fully informed consent. The Association considers that the spirit of Articles 3 and 12 above should also apply in research contexts involving young people and vulnerable adults."* BERA (2011 p6).

Elsewhere in the document, the need for parents and guardians to be made aware of research projects in which their wards may be involved with is mentioned, as is the right to withdraw. Parents and guardians are made aware of the Essential 8 core concept curriculum at interview stage and as yet none has seen it as anything other than a practical way for their children to get a grade 4 or 5 in maths. The research itself is always presented in an open and honest fashion. Over 2000 students have contributed to the data over the past three years and only one decided they did not want to complete his past experience survey, sadly they offered no reason for their decision.

The right to withdraw from the Essential 8 programme is mitigated by offering a maths course based on a traditional curriculum as is the desire of one of the part-time lecturers. His approach is less suited to the core concept curriculum and he feels his resources and experience offer students more than could our scheme of work. His cohort are formed

from a selective cross section of the local community and whilst our students are made aware of this opportunity to study outside of the Essential programme and its associated feedback opportunities, none have chosen this option thus far.

There is a critical incident (CIT5 FraiM 12) chosen for this study which refers to a learner named as Callum and the frustration and anxiety he experiences when faced with timed tests (intended to be 'low stakes' regular assessment). The idea for these came from an external maths advisor with little knowledge of maths in FE. Whilst the decision makers in the college viewed this as a harmless trial of a new resource to 'try out' on learners, the effect on Callum was adverse and awkward to witness (see CIT5.) Perhaps the BERA guidelines should be issued to all heads of departments in FE to avoid such incidents occurring...

> *"Researchers must recognize that participants may experience distress or discomfort in the research process and must take all necessary steps to reduce the sense of intrusion and to put them at their ease. They must desist immediately from any actions, ensuing from the research process, that cause emotional or other harm."*   BERA (2011 p6).

Were teachers and managers to recognise that by trying out random classroom strategies to see what the effects were that they are effectively becoming researchers then the guidelines may offer more wide-ranging protection against large quantities of young people being subjected to random activities that have little or no theoretical basis or ethical rigour attached to them. This strengthens the case made by this study which asks all practitioners to recognise their role as researcher to be inextricably linked to their role of educator.

Insider bias.

This research is value-laden by its nature. As a researcher/practitioner it would be poor practice to allow the research to take precedent over the responsibility an educator has to provide a suitably life-enhancing experience to the learner. Any less than this and the educator's integrity is thrown into question. As an insider, the temptation to discover

'what is going on' (Schostak 2002 p19) vies for priority with the main business of teaching and learning.

> *"Researchers must recognize concerns relating to the 'bureaucratic burden' of much research, especially survey research, and must seek to minimize the impact of their research on the normal working and workloads of participants."*
> BERA (2011. P6)

Recognising concerns needs to be balanced with getting to the root of the issue. The research must be carried out with compassion, honesty and openness with not only consent from learners but willing active participation. To achieve this, learners must realise their role in making things better is not merely being paid lip-service but is enabling future generations to benefit from the *"restorying"* (Clandinin, D.J. and Connelly, F.M. 2000) of their experience.

By its nature, this research needs to be conducted in an empathetic manner and largely excludes those learners for whom secondary school and the deployment of formative assessment methods were successful. This can easily skew the insider's view of education as a whole as they are surrounded by individuals who are the result of a system which failed them. Whilst this must be borne in mind, it is important to question whether such a system, the employs norm-referencing to arbitrarily pass or fail an individual (purely on their performance relative to their national peers) should be the system with which the nation perseveres.

Seeing from both sides (those who pass and those who don't) of the scenario is vital to retain balance but should not be an excuse for mediocrity or blind acceptance of a system which favours those for whom a certain pedagogy is successful. Insider bias can be partially mitigated by constantly assessing the research data on 3 levels:

1) The practical benefits to learners in terms of offering an experience of maths that can be construed as a positive success rather than failure. The 10000 workbooks and 27,000 free downloads of 'Essential 8' resources from TES and cooperstutors.com.

123

2) The contribution to the European academic community with research presented to EAPRIL and internationally via the 'Less But Better' paper published in 2020.
3) The opportunity to offer a voice to the millions of UK students who are branded as a failure by being required to attend GCSE maths in FE colleges.

These are positive impacts across a wide range of communities which could be deemed to provide reason enough to accept the insider bias attached to such a study as this, providing such bias is overt and honest. Van Maanen's 'verisimilitude' can be seen at play here, the apparent truth of bias existing having greater value than an arbitrary denial of credibility due to the fact of bias being present.

The effects on educators.

Sadly, some FE colleges, and to a similar extent secondary schools, suffer from a culture of assuming many maths teachers are not 'outstanding' educators. This is partly due to evaluating maths through an annual summative assessment exam whereby 40% will fail. (The effects of normative assessment and grade boundaries are discussed later in this thesis). Therefore, college and school leaders may assume that 40% of teaching is poor.

As a result, quality departments and external agencies are invited to tell teachers how to improve their practice. Most teachers will be reviewed at least annually. Often more frequently more in FE. Asking teachers to abandon their curricula for a core concept model is initially counter intuitive. The idea of learning less more slowly instead of the 'teach more faster' model is an anathema to many educators. This is no one's fault, merely the result of a legacy which has been driven by largely positivist values. "Pace of lesson" is a subjective criterion deployed in OFSTED reports that is completely incongruous with the idea of learning deeply and slowly.

The ethical considerations of asking educators to change to a completely new way of teaching must not be overlooked. Adopting a mastery pedagogy, being 'busier' around a classroom and reducing curricular content are all alterations which require planning and commitment. This programme has never sought to tell teachers how to teach but instead asked them to consider pedagogical practices and resources that may improve

learning, rather than improve teaching. Moreover, it encourages educations to become aware of contemporary academic theories and re-engage with the discussions surrounding how best to help young people to be their own success stories. The binary representation of good vs bad teaching is completely at odds with the complex and evolving education of young people. Unless informed practice helps teaching to evolve it will not keep pace with the natural evolution of learning. From an ethical viewpoint, asking educators to have an open mind and consider that what they may be told is 'outstanding' may actually not be conducive to effective learning, has to be a suitable response to the flawed system the UK currently deploys. If practitioners and decision makers start to question the outstanding 'sacred cow' principles, they have used to teach generations of learners then that discussion may be the catalyst for positive change; a change not measured by outcomes but by successful learner experience.

This study has asked educators to embrace the programme and enhance it for their own needs. In software terms, it is entirely 'open-source'. In Exeter college they re-print the Essential 8 questions onto a large A3 sheet and do them collaboratively. Other establishments use them purely on a one-to-one basis.

The 8 teachers at my college and its sister campus have been instrumental in creating the resources, designing their physical classrooms and changing the attitudes of those stakeholders in GCSE maths to adapt the practices which the programme requires.

It has been too much for some educators and they have been encouraged to pick the elements of the programme they see as beneficial. It cannot be of benefit to learners if it is does not have the unreserved commitment of the teachers. Whilst Dylan Wiliam (2013) puts the failure of AfL down to teachers cherry-picking some elements whilst ignoring others, the Essential 8 positively encourages the practice as it has no dictatorial element contained within it.

My educator colleagues throughout the UK have taken great interest regarding the programme being an element of this thesis and some have modified their own ethos surrounding education as a result of the findings of this study.

No profits have been generated from the book sales and the resources are free to download, In the same manner, no data or information is required to be fed back unless those wishing to have volunteered to do so.

Choosing the research methods

The work of Csíkszentmihályi, particularly the idea of utilising flow learning techniques in education, suggests a research methodology which is partly deductive as there is an assumption that the state of "optimal experience" (Csíkszentmihályi 1998), can be a factor in completing assessments. Similarly, there is an inherent belief that Dewey's multiple realities theory is at play here too.

Shah et al (2006) state that *"research has much to gain by coupling of use of qualitative and quantitative research methods."* Given the size of the survey respondent group (around 400) , the opportunity for such a scale collection of data should not be passed up. Similarly, given that this research is concerned primarily with learner experience, and the effect upon that learner experience; perhaps a quantitative study of qualitative learner perceptions, will prove to be most suitable to trying to understand just how the Essential 8 programme is affecting the experience of the learners and whether their perceptions accurately reflect their ability.

As a comparison, a smaller respondent group (a subset of the entire research population) had been asked to complete timed numeracy tests. This was an 'improving outcomes' initiative from an external advisor. The cross section of the entire respondent group (around 150) were asked to write on the back of their test sheets how the experience of being asked to complete a set of 30, largely simple, numeracy tests, within a strict 5 minute time slot, made them feel about themselves.

These data are collectively analysed to obtain an overall impression of the Essential 8 maths mastery programme. Whilst this research is somewhat deductive, in so far as the programme is believed to offer benefits on a psychological level to the learner, an additional inductive element that arises from Schostak's suggestion that *"What is going on here?"* is a worthy question to ask of this setting (Schostak 2002 p19). It is the complexity of researching the effects on learners that requires consideration of research

methods and paradigms as a metaphorical string bag rather than to a steel cage. The position adopted by Edwards and Talbot resonates here (1999 p6) when they state that the relationship between theory and data rarely is so simple that either a purely deductive or inductive approach may suffice.

Qualitative or quantitative?

Whilst not wishing to denigrate the well-trodden path of initially defining research methods as largely quantitative or qualitative; this study needs to reflect the highly nuanced nature of individual learner perspective. However, depending on respective viewpoints some might claim a 400 respondent cohort to be a study of significant scale, offering up the opportunity to discover connections and correlation between various pertinent variables. Both data types have to be taken into consideration as some of the richest insights into learner perception may come from the reaction of an individual or a comment made in passing whilst exiting a classroom.

There is a large amount of numerical data at hand, but this study does not permit such data to overshadow or diminish the research value of opinions proffered by individual stakeholders in the Essential 8 programme. It must be remembered that it is learner-perception under the microscope here; to continue the analogy, it may be grown in a Petri-dish of numerical data to nurture its growth, but qualitative perception is where the focus is set to.

Case Study or Action Research: Either or both?

Trying to categorise my research methods causes numerous issues. Considering the seven criteria of action research offered by Hart and Bond (1995 pp37-38) many seem pertinent to this study:

It is educative, considers learners as members of social groups, it may be considered as problem focused, context specific and possibly future orientated, there is definitely a change intervention, it is certainly aimed at improvement and involvement, those

involved are participants in the change process, but the key cyclical element of research-action and evaluation is missing.

This study is not entirely longitudinal in that there is no before-and-after miracle being researched. Yes, the Essential 8 has possibly improved outcomes in terms of amount of learners passing, but that could be due to every teacher (there are 8 of us) using a common resource, feeling supported, belonging to a cohesive group and having focus where previously they may not.

In action research, the data obtained is used to inform and alter practice to observe whether a research group modifies its behaviour, accordingly, intervention occurs (Cohen et al 2000 p79). This was not strictly the intended case here and was not the aim of this study, although learner feedback has certainly had an effect upon the evolution of the programme.

In the struggle to define exactly which research approach this study demanded, the descriptions of grounded theory initially seem to go some way to describe this research model; e.g *"the discovery of theory from data systematically obtained from social research"* (Glaser and Strauss 1967). The systematic element of the data from one collection tool dictating the next does not exist here, although the outcomes from one undoubtedly will influence the next.

Whilst it is true that there is a largely inductive element to this research (I want to find out if learner perception is linked to learner performance in terms of the Essential 8 programme) to start to discuss research in relation to grounded theory would be inaccurate. The discrepant cases that need to be identified and subsequent necessary coding of data (Cohen et al 2000 p150) to reach the level of data analysis that grounded theory requires, possibly lies outside the scope of this study.

This research project is not an arbitrary collection of opinions formed into a definitive answer to a research question as Descartes may have favoured. It does not deal with objective statements of fact but rather the somewhat confused and complex interpretations of how young people perceive their learning and their experience.

Reading Arwood and McGough's (2007) efficient description of Ethnographic research certainly offers some parallels with this research, which is unquestionably experiential, interactive and exploratory. They continue in their description *"It morphs easily and often (new questions emerge during research)"*and that *"The boundaries between normal activities and communication and data collection are blurred"*

All of the criteria they mention exist within my research. Whilst ethnographic (or naturalistic as it is sometimes referred) does not favour a prescribed set of data collection tools as might be used in a case study or action research; it allows the essence of different research techniques to exist within a research paradigm without limiting them to prescribed methods.

 Martyn Hammersley comments upon emerging categories of data and *"progressive focusing"* (Hammersley 1993 p41). He seems to tackle the question of how well research techniques dovetail into a research method and it bears some relationship to the comparative nature of my own research tools. He identifies the value in progressive rounds of research which may influence the researcher's decisions in the next piece of research (for instance, perhaps this research can build upon my 2017 research into differences in perceived ability by gender). He also realises that there is a necessity to be practical when considering large scale data collection methods when he opines:

> *"Hunches, third-party suggestions, or pragmatism all play their part in orienting the researcher to one area of pursuit rather than another. Choice indicates control and reflexivity." "Such decision making is not in itself technical or mechanical; it is, rather, specifically tied to the amount, nature and quality of data collected and to the possibilities of data collection in particular settings" (Hammersley 1993 p41)*

Having considered the options open to this study, it appears that the best way to categorise this research method is far from obvious. Perhaps a statement such as Shah et al (2006 p1832) best summarises this decision process:

> *"It is easy not to appreciate the distinction between qualitative techniques for data collection and analysis, and even misuse terms such as 'field research',*

'grounded theory', 'case study research', 'ethnography' and 'qualitative methods' or use the terms interchangeably"

Whist hunting for the most suitable foundation upon which to base this research, it made sense to deploy some reverse engineering to the problem and consider the nature of the techniques available to me as a practicing teacher with access to some 400 potential respondent students. It became clear that the artefacts I had collected over the years of the evolution of the Essential 8 programme had more value than a momentary snapshot piece of mass data collection. Many of these are a result of an unplanned intervention (from an external or internal source), a change in policy or delivery, an unexpected reaction from a student, a set of results or a collection of data of student voices.

When trying to find a way to present these data within a prescribed format, which will be capable of supporting an academic thesis that may serve to make an original contribution to accepted knowledge; Tripp (1993) specifies a pedagogical research approach that will serve the requirements of this study and act as robust structure to present these findings: Critical Incident Technique (CIT).

The rationale of Critical Incident Technique.

CIT was founded as a research method in 1954 by John.C.Flanagan to investigate pilot errors in aviation (Flanagan, J. C. 1954). Since then, it has been deployed in a variety of settings and there appears to be increasing evidence of its use in educational settings. As a member of The Society for Education and Training (an organisation with a refreshingly healthy regard for Further Education), I am heartened to see their article (S.E.T 2018) put CIT firmly into a setting which fits well with this study.

As a side note; beware of the use of the term 'critical incident' when used with reference to some kind of emergency situation occurring as opposed to a research method. Whilst such an occurrence may well become a subject of CIT it should not be confused.

Tripp defines CIT as an *"event or situation which marked a significant turning point or change in the life of a person or an institution".* He considers analysing critical incidents to be:

"an excellent way to develop an increasing understanding and control over professional judgment, and thereby over practice; and they are also a means for finding a focus for classroom action research".(Tripp, D. 1993 p24).

Tripp displays remarkable similarities to Dewey's 1930s views on education and the parallels he draws with the teaching profession in the field of healthcare professionals. For instance, Dewey asserts that the educator must be concerned to *"have a long look ahead"* (Dewey 1938 p75) as opposed to the physician who has to restore health as quickly as possible. Tripp points out that diagnosing one's practice in education is *"immeasurably greater"* (Tripp, D 1993 p30) than in medicine as our students decide upon which symptoms they are going to reveal to us and which they choose to hide. His views are well aligned to this study as it tries to discover the hidden effects of a programme, the effects that underlie performance, attitude, participation and comment. This is a study which needs to read between the lines of data, interpret the language of experience and attempt to overlay some existing theory with processed new data to produce an explanation of what is occurring when we offer young people the chance to become incredibly proficient in areas that had (in their perception) become off-limits or stigmatised.

How can a Critical Incident be identified?

Bearing in mind Tripp's (1993) definition (above) I can approach this study with the benefit of hindsight to some degree and analyse the associated response to form the data of this study. Having had three years of the intense and challenging experience of a programme which has been hailed as a success by some and as a failure by others (depending upon their personal agenda), chronology of the events can be maintained but are not paramount as this is an evaluation of prior events; the close examination of a programme which has been designed for a specific purpose (to raise the quantity of young people passing their maths GCSEs) that has exhibited a secondary effect of raising learner self-esteem and improved learner self-perception beyond the academic rigour of mathematics and positively impacted the lives of some young people.

The critical incidents that spurred reaction and adjustment of the programme sometimes are obvious, such as the uninformed criticism from a senior leader. Perhaps an incident may be the extreme reaction from a student when they were asked to perform an activity that was the opposite of the Essential 8; a timed arithmetic practice question sheet that prompted a learner to become very agitated and express his despair; an act which potentially could have convinced him that even attending lessons was futile.

An example of an internally triggered incident could be the time that one of my students took photos of the 8 posters on her phone, so she didn't have to keep turning around to the back wall to see them. This behaviour created conflict with the organisation – phone use is generally frowned upon and seen as a negative indicator, suggesting poor learner engagement. Clearly this was not the case in the instance and the design of the programme again has to be evaluated. The learner had chosen to use a tool, her phone, to complete the questions more efficiently. Sennett has much to say about tools (Sennett, R. 2009) and Csíkszentmihályi would doubtlessly see the value in my learner creating a scenario where she could concentrate in a self-motivated manner, tackling challenging problems using crafted skills.

This incident puts the programme at odds with college policy however so I must consider my options as a teacher and my options as the curator of the Essential 8 Mastery programme; I could choose to admonish the student for breaking rules but that will damage their learning experience so is not an option. I could forget the rules and put the programme in conflict with college policy, which is reckless. In order to avoid either scenario, it may be prudent to consider the advice offered by SET…

The Society for Education and Training (S.E.T 2018) suggest:

"When analysing a critical incident, it is useful to ask yourself questions such as:

- *Why do I view the situation like that?*
- *What assumptions have I made about the student, colleague, problem or situation?*

- *How else could I interpret the situation?*

- *What other action could I have taken that might have been more helpful?*

- *What will I do if I am faced with a similar situation in the future?"* (S.E.T 2018)

This approach may help to assess the efficacy of our mastery programme and how its evolution has been shaped by the interactions it has provoked from the various stakeholders in the programme.

Another approach to be considered is the 5 part method (Schluter and Chaboyer 2007 p109) which has its origins in the nursing fraternity which...

"uncovers tacit knowledge through assisting participants to describe their thought processes and actions during the event" .

That reference to tacit knowledge (that which is not written, or even verbalised but is implicit within the discourse) is a thread that has run through both my commercial and educational careers for the last 25 years. Tacit knowledge transfer is at the heart of the educator/learner transaction and it cannot do any harm to discover more about the process.

The 5 steps are listed as

- Identify aims
- Identify events
- Collect data
- Data analysis
- Project dissemination

This is a far more functional set of steps but there is another key difference between these two approaches; the former is constructed from questions whereas the latter contains mere directions. The inductive nature of the former is suited to this research as it tries to formulate new theories as they emerge from the CI data as opposed to merely piecing together a series of events leading to an unexpected outcome. That said, investigating why something happened is also key to this study; many of the comments that students make are so intriguing that they need to be examined in order to

understand the question that every educator should perhaps be asking of their classroom; "what is going on here?"

Research opportunities often occur during the day-to-day routine of teaching and learning, and these may be seized upon where an obvious research technique (quantitative correlation, analysing learner feedback etc) may be applied to further enlighten just exactly what the programme is achieving.

Throughout my previous research studies (a first degree, master's in education, extended practitioner research and personal development) I have found the research methods work of Helen Blaxter to offer sound theory and practical guidance and I defer to such (Blaxter et al, 1996) for much of this study.

By the very nature of CIT, the use of different methods is also deployed, both for depth of response and triangulation to assure validity of the data and associated analysis. Particular value is placed upon the narrative nature of the critical incidents used here. Blaxter et al (1996 p77) state how *"the telling anecdote may be more revealing and influential than almost any amount of figures"* gives credence to using a kind of 'reverse-engineering'; using responses to identify key issues and mixing methods to give validity to the research. Validity is less easily established using CIT than some other research methods, but it could be argued that its validity lies in its context, depth and honesty.

It would be easy to dismiss CIT coupled with narrative enquiry, merely as a collection of stories with little or no value to academic research. Only when one views the seminal work of Holt's "How Children Fail" (1963), Nuthall's "Hidden Lives of Learners" (2007) and Boaler's "Elephant in the Classroom" (2010) in terms of the retelling of critical incidents does one realise the sheer potential of the personal narrative within educational research.

Far more eloquently presented, and a quote I find personally inspirational and motivating; the following is taken from a Morwenna Griffiths keynote presentation.

> *"Personal narrative and stories use an epistemology of the unique and the particular. The knowledge that they generate is not the same as knowledge*

that comes from epistemologies of the general and universal. There are no
timeless truths to be uncovered. There are no laws to be formulated.
Contextual knowledge is probably more useful than generalised knowledge
when formulating and carrying out complex educational policy or when
carrying on the complicated business of teaching. For these purposes factual
knowledge is less useful than qualities of understanding and wisdom. Stories
made public and understood within the framework of individual experiences
help cultivate these qualities. They show us other aspects of our world and in
doing so illuminate our own small part of it. They help us question what we
have taken for granted, to broaden our comprehension, and to deepen our
insights." (Griffiths, M 2009)

Griffiths' quote resonates when one looks at the detail of her words: *"the epistemology of the unique and the particular"* and *"there are no timeless truths to be discovered"* signals a deep understanding of Dewey's principles of multiple realities. The idea that it may be possible to study a body of knowledge which exists within the realm of the individual is somewhat revolutionary against the current backdrop of diagnostic testing and differentiated teaching methods, all of which assume an unquestionable truth is to be pursued at all costs. Costs that may be very detrimental to the learner's psychological state and self-perception; costs far greater than those that could be imagined by those people deciding on the pedagogy of post 16 maths education.

 When considering the making of educational policy and the "*complicated business of teaching",* she states, "*factual knowledge is less useful than qualities of understanding and wisdom"*. In those few words is contained the essence of what many believe (Boaler, Drury, Coffield etc) may be wrong with the approach that is currently peddled nationally by head-teachers as they clamour to improve their school league table position and secure future intakes. The instrumental nature that still exists today, despite the protestations of Dewey some 80 years ago, Holt 50 years ago and their modern-day contemporaries, is a clear indicator that the current system of 'teach more, teach faster' may be the reason that the sizeable proportion of post 16 learners leaving without GCSEs in maths are completed disillusioned with the subject.

Individuals' stories, used as data within a CIT methodology, can help to build a body of knowledge which can then be used to identify why secondary schools are so entrenched in a system which favours the school, not the learner and what may be done to change such an inequitable education system. If no evidence exists, a call for change cannot be justified.

This study sets about collecting the artefacts, learner-voice, feedback and narrative to build a body of evidence than can be offered as a rationale with which to shape the way in which post-16 learners, often deluded, despairing and dejected, are offered an education which nurtures their self-perception and allows them to experience success in subjects where they have only ever known failure and derision.

As Griffiths puts it (above), the items that constitute the data of this research may; "*help us question what we have taken for granted, to broaden our comprehension, and to deepen our insights."* If a study such as this can fulfil the merest hint of that criteria, then this study would achieve the aims it set out to. Neither the breadth of our comprehension nor the depth of our insights as educators can be easily measured but we may see its improvement reflected in the actions, attitudes and attainment of our learners. As teacher/researchers, it could be argued that we owe a duty-of-care to our learners to examine research data and design study programmes aligned to their findings. If our mastery approach and Essential 8 programme can be aligned to sound theoretical foundations, then our programme and research may indeed be appraised as heading toward fulfilling the criteria of improved comprehension and insight.

Much of Griffiths' keynote address refers back to the work of Joseph Dunne, as it securely bridges the divide between philosophy and pedagogy. His book 'Back to the rough Ground' (Dunne, J., & MacIntyre, A. 1997) is enlightening with regards to learner self-perception and presents a set of parallels to much that is emerging from the Essential 8 programme.

The critical incidents within the Essential 8 programme.

The critical incidents have all been pivotal moments in the evolution of the programme so far. It must be noted that the incident may not have necessarily seemed that critical

when it happened, on occasion it is only with the benefit of hindsight that the importance of an event becomes clear. A seemingly innocuous comment can transpire to be momentous when seen in the context of change it catalysed.

Each incident is presented within Plowright's framework (2011), crucially examining the experience of the stakeholders involved. Unlike the aims of many research papers, there is less than a total attempt made at impartiality or objectiveness within this analysis. Each incident is seen through the eyes and the feelings of those involved. If appraisal of many individual experiences of the same event can be seen as objectiveness then so be it but there are no claims to such being made here; merely the reactions, or more accurately 'interactions' of those people who enabled the incident to occur.

Metaphorically, expert witnesses (perhaps Dewey, Cziksentmihalyi, Drury, Boaler etc) are asked into the dock to give their opinion on the evidence they have heard. Whilst this is purely to serve as a metaphor, it hopefully gives structure to each critical incident and increases the investigative flavour of this study.

Quantitative data techniques

Where quantitative data was collected (as for the 2017 EAPRIL conference research) (Appendix 6) it should be made clear that the nature of the collection and correlation to qualitative Likert scale responses was undertaken with around 400 learners, all of whom had had around 7 months exposure to the Essential 8 programme.

The Essential 8 questions were posed in two multiple choice tests, built in Google Forms (see appendix 4). Students received no immediate feedback on their individual answers to questions as this may have skewed their qualitative responses.

Qualitative responses quantified

The Likert scale responses were uniform in their construction, each having a range between strongly disagree, through neither agree nor disagree to strongly agree on a 5 box range. The accompanying statement was simply "I consider myself to be able to answer questions about ... (the relevant topic). This conversion of qualitative data into quantitative is a method I have deployed previously researching gender differences

within flow learning in secondary maths. It has proved to be a suitably robust method of low time-impact to learners (an online survey built in Google Forms is very quick to complete) and suited to a variety of electronic devices.

Converting qualitative to quantitative.

The conversion from Google forms spreadsheet to Excel is a simple and quick process. A two tailed Pearson correlation (due to there being no expected positive or negative correlation necessarily) was performed using simple Excel functions. Results are presented graphically to aid instant interpretation of the results (Appendix 5).

Purely qualitative responses

As part of my everyday teaching I regularly issue slips of paper with "tell me one thing that is good about our lessons" and "one thing we could do better". This learner voice is as important to me as it is to my students. Anonymity is welcomed but some learners choose to waive this right, the main thing is that they see their suggestions being put into practice and see the effect they are having on their education experience. This encouragement to widen their sphere of influence sits comfortably with Dewey's concept of interaction changing the external scenario rather than merely being a reactive process.

Experience and narrative inquiry.

> *"narrative inquiry is a way, the best way we believe, to think about experience"*
> (Connelly and Clandinin 2000, p80).

Connelly and Clandinin (1990, p2) stated that narrative inquiry is increasingly used in educational experience and note its long history both in and out of education. Clandinin (2016) suggests that it's not enough for researchers to highlight the phenomenon of experience but also to have an interest in the process of narrative inquiry as a research method; *"All researchers, despite ontological and epistemological assumptions, share a view of research as searching again, a search for deeper understandings of particular phenomenon."*

Using the distinction of phenomenon as being the *story* and the inquiry into that story as the *narrative*, the narrative researcher describes the learning experiences of the group being studied and writes narratives of those individual's experience.

Berk (1980) is cited by Connelly and Clandinin (1990, p3) as the question shifts from *"what does it mean to educate a person?"* to *"how are people educated in general?"*. This elicits stories from students and educators rather than the former question which takes no account of experience, merely considering a philosophical point.

Those stories become the data for the narrative enquirer, thus forming the methodology for the study itself. Moving from 'what is education?' to 'how are people educated?' allows a critical review of mastery pedagogy to take place, as the pedagogy is the 'how' in the question.

As narratives emerge (not just stories but stories that have been enquired into), they can be translated into metaphors for teaching-learning relationships. Recalling Dewey's tenet of pragmatism, students are not reacting *to* education; they are interacting *with* their education. Those metaphors can be used to adjust pedagogy to be the most effective it can be in a given setting.

So narrative inquiry is established as qualitative data in the pragmatism tradition. Connelly and Clandinin (1990, p3) cite as follows:

> *"Eisner's (1988) review of the education study of experience implicitly aligns narrative with qualitatively oriented educational researchers working with experiential philosophy..."*

They go on to consider the relationship between researcher and their respondent group and consider that the collaborative nature of narrative inquiry allows the researcher, practitioner and participant to see themselves as part of research community, having value for both theory and practice.

Hogan (1988) talks in terms of empowering relationships that are caring and have mutual purpose. She also talks of equality for stakeholders in the process. Noddings (1986) notes how unfamiliar this very considerate language has become in educational

research. As this study continues its investigation into a pedagogy that takes experience seriously, narrative inquiry in a collaborative setting, provides a solid foundation from which to collate and analyse the research data.

If narrative inquiry is further distilled, the concept of voice can be broached. Not purely in the audible sense but in the sense as proposed by Britzman (1991)

"Voice suggests relationships: the individual's relationship to the meaning of her/his experience and hence, to language, and the individual's relationship to the other [as in other people], since understanding is a social process."(Britzman, D 1991 p44)

The researcher must listen to the voices recounting experiences, so those voices are granted the time and space, so their stories attain the same high level of *"authority and validity"* (Connelly and Clandinin 1990, p3) that the entire research story has.

It is vital to remember that a narrative enquirer cannot realistically expect to have no effect upon the research being undertaken, even more so for the insider researcher. Rather than accepting this as a negative consequence of practitioner research, it can be viewed as a positive autobiographical account which adds authenticity as teachers tell their stories in a very focussed way.

Connelly and Clandinin (2005, p5) use the term *'active recording'*. This is where the researcher's participation in the events which will go on to form the phenomenon of the narrative enquiry actually allows emphasis, surprise, even revelation; to be entered into the account and finally become the qualitative data that shapes the outcomes of this study.

The accounts of John Holt in 'How Children Fail' (1963) and more latterly, Jo Boaler (The Elelphant in the Classroom 2005), use this to good effect. The use of their accounts as metaphors for occurrences in teaching-learning encounters can be used as a reference to identify patterns of success, failure, response and interaction in such circumstances. 'Active recording' lets educators and learners realise they are not alone, not struggling where others haven't before them and investigate ways to improve their

situation. Building accounts for others to base further research upon has inherent validity.

Returning to Dewey's account of experience, it may be claimed that a person needs to experience an event for that event to have true relevance. That does not mean that we need to live other's lives vicariously but the accounts others offer may be used to frame a situation, to give it a position in theoretical landscape.

Van Maanen (1998) talks of the importance of apparency and verisimilitude, both concerned with the way in which a narrative inquiry takes on the appearance of that which is authentic, truthful and real. He values these criteria above reliability and validity. Again, Dewey's multiple truths concept can be drawn upon when considering how true something appears to the reader. No universal truth is sought but a general impression of honesty and truthfulness can allow an account to have increased resonance and impact.

Additionally, a word of caution arises when looking at the causality of narrative inquiry and inventing links between what had happened in the past to what is happening in the present and hence what will happen in the future. Rarely are such correlations so simply explained away and the temptation to impose cause and effect where none may actually exist should be guarded against, or at least borne in mind. Similarly, Connelly and Clandinin (2005, p10) highlight the danger of the *"Hollywood plot"* scenario developing where everything *"works out well in the end"*. Here is another point where narrative inquiry aligns with Dewey's multiple realities as the researcher is asked to contemplate the idea of multiple "*I's*" whereby the critical-self must be separated from the researcher-self and the practitioner self.

 In their summary, Connelly and Clandinin (2005, p12) discuss how the researcher becomes the gentle narrative enquirer, re-storying the accounts they collect in 'active recording' of experiences and how that research becomes one of *"learning to tell and live a new mutually constructed account of inquiry in teaching and learning"*.

From the outset, Connelly and Clandinin (2000 p2) state that their work is strongly influenced by Dewey, claiming that his writing on experience form their conceptual

backdrop. They go on to discuss how Dewey's criterion of continuity, where one experience will give rise to and influence others, forms the continuum that learners experience as they participate in an imagined past, present and future. Not imagined in the sense of delusion but in the sense of individual experience differing from that of others when considering the same event. Importantly, they consider the educational experience of a learner in context; the context brought about by policy, learning environment, teacher or another factor. In short, the history which shapes a learner's present and future. The social setting must be considered with equal importance as the nature of the individual; an interdependent relationship which can be enhanced by empathy from an informed position or degraded with dictatorial prescribed ignorance.

Connelly and Clandinin were instrumental in the modernisation of Bloom's taxonomy (1943) and discuss how it sits at loggerheads with the quantitative obsessed Thorndike (1911 p22). The fabled taxonomy is not recounted here for fear of drawing attention away from this study's research tenet of pragmatism-based experience, but the intelligence of the hierarchical model outweighs Thorndike's measurement-based theories as it resonates with the mastery concept of collective progress in a contextualised setting as Further Education may be considered by a study such as this.

Justification is a constantly recurring theme when considering a holistic, experience-based research approach and the temptation to lapse into apologetic explanations for every research decision taken herein is never far away. Perhaps it is because of proponents of the likes of Thorndike that researchers seek to find the ultimate truth (to coin a phrase of Descartes) of effective education; to offer up the magic bullet (or magic black box) which will cure all educational ills and undo years of poorly conceived policies. FE leaders often have been in the sector many years. In 1999/2000, there were 136,750 teachers in the FE sector: of these, 3127 had no formal qualifications; 19,676 possessed no teaching qualification; and the status of a further 40,525 was not known (Harkin et al. 2003). It is possible that some of today's leaders had no teacher training. Their ethos may well be borne from ticking the boxes of external observers.

 Unfortunately, the easily digested instrumental approach, coupled with increasing demands for evidence-based data from OFSTED, appeals to those who lack foresight

and empathy. If practitioner research is to carry on gaining momentum and credibility, justification has to change from the defensive to the assertive.

Of course, there is no need to apologise for using research to improve the educational experience of young people, this should be coupled with a belief that if something is not making education better, it's more than likely making it worse. To try and detach oneself as a passionate practitioner/researcher from the research is therefore futile. Connelly and Clandinin touch upon this (2000 p121) and cite Schwab (1960) when he used the term *fluid enquiry* to describe a way of thinking that has no real structure based in academic theory, methodology or strategy and go on to describe their struggle with their pursuit of narrative-enquiry based research. They go on to perfectly describe where this research study is rooted and how it considers the social setting of mastery pedagogy and the rich, tacit knowledge transfer that can occur when practitioners and researchers are aware of themselves positioned within the research landscape they are depicting. Somewhat like Botticelli's 15th Century masterpiece, "Adoration of the Magi" (Appendix 8) where he includes himself looking outward in the crowd depicted; when we become part of the study, we see it from the most varied and complete perspective; in its social context.

The concern of the inclusion of myself in this diminishes somewhat as the reviewed literature on education research emerges to give permission to practitioner researchers to think, write and comment in the first person. It is an empowering and authentic tool which can evoke more response than may otherwise be the case.

> *We need to be prepared to write "I" as we make the transition from field texts to research texts. As we write "I," we need to convey a sense of social significance. We need to make sure that when we say "I" we know that "I" is connecting with "they".* (Connelly and Clandinin 2000 p122 -123)

This connection maybe why 'telling the stories' can produce research that equates to more than the sum of its parts. It can give Van Maanen's 'verisimilitude' (1988) to the study to present a believable and credible account of the landscape in which a narrative research-based study resides. Writing in the first-person allows a degree of authenticity

that may otherwise be lacking. The actor Tom Hanks recently published a book of 17 short stories (titled Uncommon Type: Some Stories), each written on a different typewriter, he explains how the action of stabbing at a key leaves a different imprint to one which is slowly pressed into the ribbon and page. It conveys emotion and gives something of the writer to the reader. Action being inextricable from thinking – one and the same. That can easily be lost in the technological age.

Whilst we consider transition from notes in the field to research notes outside the classroom and the way in which a researcher must move between the roles of observer to recorder, the job of the researcher/practitioner means that sometimes detachment has to be considered in the interests of impartiality. Obviously, I want my students to have an enhanced experience in our classrooms, but I also need to be critically objective of the mastery pedagogy we have introduced.

In closing their chapter *"Being in the Field"* (2000, p79) Connelly and Clandinin warn of over emphasising the value placed upon a single phrase or stories of seemingly huge pertinence. All too often my students say to me *"I have learnt more today, in one lesson, than I ever did at the entire time at school"*. I thank students for their kind words and to an external observer this may be an exciting 'Eureka' moment, but I hear it a lot. A truly golden moment for me is when a student comes to me and says *"I remember what you taught me last week"*. Sadly, this happens far less frequently.

The point I am trying to convey here is that narrative enquiry has to be seen in context as well as being objective in its execution. This is partly why CIT can be used to good effect when deployed as a research tool by researcher/practitioners, however. If I spot a reluctant student drawing pictures to solve a maths problem (I encourage them to sketch the "red, green and blue sweets" that are being picked from a bag in an exam question for example) that may be a huge breakthrough for that particular learner. That same student may appear to be idly doodling to an external observer with little FE maths experience and that huge breakthrough may go unnoticed. Whilst narrative inquiry initially suggests research through stories; verbal interactions, Connelly and Clandinin put the record straight when they state...

"The narrative inquirer may note stories but more often records actions, doings, and happenings, all of which are narrative expressions. This is the stuff of narrative inquiry for the researcher in for the long haul and concerned with intimacy. " (2000 p79).

That intimacy is the relationship which is formed, not necessarily between the individual and the inquirer but between the overall study case and the inquirer. Connelly and Clandinin (2000, p50) propose a '3 dimensional inquiry space' in which narrative inquiry should take place:

- the personal interaction dimension,
- the continuity of past, present and future,
- the situation or notion of place.

Reference this to the college where my research is conducted: I know my college well. I have worked there for 6 years in the same job and it is the most rewarding teaching position I have ever held. I am protective of Further Education and by far the greatest passion for my job comes from the young people with whom I interact. I have an overwhelming sense of time with my students and I know why they are there; their previous experience of maths was not up to scratch – it let them down. This study must distil those experiences into a meaningful account. It must be *useful*.

The CIT methods and artefact analysis of this study necessitate the incidents to represent the very essence of the failure my learners have experienced. Remember, this study is looking at how that cycle of failure might be broken, turned around and become a positive experience so that it might become less socially unacceptable to admit to actually enjoying maths lessons in the future.

Choosing incidents cannot be entered into lightly. Having kept records, artefacts and journals for the last 4 years allows a myriad of data to be considered. The more recent is favoured due to a personal belief in the evolution of learning and the rapidly changing political setting in which FE exists. Just as Flannagan's origins of CIT examine series of small events leading to a catastrophic air-crash, many pivotal moments which I wish to

address are subtle and easily missed by a researcher (as might be the learner using drawing to solve a problem mentioned earlier). The incidents must have value, have Van Mannnen's 'verisimilitude' (1998) about them and, above all, form an experience which may be used to change future experiences for the better. Justification of warranted study cases around which a critical incident may be construed is imperative.

Establishing a warranted study case.

Connelly and Clandinin (2000 p50) devote a chapter to discussing how to select a study case may serve as a suitable subject for narrative inquiry. This study adopts a Critical Incident Techniques (CIT) approach which is used to establish interviews where cases are deemed as pivotal to uncovering the relationship between learner experience and learner-perceived success.

By ensuring the three-dimensional inquiry space (Connelly and Clandinin 2000 p50) is adhered to, (the social, temporal and personal interaction) a genuine narrative may be constructed and aligned with the CIT methods used to construct a telling snapshot so that a story may be re-told with accuracy, empathy and perspicacity; enabling analysis which may be of value to a wider audience within the education community.

The underlying message surrounding narrative inquiry is the fact that my awareness as researcher is that I have an undeniable role within the relationship, time and place of the narrative of experience which I am constructing. As Connelly and Clandinin state (2000, p81) of their own experience of narrative enquiry...

> *"We are in the parade we presume to study."*

Justifying a mixed methods approach to research.

Mixed methods approaches to research can be seen as an indecisive solution to tackling a question or even a 'kitchen sink' tactic where everything is thrown at a topic in the hope that something works. This view is less prevalent today however than it was (as was implied during criticism of my MA experience some 7 years ago). Through personal discussion with academics and researchers, it transpires that mixed methods

may not now be held in such low esteem and many have come to see it as a more holistic approach that may have more relevance and honesty than some more prescribed quantitative methods.

During my many conversations with researchers from different fields of practice, the work of David Plowright kept cropping up. Rather than merely inform or guide, his work is very practical and challenges some of the less flexible opinions that some may hold regarding research methods. It has been highly valuable as method of organising my data and it may be useful to conclude this chapter with a brief discussion of his process and rationale.

Plowright

Plowright (2011) tackles the question of mixed methods head-on and describes a very clear model where qualitative and quantitative data may be analysed depending upon the context of the setting. He asserts that numerical data can be examined and described using narrative techniques. Conversely, data gathered from surveys, interviews and experience may be investigated by quantifying the data and then performing traditional quantitative analysis.

This aligns well with the Likert style scale (reworded by students) in the surveys used in this study as they form the basis for the further rounds of research to increase the focus down to a specific point. Moreover, Plowright goes on to suggest a highly detailed framework which may be deployed to tackle mixed methods approach. This Framework for an Integrated Methodology (he dubs this FraIM) allows access to a very clear model around which to structure the data.

Given the wide range of survey, critical incident, numerical and artefact data this study is considering, such a framework provides a highly organised set of criteria to allow data to be categorised and examined methodically, rather than becoming overwhelmed by the sheer diverse range of information collected. This also means that consumers of the research might discover the specific data analysis which coincides with their own area of interest more readily.

Central to Plowright's 'FraIM' concept is a practical diagram which is presented below: (Fig 4.)
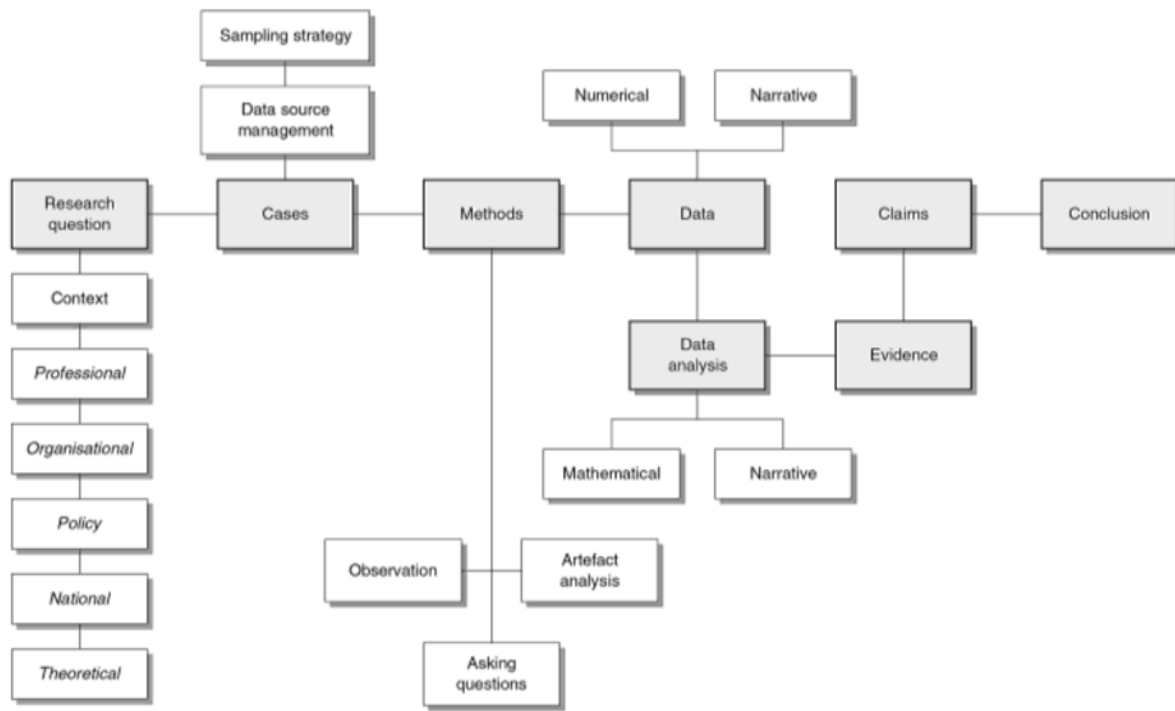
Fig 4. (Plowright 2011)

Under the 'methods' section lies the three data collecting tools that are of most interest in the context of this study: observation, artefact analysis and asking questions. This approach is a departure from the orthodox practice of defining data as qualitative or quantitative, analysing data accordingly and presenting findings.

Plowright asks us to consider the rejection of a traditional dichotomy and to embrace the use of frameworks and eschew the 'Q words' (2011 p3) of quantitative and qualitative. He pins the emergence of mixed methods to around 2007. I personally find this of great interest as the master's degree research I was carrying out around that time was certainly difficult to couch in traditional methodology terms and there was considerable reluctance to accept the mixed methods strategy I was attempting to deploy then by those directing my study. Given the more widespread credibility of a mixed methods approach in 2018, Plowright's frameworks have further appeal as the Critical Incident

Technique (Tripp 2007) I use for collecting some narrative data sits neatly within Plowright's 18-point 3D model illustrated below.

THE FRAIM: FRAMEWORKS FOR AN INTEGRATED METHODOLOGY
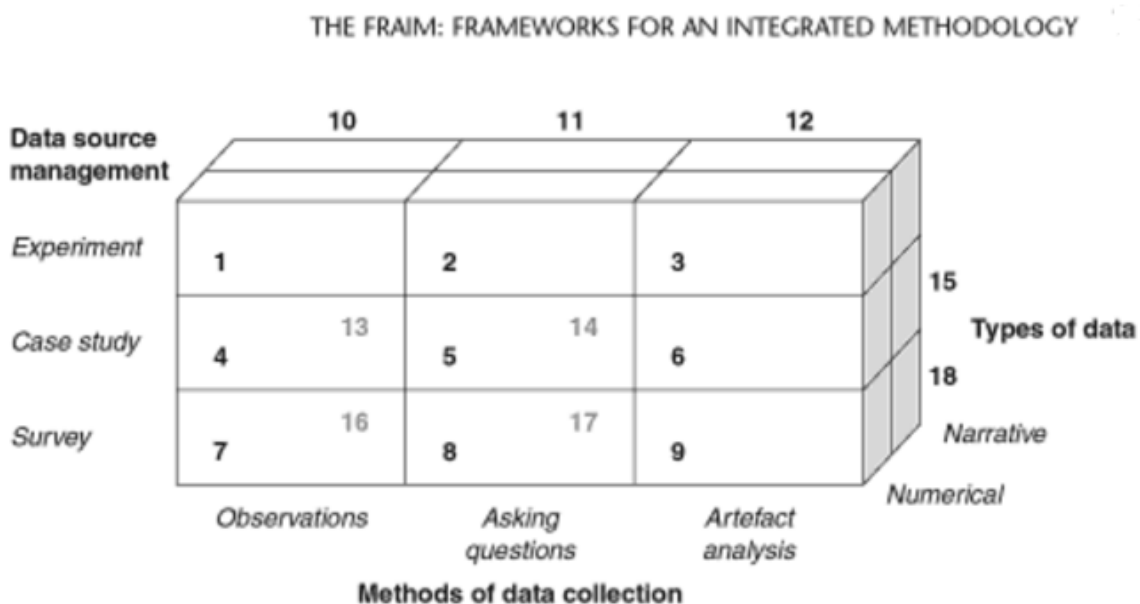
Simple three-dimensional model of an integrated approach to designing research

Fig 5.

Note the numerical data in the front row with the narrative data stacked behind it. From this the nature of each enquiry method is freed from an inherent qualitative/quantitative classification. Observations could be numerical or narrative in nature. Perhaps counting how many learners in a class readily use a whiteboard or listening in to conversations when students are discussing a maths problem. This frees the experience being observed from classification and allows for a more natural, honest and apparently real dataset which resonates with the 'verisimilitude' (Van Maanen 1998) which has emerged as a watchword for the research ethos of this study.

Plowright goes on to further tackle some of the issues that can be encountered when wrestling with matching research methods to research question. If research is truly to be progressive, simply re-hashing a well-used process may limit the evolution of research in a particular area. Given the previously mentioned lack of research in the field of post-16 compulsory Maths, the opportunity to present a contemporary study which uses

149

methodology to shape the philosophy of the research itself should not be passed up. Indeed, Plowright actively encourages this idea of methodology dictating the philosophical nature of the study later in his book (Plowright 2011 p190).

There is a holistic integration in Plowright's approach to research which seems to synergise with the intention of this study as it tries to make sense of a complex and subtle set of changes which are occurring as a mastery pedagogy starts to become embedded in the processes of teaching and learning (two processes which appear to be merging into one as this study continues). These changes are emerging through a slow evolution over a number of months and they are naturally occurring. Again, Plowright seems to capture this essence when he coins the term "ecological validity" (Plowright 2011 p30) to describe an environment where the act of observation is having minimal impact on the everyday social activities underway. The retrospective nature of CIT lends itself appropriately to this concept as the ebb and flow of learning, forgetting, re-learning, remembering and ultimately succeeding occurs with the hundreds of young people under the research spotlight of this study. The 'forgetting curve' (Ebbinghaus, H 1913) is a useful graphical representation that lies at the heart of Dweck's growth mindset theory. (Dweck, C. 2006)

Using the 'frameworks for integrated methodologies' (illustrated above) to collect, organise, analyse and conclude the data available makes for a sound structure which may be employed to formalise this handling of the mixed data, lending credence and credibility to this study.

Relevance to the collection instruments used in this study.

Given that such a well-developed, comprehensive yet accessible model exists, designing a data collection tool around Plowright's FraIM concept seems entirely justified.

In particular, the 'methods' branch of the model (Fig 6) seems almost naive in its simplicity and yet it simply is the essence of this study.

Fig. 6

This is the core of the methods I have used to develop my entire data collection strategy. Observing, questioning and analysing the artefacts (which may be either tangible or intangible in nature) is the distillation of this research.

Consequently, a re-evaluation of data collection tools appeared to be prudent, given my desire to avoid reinventing the wheel when such a well-rounded one as Plowright's already exists.

Whilst my mass questionnaire asks questions regarding feelings and emotions surrounding perception; anyone with a critical eye should see a potential flaw in this being the only mass survey as it is (quite rightly) open to the vagaries of individual levels of current satisfaction, it has no retrospective element, it may be skewed by the confidence learners are gaining from the mastery pedagogy and therefore lacking any chronological comparison. It is also asking learners to rate their confidence (essentially, an estimation) against an arbitrary value from an assessment. It has validity within is relative scale (e.g., "I think I am good at a topic" may naturally be positively correlated to '9 out of 10' in a test) yet it still essentially may suffer from quantifying emotional response, as is the way of Likert responses.

What then, if an approach to match Plowright's model is also employed to provide some triangulation?

Here then is the opportunity to simplify the question being asked without the potentially rogue element of real-time emotion. Students are asked to rate their *previous* experience at secondary school as excellent, good, bad terrible or indifferent which are

then correlated against actual performance and a simple comparison of correlation between experience to performance is made. (Appendix 12)

To recap, Plowright's bold move to reject the 'Q words' frees the study to start to tackle *experience* in its truest form ensure the constrictive bounds of qualitative and quantitative do not cloud what is actually happening.

Neatly, the survey questions, observations and analysis forms the bottom layer of Plowright's FraIM note there is little narrative data to be gained from the surveys but that is as expected. The middle layer can then be tackled using CIT to populate the 'case study' layer.

Asking those survey questions also allows for the observation of students engaging in mastery pedagogy activities (such as the Essential 8) to take place from an informed position as analysis of the artefacts of learning begin to emerge. If the 'moving forward together' phenomena is seen then perhaps Dewey's 'conjoined community' may be said to be in evidence.

Here the Critical Incidents (CIs) can be analysed by the 'expert witnesses' of Dewey, Sennet, Drury etc, each being selected for their personal expertise, as their work is used to look at what exactly the CIs are revealing. Almost like an incident-autopsy; this is deconstructing the responses of an individual or the details of an event in order to increase the insight that can be had into the workings of mastery pedagogy.

And so, the case-study layer is populated, possibly with more evidence and analysis than questions, but the numerical data here is conspicuous by its absence. However, the lower survey layer provided a surfeit of crunchable numbers, so this should not be seen as an issue.

As for the top 'Experiment' layer, jettisoning an established differentiating pedagogy for one of mastery has to be seen as a huge experiment in itself. The analysis provides equal weighting, the numerical from assessment data and the narrative from the feedback and student voice received from the many sources identified within this study.

Plowright offers a model not only to collate and store data but one which goes some way to move the highly conceptual business of understanding data analysis to almost physical proportions. It gives structure and purpose to the evidence collected and allows this study to get the most from the data in the most practical way possible whilst increasing the accessibility to any party with an interest in the experience of young people in Further Education.

In summary, two very different surveys are used to establish an overall picture of the landscape in which our learners' self-perceptions lie. Both have been tested on a separate 20 student pilot group prior to rolling out to the entire 400 learner cohort.

CIT is used to populate the case study elements of the FraIM middle layer and the experimental nature of the model is covered by in depth interviews with a small respondent group, the numerical data being served comprehensively by the mid-term mock exam results.

Artefacts are examined to offer detail to the landscape portrayed by the survey data which are intended to reveal the potential of a mastery pedagogy from very personal, human perspectives. It is in the detail of the data that the evidence for personal growth resides.

There is a danger with Plowright's mixed method framework that data is slotted in to the programme as an afterthought or somehow twisted to ensure it fits into his classifications but there are few other approaches that offer such a comprehensive solution to getting the balance of numerical and narrative data suitably presented. Whilst it is not a perfect system and can tempt a researcher into collecting data merely for the sake of filling a frame, it does help to organise the researcher's mind and present the data in an ordered fashion.

Put simply, Plowright's mixed method approach allows research to throw off the labels and consequent missed opportunities in progressive research which are the result of the qualitative/quantitative dilemma faced by many researchers. The FraIM model gives permission for a study to present true findings from contextually appropriate data

153

collection methods which together form a dataset which may be analysed to produce a contribution to the field of maths in Further Education.

The following chapter presents the data and allocates their place within the mixed method framework used for this study.

SUMMARY

This chapter has described the pros and cons of the main research methods that may be employed by a researcher then evaluated them within the context of this study. The impotance of examining the loci of the researcher/practitioner is discussed as it is argued that this should have a significant bearing on the research methods chosen as the methods will inevitabley lead to conclusions that must address the main questions the study sets out to answer. The ethical considerations when working with young people in education are presented in order that the methods are suitable for such a research cohort.

It is argued that a symbiosis should be established between the instruments used to collect data, the methods deployed and the questions to be answered. Such a relationship demands that the researcher should perhaps be bold in method choice and actively seek to use methods that may not always be readily prescribed.

The evolution of opinion regarding a mixed methods approach is appraised and it is suggested that the use of mixed methods is now seen in a more favorable light than may have been previously been the case,

Because so much of the data is derived from 'light bulb' moments noted in a journal, the use of Critical Incident is employed in order that the retrospective 'unpicking' of events leading to such revelationary occurrences may be fully documented an explored.

Plowright's FRaiM is used to ensure that the data has structure and resilience in the face of academic scrutiny. Plowright is further cited to warrant the concept of eschewing the traditional tensions regarding qualitative versus quantitative data. The use of a narrative enquiry based approach sits well with the pragmatism of Dewey as the experiences of learners are examined to give depth and context to the overall study.

Chapter 4: Analysis of the data.

This chapter is concerned with picking apart the contents of the data to try to frame the results in a context which can be use to break the failure cycle experienced by many learners. The numerical and then the less concrete student responses are examined in order to populate the mixed method framework offered by Plowright and to answer the frequently asked question of "what is going on?" in and out of the classroom.

Cognitive Load Theory is introduced which may be an underlying factor worthy of consideration as is the linked idea of teaching less for a deeper learning experience.

Links are made to Dewey's ideas surrounding collateral learning along with Dweck's mindset observations and the concept of 'collateral growth' is proposed as an emerging theory.

The very nature of dealing with numerical and narrative data is discussed in order to fully appreciate the holistic nature of the mixed methods approach taken by this study.

Some critical incidents are briefly discussed before the responses from the questionnaires are disseminated into relevant conclusions.

This chapter may be of particular interest to those wishing to see the detailed feedback from the respondent group and how it is interpreted.

What is the impact of a mastery approach to teaching maths on Further Education re-sit students?
What is the current experience of learners and teachers of experience of learning/teaching maths?
What impact does a mastery method of teaching maths have upon learners' experience and achievement in maths?
What are the wider impacts on learners of adopting a mastery approach to teaching mastery maths?
What are the challenges and limits of adopting a mastery approach to maths?

In considering the analysis of the data from this research it is prudent to recall the main questions (left) from the introduction and use them as a reference throughout this chapter.

Drawing out the big themes of this study is the main purpose of this chapter. Merely analysing the data for the sake of good order does nothing more than justify the collection of the data in the first place. Referring back to the research questions,

the main consideration emerging are impact on learner experience, change in learner perception and the vicarious effects of collateral growth.

Rather than consider the data analysis in purely localised terms, the findings are placed in the contextual setting of the FE sector, the students' and teachers' lives, the classroom and the wider influencers of government, exam boards and society in general.

The findings should not be viewed in isolation and must accept the vagaries of nuanced changes that occur when a team of teachers and students embark upon a joint pedagogical adventure with a common purpose and shared desire to improve the teaching and learning with which they are involved.

In the same way that at the early stages of the Essential 8 programme, a friendly academic suggested that the content of the 8 topics was irrelevant, it was the accessibility to success that it offered that would make the difference, it may well be true of any pedagogical programme which has momentum, commitment and a shared vision to design and construct an approach to teaching and learning that has the genuine well-being of its participants at its heart.

The stories of entire cohorts getting amazing marks in GCSEs often appear in the press (e.g Wales Online 2019) but there seems to be no 'magic bullet' that evolves from the stories to enable a quantum leap in the maths ability of a nation. Instead it appears that if enough drive, enthusiasm and commitment is ploughed into a teaching and learning community that amazing things can happen given the right mix of elements. Sustaining such success is another matter, however. Were there truly a system that meant every student in a class would get an A* then there would be no need to consider a pedagogy other than the one that works for everyone. Obviously no such approach exists as the truth behind most wonderful success stories is that certain students have been selected to form the cohort in the first place and the setting made so intolerable to those whose proclivities lie outside of the regime that they choose another learning environment in which to study.

The results in this chapter are the data obtained from a 'warts and all' set of learners. There is little or no specialist academic FE provision (unlike the secondary sector) for those leaving schools students with behavioural issues, extreme anxiety or conditions surrounding mental health. Many of the students I teach come from the 'special education' sector and I am fortunate enough to work with their teachers prior to their joining on occasion. This is why research in the FE sector and the approaches used in the FE classroom must be crafted in a different mould to that of other mainstream educational sectors. The claims of 6th form colleges regarding their FE provision must also be tempered with a contextual reality because of their selection process which weeds out any student who stands a chance of not passing their exams, passing them on to FE colleges in the process. The UK advice site 'Get the Right School' states most 6th form colleges *"look for a minimum of five GCSE exam results varying in grade from A* to C"* (Claridge. J 2021).

 This distinction is critical and further reference is made later in this chapter to the confusion of some external charities and educational stakeholders when assuming that there are lessons to be learned in FE from 6th form practice and vice versa. The two sectors are at the extreme ends of the learner spectrum – not necessarily in terms of ability or intelligence but in terms of the situation that individuals need to exist in order to achieve effective learning.

Considering that the entire rationale of FE GCSE maths is intended to allow learners another chance to pass their exams, it should be of little surprise that the 'teach more, teach faster' approach finds much favour with educators as it formed a large part of the OFSTED tick boxes which in turn influenced college policy and thus classroom practice. The data from individual learners presented here is the result of what occurs when such an approach is rejected on the basis that it did not work for the learners in FE (else they would not be there) and instead a 'teach less but better' pedagogical approach is employed.

The data that is contained within the narrative accounts of learners should be respected as the personal, subjective truths of those involved in the learning process. That respect must not only extend to their thoughts but to their perception of the situation in which

they are learning. It is important not to write-off their thoughts in terms of "oh I know kids that think that" or "that's an excuse not to learn". These accounts are not obtained from learners being questioned as to why they have failed to pass an exam but from volunteered information that has been observed in the cut and thrust of a lesson; plucked from the minutiae of the myriad of asides, comments and exasperations that learners express whilst they are *doing* the learning of maths.

Exam results.

Simply looking at exam results is a relatively dry process that is fine to produce headlines, but the underlying statistics must be addressed if the analysis is to have any inherent value. Providers can adjust the numbers being entered to the exams and hive off those unlikely to pass to Functional Skills qualifications so published results are far from accurate. This unfortunately has the effect of falsely inflating national averages that are then used by interested parties to criticise the FE sector. Until the Association of Colleges demand a full breakdown from colleges and publish results calculated by passes from entire year cohorts rather than passes as a percentage of those entered then the national averages are of little worth and can only lead to poor decisions made by misguided college leaders and uninformed national observing bodies.

Carrying out research into the way exam grade boundaries are set has been a revealing and somewhat disturbing process which causes the horizon of the landscape of this to become somewhat darker as the realisation dawns that a system exists which fixes the percentage of young people allowed to pass at a little under 60%. A futility accompanies this realisation but it should help educators (and hopefully policy makers) to shift their focus from Grade 4 GSCE summative assessments to the experience our young people have of education. That experience must be crafted, nurtured and defended by educators if there is to be a paradigm shift in the way in which young people engage with learning and continue to engage with learning. This shift of focus in the classroom may result in a shift in the nation's feelings towards maths and therefore the learning of new conceptual subjects on a much broader scale. If the data here is seen in context, the context of a setting designed to encourage rather than admonish, grades become

secondary to experience. The interpretation of the data may be under the influence of a set of values which is laden with hope for change rather than despair of the status quo.

Numerical analysis.

The statistical landscape.

There is an underlying, sometimes unsettling, element concerning research into almost any education of young people and that is the spectre of assessment which marks the end of a learning programme. As an adult, I learnt to ski – there was no 'alpine-master' waiting to give me a certificate at the base of the mountain. I enjoyed the experience, my personal reward was inherent within the learning itself, it was rich, sometimes funny, shared and ultimately a satisfying skill to acquire. Perhaps because I *wanted* to learn, I needed neither a tempting, juicy, carrot of a certificate at the end of it, nor the stick of a dire warning of a personally Dystopian future should I be judged a failure.

In secondary school education in the UK however, the entire system is based on summative assessment. Black and Wiliam's (1999) 'formative' assessment may be held up in argument but that holds little currency when we subscribe to a system that is entirely based on a percentage, which is converted to a grade, which is used to determine access to the next stage of education or employment. Vocational courses, undergraduate places and employment often depend upon getting the required maths and English grades to proceed.

Of equal concern is the practice of schools and colleges to misinform the public, media and official organisations regarding the amount of GCSE passes they manage to attain. My own daughter and some of her peers became part of this practice when their two maths GCSEs (one in Maths plus one in Further Maths) were conveniently reported as simply maths GCSEs, meaning their success could be 'lent' to a learner less fortunate than themselves for the sake of statistics. Many schools and colleges withdraw students from exams if they are unlikely to make a grade 4 (pass) in English and Maths as they conveniently drop them from their figures.

"More than 10,000 children in England disappeared from schools at a "critical stage" of their GCSE courses, according to OFSTED, raising fears that schools are continuing to illegally "off-roll" pupils to improve exam results" (Adams, R 2019)

Colleges frequently decide that any potentially failing learners miraculously are enrolled on a two year course and therefore do not form part of that year's cohort. These are the learners who are then prioritised for apprenticeships, to whom GCSE is then no longer offered, being supplanted by a functional skills qualification instead.

This malpractice by school and college leaders is a result of the government's decision to publish league tables and have parents clamour to get their children a place in the establishment where, statistically, they will do best. It is a sad, corrupt and pernicious system with avarice at its heart. It is a widespread, common-place practice, unaudited and immoral but it is the foundation of our current compulsory education system.

The statistics in this study.

Hopefully, it is clear that my assertion is that statistics in education should be taken at best as unreliable and at worst actively misleading. In preface to the numerical analysis I offer here in fulfilment of the numerical case study sections of Plowright's FraIM, (elements 4,5and 6) I should be clear that I have nothing to gain from presenting an untrue evaluation of the data available within the scope of this study. On occasion, that is not the case in my role as teacher of mathematics however and I have become adept at presenting numerical data for a desired effect. For instance when pressed to make an accurate estimation of the final grades of each of my 200 learners, I said with some authority that I could precisely predict the grades for around 15% of my learners to within one or two marks. I chose not to elaborate as my superiors were impressed but in fact, that 15% were the 24 students that I had never met, had never attended college and certainly wouldn't be showing up for the exams. I knew my prediction of zero marks for those learners was entirely sound and accurate. It is prudent to look past the numbers where education is concerned.

It is the experience of my learners that is the focus of this study. Possibly somewhat contentiously, I view their final grades as a by-product of their experience within their

maths classes. Much of the anxiety surrounding the event of an exam is generated by the pressure heaped upon the outcome and the very high stakes attached to it by teachers. Whilst it is nearly always the case that educators wish their students to succeed, their reasons are seldom entirely unselfish. There is often comparison made between teachers in schools and colleges basis learner success. My overarching desire is that learners who have been offered the chance to learn in my classroom are allowed to discover a way in which they can improve their confidence with maths whilst seeing a light at the end of the tunnel rather than a fire breathing monster of an exam.

Ideally, I would like them to be able to replicate their abilities in the classroom when answering the questions in their exam paper. The way they deal with the *disturbance* (in the Deweyan sense) of the exam is key to their obtaining a satisfactory grade.

To this end, I need to be able to retrospectively examine our mastery approach and decide whether the numerical data can assist beyond the learner voice garnered through conversations and written feedback. The evidence to see if our approach is working on such a nuanced criteria may, or may not, lie in the numerical data of scores and grades but it would be nevertheless remiss to not investigate it accordingly.

The scores from each personal learning checklist (derived from three assessments that are conducted by students at intervals throughout the year) are compared to their final exam grade, as awarded by the exam board (in our case Edexcel). That comparison takes the form of a whole college cohort (around 400 students) having their work correlated (Pearson r value) against their final exam score. (Appendix 11)

To avoid inaccurate results, those students who did not complete any one (or more) of the three assessments were excluded from that particular analysis. As is generally considered acceptable , R values of greater than 0.3 are deemed to be significant, less than that is considered to indicate no correlation is present.

Over the past 3 years of running our programme, each cohort has exhibited an increasingly strengthening correlation between their classwork assessments and their final grade. As an advocate (and something of an evangelist) of our Essential 8

161

resource, this is excellent as it suggests that the programme is working when seen in the light of a steadily increasing number of passes each year.

However, correlation alone could suggest that poor performers are remaining poor and strong performers doing well. It is all too easy to interpret a pedagogical success from statistics but this correlation coupled with an overall improvement in consecutive assessment grades does at least hint at the programme having positive effects.

Correlations typically rise in strength from around 0.35 to 0.55 and this is statistically significant because it suggests that something longitudinal is happening when our learners are in the classroom. This is where the repetition of learning subjects arises and affects the long term memory of our learners. If, as the figures suggest, they are managing to retain skills and mental processes, then they are gaining *meaning* from the process and may be forming the Deweyan *habits* discussed earlier in Chapter 2. Moreover, if their classroom experience is such that their exam performance is being more closely mirrored as their learning year progresses, it may be interpreted that their reaction to the *disturbance* of the act of completing stressful exams (there are 3 exams, each of 90 minutes, spread over 4 weeks) affects their performance in a lesser way than may have been the case in their previous experience of secondary school.

Of further interest was that class sizes (between 10 -22 students) seem to have little effect on results though attendance figures for learners following a vocational path in the construction based skills (carpentry, bricklaying, woodworking etc) are noticeably poorer than all the other courses attended by our maths learners. This is despite a concerted effort to show the relevance of maths within construction based courses. Perhaps the relevance and connections that adult educators perceive as existing do not hold the same perception for learners involved in actually doing the training. For instance, many bricklaying trainees are aware that a 3,4,5 string is used to give a reliable right angle but fail to appreciate that this is Pythagoras' Theorem being put into practice. Laying a floor for a shed and completing a maths exam are perhaps not parallels that young learners

wish to acknowledge as readily as those educators delivering their maths and building lessons.

Avoiding over-interpretation.

In this analysis I have tried to avoid the 'Brute Data' that Usher (Scott, D & Usher, R 1996. p17) refers to and what Byrne (2002. p15) terms 'brute realism' whereby data is analysed and then attributed to 'unitary causation'; arbitrarily assigning the outcomes squarely to a single contributing factor. By the same token, I have been cautious to avoid appearing as either of the two opposing groups that he refers to as the *reductionists* and *innumerates*. He sums them up respectively with clarity and humour:

> *"The first can count but don't know what they are counting, why they are counting or what to do with what they have counted when they have counted it. The second can't count, won't count, and assert that counting is a vile and perverse activity which ought not to be allowed. The reductionists are positivists but don't use the term all that much. The innumerates use positivism as a pejorative label for all quantitative work."* (Byrne, D. 2002 pp14-15)

During the analysis of numerical data (I purposefully am avoiding the use of the 'Q' words as per Plowright's suggestion) within this study, the above quote from Byrne is a constant reminder to walk the tightrope of being in neither camp but sympathetically try to draw conclusions from the available data whilst always being mindful of the multitude of factors that are at play when young people are learning, being taught and tested mathematics.

Whilst it is imperative to be aware of the various opposing factions within numerical research, these 'paradigm wars' serve little purpose other than, as in many wars, to produce casualties, and in education it is inevitably the young learners who are damaged by the constant spectre of assessment, analysis and knee-jerk reaction. Adjustments to curriculum, pedagogy and procedure should perhaps be made as those made by a skilled mechanic, responding to the data received from a racing car. Tiny

alterations are made to enhance the performance of the vehicle but it will always be the driver, who is immersed in the driving experience, whose views must hold most sway.

That should be the same for our learners. They are in the driving seat of their learning and perhaps their views that should be interpreted in order to provide a framework in which numerical data may be set.

Fig 7 'Plowright's FraIM' (Simplified from the original 3-Dimensional version in Chapter 3)

I will populate this with the data I have collected, its analysis and conclusions.

	Observations	Asking questions	Artefact analysis
Experiment (Numerical)	1	2	3
Case study (Numerical)	4	5	6
Survey (Numerical)	7	8	9
Experiment (Narrative)	*10*	*11*	*12*
Case study (Narrative)	*13*	*14*	*15*
Survey (Narrative)	*16*	*17*	*18*

1. Correlate assessment scores to actual scores
2. 2017 boys vs girls and vocational course findings
3. The attendance paradox
4. 2019 results.
5. 10 years of GCSE results. Do grade boundaries facilitate social control?
6. Yasmin's interview
7. Students that equate experience to teacher, setting or other.
8. The mass survey (compare secondary experience to Assessment 1 score)
9. Past papers
10. The use of "we" and "us" in verbal communications
11. Just 3 words experiment
12. Back of the Ninjas
13. CIT
14. CIT
15. CIT
16. Words use frequently that make up the sentence from the survey slips

17. What happened at school?
18. Thank you cards – What words are used?

The analysis of the feelings of learners.

It is difficult to couch this heading in terms which summarise the delicate nature of interpreting the feelings behind the words, actions and responses of those providing the data for the narrative data within this study.

There is a tendency to disregard the 'soft' data of words and feelings in preference for the 'hard' numerical data. Purposefully avoiding the respective terms of qualitative and quantitative as Plowright advises allows learner experience to rise above learner performance without as many recriminations than may otherwise beset a determined researcher. It is that determination that can cause researchers to chase 'ghosts' in their numbers. Those ghosts can become very real in the mind of the researcher and present self-fulfilling prophecy as numbers are manipulated, interpreted or simply adjusted to add up to something that the researcher wanted to prove all along. Despite the perception that it is in the cold hard facts of numerical data that lies the indisputable truth of a situation, the subjective truth of FE GCSE maths appears to possess almost no 'cold hard' data whatsoever.

Every stakeholder in the arena of FE GCSE maths has their own set of numbers, twisted and adjusted to suit their own ends. Misreporting is rife, the data from exam boards bears no resemblance to the data issued by colleges and there is a huge industry surrounding extra-curricular teaching of maths. The podcasts, books, online tutoring, in-person tutoring and myriad of alternative methods to working towards passing the maths GCSE are an important part of many educators' lives and few schools do not spend a proportion of their annual budget on some form of online software application.

The data analysis recognises that regardless of all the activities that are available to bolster maths performance there is a constant that is pertinent to each individual learner and that is their own personal truth of experience. It is that experience which starts to emerge as perhaps one of the main points to emerge; there is a tendency among

learners who are most expressive regarding their learning to respond to enquiries regarding their experience of maths using plural pronouns. Whilst questions are directed to individuals they respond by placing themselves in a group. It is this belonging to a learning community that may be at the heart of differentiating between successful maths learners and those who struggle. There is a type of learning at play here that allows people to learn together and possibly even grow together. The 'together' element of learning is wrapped up in Dewey's 'conjoint community' (Biesta and Burbules 2003 p29) using their language (not just verbally) as a tool which they have developed together and use to grow their knowledge, skills and ability to interact.

The community of learners and collateral growth.

Learning with others appears to be key to the success (not necessarily just in exams) of many of the learners within the research group and strong bonds are formed between individuals who may only see each other for their maths lessons twice weekly. Building on Dweck's growth mindset model (2006) and moving from 'can't do it' to 'can't do it yet' is intriguing because Dweck advocates that mindset should be taught discretely in order for such to develop but it would appear from the accounts of learners that such a 'mindset' can occur through collaborative learning in a situation that has been engineered to allow this to occur.

By considering Dewey's commentary on collateral learning, which deals with the actions around the business of actually *doing* learning, it may be permissible to link these two concepts and allow the idea of collateral growth to emerge. If such growth is evident, individuals finding their locus within a group dynamic, maths may be offering far more than just passing a GCSE. If the process of doing maths is actually promoting young people to act as individuals within a group rather than an isolated member of a group of disparate individuals, then they may be developing the skills required to truly be 'useful' to society and the future world in which they will work, play and interact.

Whilst differentiation and 'assessment for learning' has been concerning itself with the individual learner perhaps, those successful in such a situation may not be the community-centric innovators our future world demands. Increasingly young people are considering their impact on the planet and the people of the planet. That same social

166

conscience is not best served by an education culture built around personal learning checklists, interventions and 1 to 1 intensive study. A mastery approach with 'no one gets left behind' at its core however does promote social awareness, empathy and compassion. If collateral growth does emerge as a by-product of learning maths in a mastery setting then it will offer societal benefits far beyond that of GCSE.

Cognitive Load.

Never more eloquently has a learner explained their anxiety to me than when Yasmin told me that when her "mind is full with anxiety, there is no room left for any maths to go in". It is here that the data surrounding mock exams and their effectiveness is revealing as the correlation was barely significant to the actual exams, indeed a low-stakes assessment of just the 8 topics proved to be a more accurate indicator yet each method of assessment were carried out within a few days of each other.

If Yasmin has a working memory full of anxiety it could be construed from this model that some of that anxiety will enter her long term memory. It will also hinder her ability to effectively churn the gear wheels of rehearsal and practice. Anxious learners rarely produce any work beyond copying from the board. The model in Fig 9 describes the proposed relationship between the different types of memory.
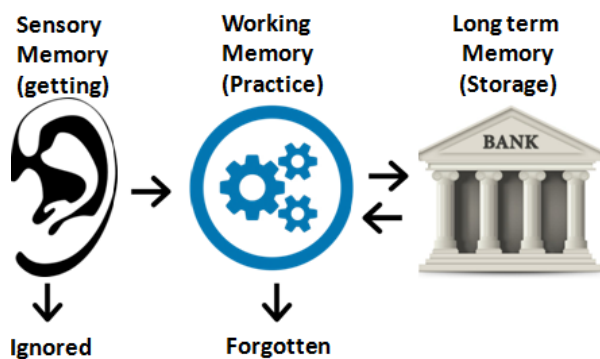

Fig 9. Memory model (Adapted from Atkinson, R.C.& Shiffrin, R.M. 1968)

Whilst considering cognitive load, the secondary data used to compile the correlation between PISA maths scores and the suicide rates of countries is alarming but must be tempered with a contextual awareness (Appendix 7). It should not be construed that

being good at maths leads to suicidal tendencies as the data does not concern itself with individual circumstances but with nations as a whole. There are also many spurious correlations in existence that are no more than coincidence. However, a logical approach does lead one to assume that every individual in those countries has been exposed to maths instruction at school and therefore will have that experience in common. It may be that in demanding performance to pass exams there is a detriment to how 'successful' individuals feel in later life. Whether those choosing to take their own lives had maths qualifications cannot be discerned form the data but the situations in which they learnt may well have been more focussed on their academic, rather than mental, health.

During the process of analysing the data, an overwhelming sense of despair starts to cast its shadow over the findings of this study but that must be guarded against. It must be remembered that the respondent group have been through primary school, secondary school and judged to have been found wanting where maths is concerned. These learners will, by the nature of their position, be resentful and frustrated by what has gone before. This is why there is such passion in this study with regards to ensuring the practices of secondary school (which have not worked for our learners) are not repeated in FE, else the same outcomes will prevail. Our mastery approach should not be seen as a means to an end; not purely to pass an exam, but a way in which our learners might realise that *doing* learning may actually be alright. If the data is analysed without the ever present spectre of summative assessment then the whole picture becomes far brighter and the possibilities of positive learner outcomes, subjective success stories, start to emerge. Putting the GCSE exam on the back-burner as it were may seem counter-productive in a study of GCSE learners but there is an uncomfortable set of facts surrounding the engineering of pass rates and that is the setting of grade boundaries, in which the government has a hand. The fact that boundaries have been set to ensure exactly 59.9% of entrants pass for the years 2016 – 2019 is testament to how exacting the government is when it comes to influencing the amount of young people entering apprenticeship, sixth form colleges and FE colleges when they continue post 16. Whilst this study did not set out to specifically address the

issues surrounding grade boundaries it has become increasingly clear that the topic must be broached as it is the raison-d'etre for FE GCSE maths.

Grade Boundaries.

The question that has to be broached is whether grade boundaries are being used to control how many learners received a grade 4 GCSE. Given that English and Maths GCSE is now being used as a criteria for the access to so many vocations, study courses and life paths, just how much importance should be attached to what is happening? It is contentious to claim that the qualification has been turned into some kind of tool for societal engineering but in a capitalist society (and I offer no suggestion for an alternative) there has to be an order and hierarchy. People need to have more than others so research and technological advancement create wealth and thus ambition for individuals to better their chances of success through a desire to better themselves. Perhaps the role of education may have been subverted somewhat by making a summative assessment a barrier to personal progress?

Rather than get side-tracked by this sociological argument, it may be prudent to defer to Dewey and his chapter on education as a social function:

> *"As a society becomes more enlightened, it realizes that it is responsible not to transmit the whole of its achievements, but only such as make for a better future society. The school is its chief agency for the accomplishment of this end."* (Dewey, J 1916. p11)

This is referring to the way in which the values and opinions of a developing society are offered to children in schools but the question of the nature of terminal assessment remains unaddressed.

The overriding reason for the grade boundaries being set as they are is merely to account for easier or harder papers, whilst ensuring desired pass rates are maintained. The inconsistencies between exam boards do not point to overall rates being adjusted each year to keep a desired pass rate in place. However the tendency of OCR to exhibit a negative correlation to pass rates does indicate that they may respond to pass rate

fluctuations. Then there is however a revealing statement made by OFQUAL that does suggest that grade boundaries are dictated by a higher power...

"Maths is a little different from sciences and languages in that we have rules about the proportion of marks to be targeted at particular grades. There are no similar rules for languages and sciences, because the content is not targeted in the same way." (OFQUAL 2018)

So the question has to be, who sets the rules; the answer is the Department for Education. This removes the contention as to whether grade boundaries in GCSE maths are used as a method of social control. Maths is singled out by OFQUAL as the subject which will decide the futures of our nation. This is a sobering fact. For teachers of GCSE maths, this is a huge responsibility.

That responsibility should not be delegated, re-assigned or avoided. It is a responsibility that accompanies the privilege of working with the young people that are the future. This means that simply toeing the line and ticking the boxes is not good enough for learners, they deserve well-informed educators that are brave enough to embrace alternative approaches to ensure the cycle of failure does not continue. One such approach is the reduction of curriculum to core concepts and the engineering of a situation which allows collaborative, rewarding and meaningful learning to be made available to each and every student in FE maths. Offering success where there has only been failure is a genuine option for teachers willing to make the effort to engage with innovative ways of helping young people to achieve competency in maths. Teaching fewer topics to a deeper level can offer such an opportunity.

Less but better.

The idea supporting this approach deals with the aforementioned cognitive load, mitigates the grade boundary issues somewhat by focussing on the topics which must occur and gives learners a sense of moving forward together with clear success criteria in a group setting.

Designing a reduced core curriculum has also brought the teachers involved in the process closer together and instilled a true collegiate spirit within the groups of

educators who have engaged in the programme. Whilst not specifically part of this study, teachers from around the UK are using the programme and joining the conversation with some innovative adaptations whilst remaining based upon the foundations of the underlying principles of teaching fewer topics to a deeper level of understanding. Harriet, a teacher from an FE College in the South West recently offered this response when I asked her how the programme was going:

> *"Everything is going well with the Essential 8, I repeated the topics all of last term to the students in the first 20 – 30 minutes of the lesson in various formats. The results have been very interesting. Most of my students have made great progress and definitely seem more confident in picking up these key marks. An unexpected outcome is how much the students love tracking their progress! They want to track everything now. I have found a preferred format for presenting the questions (example attached). After feedback from learners they said that they like to see everything in one go rather than work through page by page. They said this was because they feel like they have to complete everything like in an exam if the questions are in a booklet, whereas if they can see everything they feel more confident to go in any order and end up attempting more.*
>
> *We are planning to adapt our scheme of work for next year with more of an "essential 8" focus, so that we are teaching these skills earlier on and begin the tracking sooner. We're also going to work on a tracker that links to the scheme of work."*

Harriet has adapted the Essential 8 to move it completely to a collaborative learning resource where learners work together on a large format sheet of paper with all 8 questions presented at once. This development of the programme to meet the requirements of her learners is a hugely encouraging evolution and it stands as testament to the benefits of sharing best practice through innovative pedagogical approaches.

The feedback from interviews with the small focus group of learners threw up many positive comments regarding the Essential 8 approach, the autonomous support offered

by the numbered posters, the feeling of being part of something different and the practice opportunities, all have led to a general atmosphere of collaboration and positivity in the classroom. The data from the survey specifically asking for feedback on using the Essential 8 revealed students using positive words surrounding the programme providing help and practice opportunity.

The data organised within the FraIM Framework.

Organised in Plowright's FraIM, the various different type of data instrument deployed in the mixed methods methodology are listed sequentially but should be referenced by their number to the framework in fig (7).

This allows the outcomes to be easily referred to and allows this study to be used to check against results emerging from other researchers' investigations in the future. Interpretation of the results also benefits from this method of organisation as the way in which the collection was carried out (survey, interview etc) should also have a bearing on the interpretation, size of the respondent group and general intent of the exploration of each respective question accordingly.

The Essential 8 programme and its effects.

(FraIM 1 Correlate assessment scores to actual scores)

The effectiveness of the programme for each learner is assessed 3 times throughout the academic year by virtue of assessments that are solely based on the Essential 8 topics. No other GCSE maths topics are included within these tests. A personal learning checklist (PLC) is generated from the results and learners are then in possession of a document which shows them which of the 8 topics they need to concentrate on.

The value of this checklist is debateable and it exists mainly to appease the 'progress hungry' stakeholders who demand evidence of learning, in lieu of any more subtle, creative and human signs of learners becoming more confident. Some learners have indicated that they find the checklist useful however.

Over the past two academic years, the pattern of correlation between end of term assessments and final exam scores have been more or less identical; Pearson correlated 'r' values of 0.45, 0.55 and 0.6 exist for the 1st,2nd and 3rd assessments. (See

172

Appendix 11) This suggests that as the learners have increased exposure to the Essential 8 programme, their GCSE-relevant ability increases accordingly.

This is possibly more telling than merely reporting increasing assessment scores. Assessments are not the same as exams, the stakes are lower and the content limited to just 8 topics. Mock exams, also provide an indicator of performance having a correlation coefficient 'r' of around 0.7 – a slightly higher correlation than the final Essential 8 assessment.

The accuracy and value of assessment is tackled by Nuthall when he reveals that his extensive research suggests that *"most of the current forms of assessment do not serve the needs of teachers or students and have little relevance to effective teaching."* (Nuthall, G. 2007,p31). He continues on to consider whether interviewing students would actually give a more realistic analysis of just how much a student knows and understands.

Educators may find themselves walking a tightrope where assessment is concerned and perhaps should embrace that balancing act as part of effective teaching. Whilst testing may not be very efficient at finding out how much a learner actually knows, the GCSE is the summative assessment that this study is concerned with. Practice for the exam by completing past papers and the like can still be undertaken in a non-assessment manner by engineering an environment whereby exam questions can be tried out in a low-stakes setting.

2017 gender and vocational study.

(FraIM 2 Correlate male and female perception of ability against actual ability.)
Data from the 2017 (See Appendix 6) cohort was collected from a mass survey of perceived ability against actual ability, derived from 2 similar assessments spaced 3 months apart. Students were asked to rate their ability in each of the 8 Essential 8 topics on a 1-5 scale. The data presented the following findings:

From the first electronic assessment:

• Boys were worse at every topic except Probability.

• No outstanding differences between the different vocational groups.

From the second online assessment and questionnaire:

• The gap between the boys' and girls' performance closed considerably.

• The performance for Straight Line Graphs doubled after a lesson taught on the topic, suggesting much prior learning from secondary had been forgotten and that interleaving alone (where multiple topics are mixed) could not fully succeed unless a topic had been fully explained first.

• No overall improvement in performance from the previous assessment.

• Boys felt more confident in their ability to do each of the eight topics compared with the girls.

• There was no correlation between the learner's confidence in a topic and the ability to get the question correct.

• However, there were correlations between Essential 8 topics for the boys' perceived ability, suggesting that the boys make links between the topics. The girls showed vaguely similar correlations in the same pattern as the boys but to a far lesser extent.

Despite a wide range of literature on the subject, maths ability at GCSE level seems to have little to do with gender in this study. Differentiation for such should not been entered into. Whilst females are generally expected to be less likely to enter STEM employment their lack of self confidence seems to have little impact on the maths ability within an FE setting.

These findings are very similar to the very large scale survey (28000) conducted by the specialist maths organisation, EEDI. In a broadcast email they write:

"At every 'ability' level, boys are more confident than girls. Moreover, this is not just the median. The whole distribution of confidence is shifted for boys and girls."(EEDI, 15/10/2019)

The disparity between confidence of young males and females does not translate into increased exam success for males however and may say more about confidence in general than just in maths.

An anomaly that may be worth considering for further examination is the connections students make between topics and whether the importance of such connections are as vital as some commentators suggest. Once again, it is imperative that the subjective truth is considered rather than that which is based purely on logic and common sense. Logically, it should be the case that learners linking maths topics together should be the ideal state of affairs however if teenage learners actually do just as well by retaining knowledge of discrete facts, should it be that all educators are advised to focus on their students making connections between topics and seeing the relevance in every maths skill they acquire? There is a case for maths to be understood for the sake of understanding maths. In the same way a hobbyist may learn to juggle oranges, the joy of mastering a skill may be all the reward and justification required, with no consequent benefit necessary.

The attendance paradox.

(FraIM 3 Correlate exam score to attendance.)
There is another, far more intriguing result that occurs when a statistical analysis is conducted by correlating final exam results against attendance figures. No significant correlation exists between the percentage of lessons learners attend and the GCSE score they obtain in their final exams. (0.23 Pearson r value) (see Appendix 10).

This is of far more interest than the somewhat pedestrian discovery that the Essential 8 (which after all was designed around the most frequent and most high-scoring questions in the GCSE) rewards the most able learners with the highest GCSE grades in the study cohort.

Conjecturing around why no link appears to exist between attendance and grades may seem to negate the whole process of examining FE pedagogy at all – if the learners are not in classrooms, why bother to research what happens in the classroom?

Having spoken with some fellow practitioner/researchers, I appear not to be alone in finding that attendance and attainment do not carry the inherent connection that might be desirable in a study of pedagogical approaches when it appears that the research cohort being present is of little consequence.

I needed to find out what marked out successful learners with low attendance from the less successful ones with a similar percentage of being in lessons. The overwhelming reason for the successful learners not being in class was that they were completing tasks for their vocational courses. The reasons of the less successful learners had no such alibi but rather a varied selection of different excuses.

Understanding the motivators behind attendance is not immediately obvious but for some, the learning experience is what encourages them to attend. One learner said that maths was more like a 'social event' than a maths lesson. Again, Dewey's assertion that learning is foremost a social event is borne out by this comment. However, it was also evident that the more successful learners who were not turning up for lessons were often engaging in personal maths study using the supplied online software packages.

Those less-successful learners that however attended regularly pose another issue. Why do some learners never improve? What can be done for those whom the mastery approach has no effect whatsoever? Many are engaged, happy, participating learners yet still they cannot reach whatever grade boundary is set in their exam year.

The stress of exams may well be the 'disturbance' that Hildebrand discusses (2018) and perhaps the mastery pedagogy needs to be updated to account for a form of de-sensitising to exams.

2019 GCSE Results

(FraIM 4. Measuring exam success of the research cohort.)
When considering 2019 exam success, there are a number of factors to consider. The headline pass rate (those achieving 4 or above) has risen again to around 27%. This surpasses the national average for 16-18 education including provision offered by selective settings such as 6th form colleges and schools. Representing another year-on-year increase since 2015, it would appear that the approach is 'working' in the gross

sense of how many pass compared to how many are entered. It is worth noting that some colleges and schools are failing to enter students whom they believe will not pass to enhance their percentages. Bear in mind the percentages have a direct link to funding as fewer students will enrol to colleges publishing poor pass rate figures and as a result, colleges reporting low pass rates will receive less money from the ESFA (Education and Skills Funding Agency). Every student makes a huge difference to college funds bringing in around £4000 for each term.

The 'value added' figure is a term applied to students who have improved a grade from their point of entry. Sadly it does not carry as much weight as those achieving a grade 4 'pass' but it does provide another metric which should be of more interest to parents or learners for whom the grade 4 GCSE is perhaps too much of an expectation.

20 years of grade boundary engineering

(FraIM5 Examining the national strategy of controlling pass rates.)
Analysis of the last 20 years of maths GCSE pass rates in the UK shows a steady growth from 50% to 60% achieving a Grade C (or a 4 from 2017 onward).

The control method of setting the pass rates is grade boundaries. OFQUAL meet with exam boards to agree on the grade boundaries once all the papers have been marked. In theory this should allow adjustments for the difficulty of examinations from year to year. The available information for the last 10 years has been plotted against pass rates and there are some curious differences between the exam board's approach to setting boundaries.

OCR details their 'comparable outcomes' approach online which makes it all sound very honest and fair, claiming that grades are set to account for differences in exam difficulty between years. Only Edexcel are an openly profit-making business, their boundaries vary the most between years. AQA has a variation similar to that of OCR. OFQUAL reports around half a million students sit with Edexcel, half of that sit with AQA and around a tenth of that sit with OCR. Interestingly, OCR are the only board to exhibit any links to the pass rates, with a significant negative correlation (-0.6).

Grade boundaries for grade 4 (or C before 2017) vary wildly for exam boards and are displayed graphically in Appendix 9.

Yasmin's interview (FraIM 6)
This interview may be found in appendices (Appendix 3) and is analysed in Chapter 5.

Straw poll of experience. (FraIM 7)
A very quick, paper based response was taken from 129 learners (my own classes) to see ask learners what the main factor regarding their experience of secondary school had been. Just over one third reported that their teacher was the main influencing factor, another third suggested it was the classroom setting, including behaviour issues and the final third considered it to be something else such as the subject itself or long held preconceptions regarding their ability toward maths in general.

Questionnaire survey analysis

(FraIM 8 Correlate secondary school experience to assessment 1 grades)
The questionnaire issued to 379 new college students utilised an adapted Likert scale (Plowright has this at the centre of case study framework 2011, p19) to rate their experience of secondary school and then their experience of maths in secondary school by ticking one of 5 boxes ranging from "terrible" to "really good". This scale allows for simple conversion from narrative to numerical data. It should be viewed as a simple but effective method to facilitate the correlation of mass qualitative response with mass numerical data. The popular 'strongly agree, agree, disagree' etc. response descriptors were identified by the pilot group taking the prototype questionnaire as being hard to understand and largely meaningless, hence the change for the words used in the revised survey issued. (Appendix 14).

The respondents were then asked to rate their ability for each of the 8 main maths topics we use to deliver our mastery pedagogy. This serves a two-fold purpose in allowing students to consider their specific abilities beyond the common "I'm rubbish at maths" response as well as allowing specific topics to be analysed against other possible criteria and data.

Just over 10% of the responses were spoiled or rendered useless by extreme answers (e.g. everything maximum or minimum of each scale). These were excluded from analysis.

Once collated, (Appendix 12) the data revealed that no significant correlation occurred (a Pearson correlation coefficient greater than 0.3 is generally accepted as significant) between the combined self-assessment ratings and the experience rating of secondary school.

A significant correlation of 0.44 existed between their opinion of experience at secondary school in general compared to their experience of learning maths in that setting.

Comparison between those with large gaps between their experience of maths and their experience of general secondary education indicates no correlation occurs when set against performance.

The gap between actual performance and self-assessed ability is correlated with perceived experience in secondary maths and in secondary in general. This indicates experience of secondary maths has little effect on learners' ability to assess their own competence.

The only significant correlation between any criteria was that of learners' perception of their secondary maths experience with their overall experience of secondary school.

No links could be established between their experience and their numerical results. Perhaps this was due to a lack of their schools to ever actually consider experience as a factor in learning or because the experience was so uniformly witnessed by the vast majority that the concept of experience was less the foremost in the minds of the students. As these learners were yet to experience a mastery approach in an FE setting the lack of correlation is less concerning than it might be when asking the same question to successful learners leaving after their first attempt at a resit in the FE setting.

(FraIM 9 and 10 have been used to generally inform this study and are not intended for individual analysis.)

Quick responses:

(FraIM 11. The essence of experience in just 3 words)

Investigating the genuine perception of the experience of learners can be frustrating. In verbal interviews there is often evidence of a desire to merely please the teacher. Being candid is generally not something that is encouraged in educational settings. The vast majority of secondary school settings have no feedback routes at all. Teaching is a one way process in far too many maths classrooms and as a result it is easy for learners to become disenfranchised from the teaching/learning interactive cycle. Feedback is often demanded but it is usually in a binary form, an answer is right or wrong, an assessment is passed or failed and learner is a success or a failure.

To elicit a genuinely truthful response, it is important to offer anonymity, with such freedom to voice an opinion comes great responsibility however. For 124 learners in my classes over a week I used a simple slip of paper with space for 3 words. I asked my students to enter a word to describe their feelings about our maths lessons so far this year.

I had no idea what to expect and I decided to adopt a simple approach to analysing the results. For a simple numerical view I coded the answers as positive words (e.g. interesting, fun, useful) negative words (e.g. boring, difficult, long) and neutral words (e.g. educational, work, whatever).

The positive words account for 78% of responses, just 13% negative comments and the neutral words make up the remaining 9% (percentages rounded to whole numbers). The top two positive words are "fun" and "funny". Those 2 words account for around 16% of total responses. (See FraIM 17 for raw data).

This should surely set alarm bells ringing for an educator of what is essentially a conceptually challenging subject. Should learners be having fun in maths lessons? Should they find lessons funny? Always at this point there is regret that the privilege of anonymity was granted to the respondent group as I am desperate to know whether

those experiencing such fun in lessons are those who are progressing well and fully engaged in the subject. That concern having been voiced, I know there are far fewer than 16% of my students who I would class as finding the lessons difficult to engage with, which suggests that at least some of my most able talented students find a degree of fun in their maths studies.

Of course, were anonymity not granted, there is every chance that the responses may have been quite different (less honest) than those expressed in this small feedback experiment. Such is the nature of collecting data from students who have been conditioned to seek approval from their teachers or simply want to say positive comments through a desire to be kind.

The most frequently used words of negative sentiment are synonyms ("long" & "boring") so are grouped together to account for a total percentage of comments amounting to less than 6% of the total comments.

If learners are using "fun" as an antonym for "boring" then perhaps, as an adult, I understand "fun" as meaning something different to a 16 year old. I know that the term "long" has evolved since my school days so there is every chance that "fun" is also undergoing a subtle change of understanding. Much of my misgivings around the educational decisions taken in schools and colleges are that they are to aid teaching, not learning. We must surely think like young learners if we wish to achieve the best outcomes for young learners?

Student voice should not be considered as totally reliable but the way we use that feedback as educators is just as open to misguided decision making. The 'reflective' model that is drummed into trainee teachers asks educators to look at themselves and adjust their practice accordingly. I argue that we should look to our learners' perception of their learning experience and adjust accordingly to it, but only once we are sure that our interpretation of their feedback is as they intended. Reacting to feedback requires us to understand that those offering their opinions may hold a different set of success criteria to that of the educator.

A classroom practitioner has to ask whether they are doggedly going to press on demanding their version of good teaching or adopt a model which their students consider to be their version of good learning. In the same way TVs 'River Monsters' famous angler, Jeremy Wade titled his book "How to think like a fish" perhaps educators need to learn how to 'think like a learner'.

The clarion call for all educators to adopt reflective teaching practices is a constant source of concern given that it doesn't seem to be improving the quality of learning. It may be improving the quality of teaching but there can be little justification of honing a skill until it becomes increasingly less relevant to its intended purpose. Initial teacher training may be missing the point somewhat as it trains teachers to be skilled in the areas deemed important for teaching but largely irrelevant for learning.

School Centred Initial Teacher Training (SCITT) courses allow individuals to become teachers without an overseeing university which in turn reduces applicants to the university route of entry and the academic rigour available for teacher training is continually eroded. Without the innovation and progressive research of academia, teaching will not evolve but learning will. The gulf between teacher and learner will widen as learners are shaped by their surroundings and their world tends to move faster than that of their elders. This is especially true with the way in which they access resources and interact with each other using rapidly evolving technology. That peer interaction in the classroom is less subject to change but it still evolving as learners adapt and change to the 'situations' educators create. 'Thinking like a learner' allows the teacher to become part of the learning, not just the teaching, acting for a catalyst of the tacit knowledge transfer, facilitating the collateral learning that can be transformative in the experience and enjoyment of the learner. The power of that enjoyment, or 'fun' should not be overlooked.

"Fun" might be an unforeseen by-product of learning with a reduced content, core concept curriculum such as offered by the Essential 8 mastery programme. In my experience, understanding how young people think is often overlooked in teacher training, with greater emphasis being given to getting young people to think more like

adults; being compliant, taking responsibility and good citizenship are concepts that, quite rightly, change with age.

From a simplistic viewpoint, it may be fair to surmise that people generally remember things that have pleasant connotations and naturally forget those details around stressful or unpleasant experience. If the overwhelming experience within a classroom is positive then perhaps the tacit nature of Dewey's collateral learning is at play.

> *Perhaps the greatest of all pedagogical fallacies is the notion that a person learns only that particular thing he is studying at the time. Collateral learning is the way of formation of enduring attitudes, of likes and dislikes, may be and often is much more important than the spelling lesson or lesson in geography or history that is learned. For these attitudes are fundamentally what count in the future. The most important attitude that can be formed is that of desire to go on learning.* (Dewey, 1938 p48)

There are indicators that teacher training is starting to come round to this idea as contemporary commentators recognise the value in not placing over-emphasis on explicit knowledge:

> *"What teachers, as well as students, need to concentrate on is not knowledge so much as understanding, especially of key concepts in each of the subjects. In that sense, we need not a core knowledge curriculum, nor even an enquiry-based curriculum, but quite simply a core concept curriculum. If the focus were indeed on understanding core concepts, students, led by good teachers, would inevitably pick up valuable knowledge, through asking good questions and applying good reasoning."* (Anderson, B . 2016, p27)

Critical Incidents:
(FraIM 13,14,and 15)

When analysing the Critical Incidents here the following criteria are used as a guide to evaluate the nature of each account:

- *Why do I view the situation like that?*
- *What assumptions have I made about the student, colleague, problem or situation?*
- *How else could I interpret the situation?*
- *What other action could I have taken that might have been more helpful?*
- *What will I do if I am faced with a similar situation in the future?"* (Institute for Learning 2018)

CIT1. It doesn't matter what the topics are – just teach 8 of them!

When my colleagues and I first embarked on our journey into mastery we had little idea of how to change the way in which we delivered our lessons. All experienced teachers with secondary and further education backgrounds, we thought ourselves to be as good as we could be when it came to teaching maths. And yet our pass rates were woeful (around 10%) which was above the national average for FE but still too low as far as we were concerned.

Having secured a grant from the DfE, we called in a local University to observe our lessons and help us to improve. A Senior Lecturer in Mathematics Teacher Education sat in a meeting and told us that the teaching he had seen was engaging, effective and appropriate for our students. He went on to tell us that what we needed, were not better teachers but better students.

Obviously we recoiled from the suggestion that it was our students at fault somehow until he went on to explain that it was our job to enable them to become better students by giving them a chance to succeed where they had been unable to before. His suggestion (bearing in mind the advisor had been a departmental head of mathematics in his time and is a true innovator in maths) was to teach them just 8 topics. He suggested we go away and discuss the 8 topics we thought would be most useful to our students and only teach them those 8 things. He went on to talk about Helen Drury (2018) and mastery pedagogy, the Ebbinghaus (1885) forgetting curve and student working memory. There was research behind this madness, so we listened.

At first, the idea appeared ludicrous. That was until we started to look at past exam papers, filter out the most occurring questions and further rate them by available marks. My colleagues, Louise Kazimierczyk and Mike Richards suggested 8 topics (transformations, area, probability, angles, fractions, ratio, algebra and graphs) as those areas which appeared frequently and carried most marks.

Rather excitedly we presented the topics to our advisor at the next meeting. He was quite uninterested in what we had selected and then simply said:

"It doesn't matter what the topics are. Give your students confidence in 8 things and you will have given them the confidence to pass math exams."

That is the critical incident that occurred right at the start of our journey of improvement. Attendance improved, motivation improved, our teaching improved, our learning improved. That single sentence changed my whole perspective regarding my role as an educator. The instrumental instruction that is at the centre of so much maths is far less important than offering success, achievement and hope to those whom have never known such before.

As educators we can make judgement calls thousands of times a day and it is the refinement of those which can make the difference to the learning situation. (Stenhouse 1975 p.141). Our responses, decisions and questions are calculated to offer the best learning experiences to our learners.

CIT2. Well this didn't work did it?

After a year of the Essential 8 mastery programme, exam results were in and we had improved, but only a little. In the classroom, attendance had improved, all the educators were excited about teaching, one even reversed their opinion to leave the profession as they had found renewed interest in teaching since adopting the approach. It is fair to say that we were on a bit of a wave. Other colleges wanted to use our programme, we were writing workbooks to be published for the new academic year and there was a positive buzz around our department that had spread to functional skills maths and English teachers as well.

One Wednesday, close to the end of term, I received a rare visit from a senior manager in the college. With very little prior conversation, he picked up a copy of our Essential 8 workbook resource and (holding it like one might hold a dead rat by the tail) said, with some bizarre satisfaction:

"Well this didn't work did it?"

I explained all the good things that had come from the programme but without a meteoric leap in exam pass rates, there was little I could say to change his opinion.

This may point toward a main issue with further education; some decision makers in many FE organisations do not have a desire to see academic student success. They view their potential customers as failures, for whom they will give basic instruction to so they might earn money and pay tax rather than be a burden upon society. Success is not for their 'types' of student. They desire to offer pseudo success, a spurious diploma or a grade in a commercially viable trade but they are ignorant to the personal triumph that a student may feel when they are confirmed as a success in an academic, intangible, rigorous subject like mathematics.

I feel that more context may be needed to address this issue fully, lest my point is viewed as mere sour-grapes: I left school at 15, returned to pick up a few O'levels (The forerunner to GCSEs) and became an apprentice television engineer. This was in the early 1980s when a television cost around 2 months wages and often went wrong. Many people rented a television, just as people lease cars today. I trained as an electronic engineer for 5 years. The work at college was demanding, the maths much harder than I had seen before and the practical was even more so. We were taught to fault-find to individual component level. A television could have in excess of 4000 discreet electronic components.

As I mentioned, I trained for 5 years. In the late eighties, practically overnight, televisions plummeted in price and stopped going wrong. All the training, the exams, the lessons, the practice; all now worthless in terms of employability. And therein lays the danger of purely considering young people in terms of employment. When all we offer a student is a means to an end, training to do a job, what happens if that job disappears?

186

Gambling with young people's futures should not be the aspiration of an FE college. However, helping young people to overcome anxiety, taste success where there has only been failure and become confident in themselves as individuals, ready to tackle whatever obstacles come their way and experience how mastery in a subject can lead to a mindset which will enable mastery in many other skills; should surely be the goal for Further Education colleges, as well as practical, vocational training.

Whilst colleges are run by business managers to make money, rather than by educators to raise the intellectual and knowledge based skills of a nation, then the business of profit will always take precedent over the business of learning. It may be time to re-evaluate the qualities desirable in potential college leaders or adjust management hierarchy.

Why there was some satisfaction in the manager's assessment of our mastery programme as a failure is hard to fathom. As a dyed-in-the-wool FE educator, it is possible that his legacy of teaching those destined for a vocational future was that they did not deserve of require a GCSE in maths to lay bricks or cut hair. Maths was obviously viewed as unimportant, perhaps even superfluous, by this college leader; crucially the students who have met success (in whatever their perception of success is) through studying maths in FE do not share his cynicism. Thankfully this particular college leader has retired now, and it would be wrong to berate him for his attitude as it has been formed by the experience he has had in the sector but the ripple of legacy issues surrounding FE can still be felt in colleges across the UK and must be guarded against as the sector evolves into a crucial means of young people becoming qualified in maths. Anecdotal experience does suggest that the FE sector is losing some legacy resentment of academic qualifications so things may well be improving as maths and English become more ensconced within FE colleges.

CIT3. This is my safe haven.
Every other term I give my students yellow slips of paper to tell me how I could make my lessons better. I ask for one good thing that already happens in lessons and for one thing they would like to see implemented in the future. It informs my practice and helps

me more to see our lessons through the eyes of our learners, but certainly not in the reflection of myself, as is still taught in initial teacher training.

As stated earlier, student voice must be treated with great care and the value we attach to it as educators must also be considered carefully (Boring et al 2016) but neither should it be devalued or ignored. There is an inherent benefit to learners when they see their feedback being sought and, most importantly, acted upon. One of the feedback slips came from Shane.

Shane is a shade under 2 metres tall and is very style conscious. Of mixed heritage, he has a Mediterranean complexion and is outwardly confident, almost to the point of arrogant. The drawings he produces in his art classes are sometimes challenging to view but perfectly executed. He is young, perfectly groomed, talented and fashionable – in every way, the opposite of myself.

Our relationship in class was boisterous. I would coerce him into working with gentle insults or slip his name into embarrassing questions (e.g Shane buys 3 Cliff Richard albums for £9 in a charity shop with a 25% discount. How much was each album before the sale? etc). He would feign exhaustion at every request to work and generally make a nuisance of himself from time to time. In class discussion, he showed great insight and often startling perspicacity when verbally tackling maths problems. His abilities and output level grew and he passed his GCSE with ease when the time came. His questions became more directed at others in the class and this was conducive to learning for the whole group; he became a catalyst for teaching and learning with his quick wit, inclusive nature and irrepressible good humour.

The feedback forms I give out are anonymous, and yet Shane chose to put his name on his. He wrote *"John's classroom is a lovely haven; this is where I come in my breaks to do work and relax. John has influenced me in the way I imagine a dad would if I had one. He has taken me from a D to a B."* (Appendix 15)

Shane later shared with me that our twice-weekly maths lessons had prevented him from making a catastrophic decision, the tragedy of which would have deeply scarred all who knew him. School had left him with a crippling, hidden self-doubt that, somehow,

188

succeeding in maths, belonging to a group and achieving a positive relationship with many in his cohort, had alleviated.

When I meet young people like Shane, living with the doubt that their formative years has convinced them of; I am reminded of the words of John Holt. *"To a very great degree, school is a place where children learn to be stupid. A dismal thought, but hard to escape".*(Holt, J 1965 p156)

In early life, Shane had experienced something that had prompted him to form habits to cope with the situation. Those habits had not prepared him for the disturbance of success. As his situation changed then, slowly, so did the meaning of his experience and his experience of education began to change for the better. Obviously nothing really changed in education but his perception of his self-worth did when he found his community, his maths class, with a mastery based pedagogy that was based on progressing together, rather than the differentiation based systems which had proved unsuitable for his learning in secondary school. It was this that led me to be further convinced that teaching and learning maths could actually have a profound effect upon a student, allowing them to seek similar positive aspects in other areas of their lives.

Of some concern is the comment about his teacher (me) being the 'father he never had'. Shane and I never once interacted outside the maths classroom, beyond a nod or a wave across the college campus. To Shane, a maths teacher he saw for 3 hours a week became a father figure, through teaching maths. Shane has moved on now and I am unlikely to encounter him again but the point here is that as teachers we never really know how we are perceived by our students and as such great care must be exercised when such responsibility exists.

CIT 4 I'm not the dumb one any more

Katie had been trying to pass maths GCSEs for years. She wanted desperately to go to university to study art but found maths a hurdle. She was infuriating to teach as she was, by any definition of the term, a model student. Always present, always punctual, always attentive and always industrious. Katie however thought she was stupid. She

would often refer to herself as 'Sid the Sloth', a character from the film Ice Age. This was Katie typically apologising for being slow even before she had tried anything. She found maths conceptually challenging and an unrelated mess of different rules and procedures. I would often see her in the local supermarket where she worked at the weekend and we would acknowledge each other outside of our normal setting.

I asked for volunteers that would like extra help with maths in return for being my research cohort when I was carrying out a study funded by the DfE. Katie volunteered and I was fortunate enough to spend a dozen or so hours with her over 3 months to help her to prepare for GCSEs.

I spent a lot of time with Katie at her home, her father decided to do his GCSE maths exam at the same time so they could study together. Despite a reluctance to admit it, Katie started to get more and more correct solutions to maths problems. Her experience of school was not a subject she was comfortable discussing, it eventually transpired that maths had been a series of different cover teachers and a litany of poorly presented topics.

It was a few months after Katie had sat her GCSE exams that we met up again and we discussed her results. Sadly she was not successful but she was strangely upbeat about the situation. I asked why she seemed not to be too upset about the outcome and she explained that the process of learning maths for her GCSE had offered a sense of achievement that she hadn't experienced before. In conversation I asked her to expand on her feelings:

> *"It's like I'm not the dumb one anymore. Not in maths, but when I'm talking to other people. Before I came to college , if I was talking to a customer I didn't feel like I was as good as them but that's changed now. It's because I know I can do stuff that I thought I couldn't. If I can do maths, I can do anything"*

Katie is currently about to embark upon her final year of an art degree course at university and still works at the supermarket on Saturdays. Her story and insight have become inspirational driving factors for the entire Essential 8 led mastery

pedagogy that forms the experience for thousands of young learners. She is not the dumb one anymore.

CIT5, (FraIM 12) Thanks for showing me that I suck at maths. Ninja Maths.

A university with whom I have been involved with for many years invited local FE GCSE maths providers to join an improvement programme intended to boost exam pass rates. It was based on a common scheme-of-work with co-ordinated rounds of assessment, instruction and feedback. It is an ambitious, research-based programme, initiated by excellent secondary practitioners. It derives theories from the Ebbinghaus (1913) forgetting curve and draws heavily on the work of the revision guru, John Dunlosky (2013).

One of the resources incorporated into their plan is a highly differentiated set of questions designed to test students' skills with multiplication, division, subtraction and addition. Called Maths Ninjas, it is aimed at secondary learners and is a scaffolded platform incorporating homework, assessment and drill. It is heavily differentiated with, gold silver and bronze levels of questions. It is everything that I had seen in secondary and akin to the reasons my learners were in FE. I railed against putting something like this in front of my students as I believe the time taken to complete the task, coupled with the instrumental, isolating nature and distressing failure associated with a programme designed to push learners to failure each week was incongruous within a mastery pedagogy. I also have concerns regarding the over-simplistic way in which Dunlosky is interpreted when considering learning mathematics; he readily points out that maths may not adhere to the same effective learning strategies as fact-based subjects such as history or literature. For example, when considering 'self explanation' he notes:

"Three studies equating time on task reported significant effects of self-explanation. In contrast, Matthews and Rittle-Johnson (2009) had one group of third through fifth graders practice solving math problems with self-explanation and a control group solve twice as many practice problems without self-explanation; the two groups performed similarly on a final test. Clearly, further research is needed to establish the bang for the buck provided by self-explanation before strong prescriptive conclusions can be made."
(Dunlosky et al 2013 point 2.5).

Interleaved practice is the only method identified as particularly beneficial for maths (Dunlosky 2008 p20) which is the very essence of the Essential 8 programme.

Unfortunately, I was instructed to carry on despite my concerns and duly presented it to my learners as a 'starter' (the idea of a 3 part lesson is now finally being questioned as the value of dialogic process is emerging). To gain at least some value from the process, I offered my learners the opportunity to write on the reverse of the Maths Ninja worksheet, how it had made them feel. Their responses were mixed and it would be wrong of me to assume that my opinion of the activity had not possibly increased their negativity towards it (my colleague also engaged in a similar activity which had a less negative response from her own students).

Callum had not fared well with the 10 minute assessment and simply wrote *"thanks for showing me that I suck at maths".*

This was a student who had not engaged well with secondary school, by his own admission truanting from many lessons and frequently being subject to disciplinary action as a result. However, his attendance to maths at college was very good, he had a quick wit and listened well to others who would help him on the occasions when a topic eluded him. But this single act of exposing his shortcomings could have negated all his recent efforts.

I presented my students' responses to my line manager (I have a superb, supportive boss) and she understood my concerns immediately. I have disengaged from the university's common scheme-of-work resources.

Some of my colleagues retained the activity. I asked them why they had chosen to do so and the main reason was ease of assessment. Not ease for students but ease for teachers; that is what is at the heart of so many decisions taken within education – how easy is it for teachers to see how their students are performing. Performance is a word which is used in education a great deal and yet the word itself has connotations which seem somewhat incongruous to learning. By definition, a performance requires an audience, it is not designed to occur in private, and yet our learners complete their exams with no immediate audience. Exam performances are judged and graded after

the event. Perhaps it is now time to ask learners to be their own arbiters of their abilities, to take a step away from the constant monitoring and allow groups of learners to work together, enhancing their skills as they progress.

The critical incident here is Callum's response, his notion that all the maths he has learnt can be rendered completely without value by a single assessment at the start of a lesson.

This particular incident may be well served by examining Csíkszentmihályi's concept of flow; more accurately, what happens when flow doesn't occur in an environment where it is designed to do so. Around 8 years ago, as a newly qualified teacher and embarking upon an MA on the subject, I wanted to 'flow enable' my lessons. It seemed like an obvious route to take; the individual learners would find themselves in a state of accelerated learning and they would all find happiness and success in their study of maths. Except it didn't work like that. The problem is that there is a difference between learning and practice and performance. In order to practice a skill, not just maths, you have to learn it first; you need someone to guide you, like Wittgenstein suggests in his London metaphor (Gasking, D.A.T and Jackson, A.C 1952). And this is my concern regarding flow in the learning environment. Flow is defined by the inspirational Csíkszentmihályi as...

"the optimal state of inner experience in which there is order in consciousness. This happens when psychic energy – or attention- is invested in realistic goals and when skills match the opportunity for action. The pursuit of a goal brings order in because a person must concentrate attention on the task at hand and momentarily forget everything else. These periods of struggle are what people find to be the most enjoyable times of their lives (Csíkszentmihályi 2002. P8).

It is worthy of note to remember that Cziksentmihalyi spent his formative years in a WW2 concentration camp where he mastered chess as a distraction from the horror around him. It is also prudent to recall that the man is the epitomy of optimism, he has a huge intellect and a wonderful reputation for spreading happiness and hope.

Flow plays a large part in the pschology of sport and musical performance, but it is a performance tool; possibly not best depolyed when learning or practice is required. I shy away from comparing the ability to solve maths equations with the act of playing instruments or sporting endeavour as the fine motor skills play a huge role in the physical element of those pursuits but, as Didau argues in his blog (2013), if we are lost in the moment of performance, where is the time to make improvements, deepen our understanding or share our experiences with others?

Callum was not in a state of flow. The questions he faced range from patronisingly simple to nigh-on impossible for all but highly proficient learners. He was in the high difficulty/low skill area where flow cannot exist. A worksheet which was designed to test him until he failed; the difference between the long-jump and the high-jump to use a sporting metaphor. Respectively, he was used to seeing how far his successful leap could carry him in the sand of the Essential 8 resource but was simply cringing at the thought of knocking into the crashing bar of the Ninja Maths worksheet, as he knew at some point, he would fail.

This was his experience of school. On one of his, optionally anonymous, feedback forms (my learners have 4 opportunities to feed back over their year with me) he wrote that he considered the main difference from school maths to college maths was that at college, the teachers care. Perhaps we need to start using 'long-jump' resources that we can measure but that do not have a failure bar set, waiting to be knocked into. It is often remarked to me that resources are far less important than pedagogy but I fail to see the two as separate entities. By offering resources with in-built failure points, such as the Ninja Maths worksheet (to avoid any confusion, it may be a valid programme, led by people with excellent intentions for secondary learners but it may not be suited to use in an FE setting) we are reinforcing the negative experiences of our learners rather than changing them to positive experiences.

CIT6 Is it my confidence or ability that's got better?
Evangelia arrived in England 3 years ago, is of mixed heritage and has Greek as her native language. She is bright, funny, learns quickly, helps others and is always very inquisitive. If she gets bored in lessons, she will fall asleep and snore loudly.

Her scores in maths exams have increased greatly over the last few months and she is always keen to know if she has found the solution to an answer as soon as she can. An excerpt from a recent conversation is transcribed below.

E: John, John, tell me if this is correct. I got 23.5 but Hannah says its 23.542.

Me: What do you think? Do you think you are right?

E: Err, yeah. Otherwise I wouldn't be asking you but Hannah is better than me.

Me: Are you better than Evangelia Hannah?

H: Yeah right! That's why I failed again in November. Of course I'm not better.

Me: You are correct Evangelia, significant figures include those before the decimal point. You should have more confidence in yourself, all your hard work in maths is paying off with right answers.

E: How do I know if I need more confidence or more practice then John?

Me: Oooh. I need to think about that question. Let's talk about it during break.

Evangelia's question had floored me. I advised her to have more confidence and she saw this as a separate entity from maths practice questions. She didn't readily make the link between practice and having confidence and yet I assumed this would be obvious.

When we discussed her question at break time she told me that she didn't think it was right for her to be getting answers correct when others around her were not. It appeared that she only doubted her answers when she could see others with different ones. Evangelia appeared almost guilt ridden when it was her answer that was correct and not her friends. She started to put it down to a random act of luck and Hannah's failure due to the question being poorly worded. Accepting success is not something that we should simply assume learners will be able to do automatically.

Dewey's thoughts on learning happening in communities are at play here. The individual learner is actively considering the views of others in the learning cohort and the learning has been given *meaning*. This is when the preparation for the *disturbance* of the exam can be considered as learners begin to increase their confidence through experiencing success. Once a learner has seen how they may have achieved a level of skill that others haven't, their act of helping others may serve to cement the knowledge for future recall.

Questionnaire words analysis

(FraIM 17 The words used in responses to using the Essential 8)

150 students were offered the opportunity to answer a single electronic survey question with a blank page response box. The pilot responses ranged from 1 word answers to lengthy sentences. As the words used were crucial to understanding the feelings surrounding our mastery approach the questionnaire was adjusted to allow a maximum of 25 words. This made the data manageable and avoided a respondent repeating words which would have skewed the frequency analysis.

What are the main benefits you have experienced from of our approach to teaching and learning mathematics together and the use of the Essential 8 workbook?

Around 129 responses were collected and the words used were transcribed verbatim into an electronic document. Spreadsheet software (Microsoft Excel) was used to calculate the number of times each word was repeated and the resulting list is displayed below.

35 to	6 week	3 getting	2 keep	1 they	1 previous	1 info	1 confidence
26 practice	6 used	3 easier	2 how	1 that	1 prepares	1 improves	1 by
22 topics	6 them	3 doing	2 focusing	1 teaches	1 preparation	1 helpful	1 being
16 you	6 questions	3 do	2 familiar	1 teacher	1 perfecting	1 has	1 become
15 helps	6 me	3 different	2 exams	1 solve	1 pass	1 grade	1 applied
14 the	5 your	3 constant	2 every	1 shows	1 over	1 good	1 answer
14 get	5 understand	3 be	2 don't	1 set	1 only	1 goals	1 allows
13 and	5 see	3 areas	2 covers	1 revise	1 not	1 gets	1 advantages
12 it	5 know	2 understanding	2 repetition	1 retain	1 none	1 gaining	1 active
11 remember	5 can	2 topic	2 at	1 response	1 minimum	1 full	1 able
11 more	4 keeps	2 things	2 as	1 repeated	1 memorising	1 forget	
11 learn	4 each	2 stuck	2 are	1 reminds	1 memorise	1 focus	
10 E8*	4 basics	2 stick	1 working	1 reminder	1 maths	1 feel	
9 what	4 a	2 so	1 work	1 relevant	1 master	1 explaining	

9 on	3 well	2 skills	1 wording	1 relearn	1 marks	1 exactly	
9 in	3 we	2 repetitive	1 with	1 refreshed	1 many	1 eventually	
9 exam	3 repetition	2 refreshes	1 will	1 refresh	1 main	1 evaluate	
8 recaps	3 practising	2 recap	1 which	1 refection	1 less	1 essential	
8 need	3 needed	2 practise	1 where	1 really	1 learnt	1 enhance	
8 improve	3 memory	2 out	1 ways	1 realise	1 learning	1 easy	
8 for	3 likely	2 one	1 very	1 re	1 knowledge	1 drill	
7 of	3 I	2 mind	1 us	1 range	1 isn't	1 definitely	
7 confident	3 help	2 marks	1 time	1 question	1 is	1 crammed	
7 better	3 head	2 makes	1 thing	1 progressing	1 instead	1 cover	

(* Where used, the term 'Essential 8' has been abridged to 'E8')

There are various methods available to a researcher to codify, apply weighting to and explicitly analyse data arising from open ended questionnaires. Ensuring credibility when analysing such response should be uppermost whilst trying to interpret the data. Plowright (2011 p101) offers this when considering critical discourse analysis:

> *"Words and language do more than express ideas that mirror what we talk or write about. They are inextricably linked with the way we interact with and develop an understanding of the world. Further, that interaction is based on an understanding that is structured by language as well as other types of experiences."*

This resonates with the Deweyan concept of interaction and experience which has been the catalyst for this research. Moreover, I am less interested in sentiment but more by the choice of words used by the respondent group as their choice of words may belie their true subconscious feelings more so than the carefully considered structure of their response.

There are many multi-stage approaches that seek to offer academic rigour to analysing open-ended responses. Whilst somewhat dated, Hickey and Kipping (1996) sum this up well when they state:

> "One of the criticisms of qualitative research is that the processes and procedures of data analysis are often not made explicit (1). This criticism is particularly pertinent to the analysis of open-ended questions"

Whilst researching suitable methods of analysing the response data, I was struck by how overwhelmingly obvious the sentiment of the responses were when just looking at the first 12 most frequently used words. Re-arranging the words just a little, gives this sentence.

"To practice the topics helps you get it, remember and learn more"

Such a naive representation of the data could easily be dismissed or ridiculed in a paper that mentions 'academic rigour' in its previous paragraph but I stand by this interpretation of the data, it has the 'apparency of honesty' that Van Maanen (1988) discusses in his concept of 'verisimilitude' and it sits squarely within the overarching ethos of this study.

The list of words is very encouraging as it has words used frequently that one might not immediately associate with a maths lesson. 'Confident and confidence' appears frequently, which may be viewed as testament to a pedagogy that values learner experience above performance.

Pronoun analysis

(FraIM 16 the use of us and we)

I personally am heartened by how the words (or similar, plurals, different tenses etc) which occur most frequently completely eclipse their positivist opposites: The words 'question' appearing 7 times and 'answer' occurring only once. Similarly 'teaching' is

mentioned twice whilst 'learning' appears 12 times. Whilst allegations of bias may exist in this interpretation, the fact that learners are using words that centre on their personal positive experience rather than negative concept that are actions 'being done to them' and shines some light on just what a mastery pedagogy means to those who are at the centre of it. It is evidence of the 'learning community' talked of by many of the protagonists within this study, lending further credence to the proposed concept of 'collateral growth'.

Thank you cards

(FraIM 18 unsolicited gratitude)

Perhaps the single most revealing artefacts of the way in which young people feel lie in the cards they choose to give at the end of the learning year. These appear before they have their results so are not prompted by the product of exam success but the embodiment of the desire of a learner to publicly recognise their gratitude for the efforts made by their teachers.

In a world of emails, instant messaging and social media, when a disaffected teenager feels it necessary to go to the lengths of paying money for a card they have chosen and consider the words to use in it then the process of teaching and learning maths in FE is endorsed by their action.Often signed by small groups as well as individuals, the community of learning represented by these tokens should carry as much weight as any survey or numerical analysis. Affirming that education has at its core a very human set of requirements and values.

Data summary.

The mixed methods approach has provided a way to collect a wide range of data and try to piece them together to form a complete picture of GCSE FE Maths within the scope of this study. Analysing that overall picture is the purpose of the following chapter.

SUMMARY

Whilst this chapter starts out with quite a bleak vision surrounding the manipulation of exam result data, the results from the various research activities undertaken reveal a far more hopeful picture of young individuals working together for a common goal. The community aspect of studying that emerges begins to take on a far greater importance than the comparatively tainted business of exam results.

During the process of analysing the data, it is impossible not to notice how the failure cycle is actually not dependent upon passing exams but is entirely dependent upon reframing the learners' perceptions of success. If the Essential 8 mastery programme is achieving that (to whatever extent) then it may be that the trepidation of exams can be relegated to a by-product of successful learning rather than the binary pass/fail judgement as it is traditionally presented to many learners.

If the pedagogical approach that the respondent learners are subject to is indeed achieving a paradigm shift in how they view the purpose of learning in general then it has merits beyond simply passing summative assessment.

However the issue facing the insider/researcher must be borne in mind when claiming an approach produces a Utopian learning experience from a Dystopian educational regime. The possibility of deductive bias must always be at the forefront of consideration when data analysis is proclaimed as revealing favourable outcomes.

If approached from a truly inductive angle, it may be pertinent to assess whether learners have truly immersed themselves in community learning or if it is just wishful thinking. This tension between the inductive and deductive reasoning is examined in the next chapter.

Chapter 5: Key themes emerge from the Data Analysis.

This penultimate chapter identifies the key themes that arise from analysing the data. As is so often the case, there is tension here between the approaches which either favour a purely arbitrary set of outcomes or that which considers the learner as a whole and looks to address learning in an evolutionary landscape of developing educational strategies. Both must be considered but it may be pertinent to also consider that cause and effect may be at play. The idea that a learning who has discovered meaning in the discourse of learning maths in the right situation is plausible yet the concept that good grades are likely to promote effective learning is somewhat less credible.

Denscombe's account (1998) is used to give structure to process of drawing out key themes and it is prefaced with an examination of the nature of the entire approach to settling on the key themes by evaluating to what extent inductive and deductive reasoning influence the themes and concepts which are identified as be in emergence. In turn, this offers the researcher some assurance that by matching their data to accepted theory then developing emergent themes, an iterative process is created (illustrated here by a spiral) which lends them some traceable credibility.

The three main themes of cognitive load, reducing explicit knowledge transfer to improve understanding (termed as 'teach less to learn better') and the proposal of a theory of 'collateral growth' are examined an held up as the final shoots which will form the emergent branches of this study, hopefully to be further explored in subsequent research.

Denscombe's Account

In tackling the tension between inductive and deductive reasoning, Denscombe offers a comprehensive summation which is pertinent to the processes adopted within this study and then seeks to add clarity to the question of the nature of the reasoning employed.

(Denscombe 1998, p292)

" In essence, the process of interpreting the data involves a series of four tasks:

1. ***Code the data.*** *Codes are tags or labels that are attached to the 'raw' data. They can take the form of names, initials or numbers.*

2. ***Categorize these codes****. The next task is to identify ways in which the codes can be grouped into categories. The categories act as an umbrella term under which a number of individual codes can be placed.*

3. ***Identify themes and relationships*** *among the codes and categories. A further stage in the analysis comes as the researcher begins to identify relationships between the codes or categories of data, or becomes aware of patterns and themes within the data. The task for the researcher is to 'make the link'.*

4. ***Develop concepts and arrive at some generalized statements****. The final stage of the analysis requires the researcher to develop some generalized conclusions based on the relationships, patterns and themes that have been identified in the data. These might take the form of concepts or hypotheses. Occasionally, the researcher might be ambitious enough to suggest a theory based on the empirical research. More prosaically, they could consist of a narrative explanation of the findings. These tasks, as has been noted, form part of an iterative process. They are steps in the 'data analysis spiral' which means that each task is likely to be revisited on more than one occasion as the codes, categories and concepts get developed and refined. The iterative nature of the process also means that, ideally, the researcher should return to the field to check out emerging explanations."*

(Denscombe 1998, p292)

It may be prudent to preface the 4 stages with an additional process that informs the journey from raw data to generalised conclusions. The review of literature does shaping work that identifies the important features or concepts that researchers have found to be significant in their investigations into similar or related educational areas. These ideas and concepts of others bring the advantage that they can help us to see things that my data analysis might overlook. The risk is that the ideas and concepts from other

research define and determine the data analysis. The challenge, once this initial step is added, to walk the line in a way that balances the drawing out of deductive concepts (ideas in my data that are equivalent or close to ideas in the literature) and inductive work that finds concepts from the data. Achieving the balance between the inductive and deductive connects the literature to this research and vice versa.

So we now have a 5 stage process...

Preface stage: Establishing the data's position in the landscape.

Before offering the data to the 4 stage process ensure the data has relevance which links what the instrument (survey, interview etc) set out to investigate to the established theories and concepts in literature. Whilst this sounds an obvious task it has merit in the appreciation of the data in terms of both its inductive and deductive tendency. This appreciation informs the approach to take when going through the journey which will take responses through to conclusion. This can be an overlooked stage but it addresses the idea that the spiral of journeying inductive research to deductive reasoning using available literature has been completed with due diligence. Merely looking to second that which has already been stated without adding depth to the discourse has less merit than research which seeks to further the understanding of the given area of study.

1. Coding the data.

Plowright's FRAiM has proved to be a comprehensive tool in the coding process. By eschewing the quantitative/qualitative labels (preferring the less emotive terms of mathematical/narrative) and having the two identical descriptors for the subsections of each, Plowright's Fraim ensures the coding process is inherent within and integral to the structure of the data.


A section of Plowright's (2011) flow chart.

Note how the four grey boxes that follow on from the 'Data box' work alongside the four steps of Denscombe (above). They are not the same but can be seen to work in conjunction with the process.

2.Categorising the data:
Plowright's Fraim (2011) allows for comprehensive categorisation of the data

Simple three-dimensional model of an integrated approach to designing research
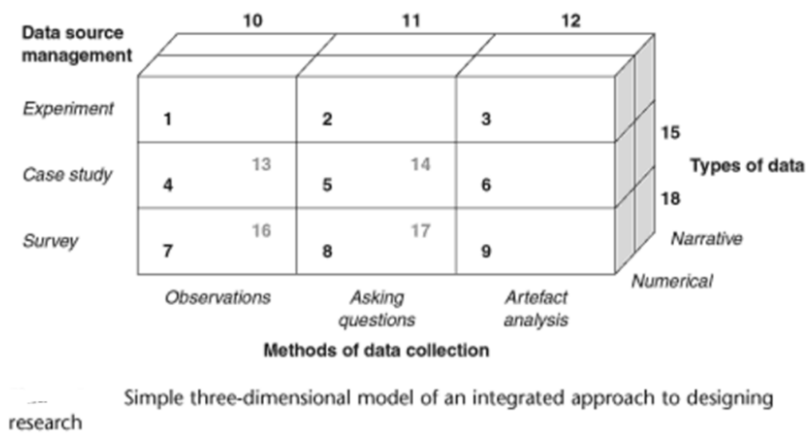
This integrated approach requires the researcher to actually design collection instruments in a way that will fulfil the requirements of the structured dataset.

Actually categorising data collection instruments can be challenging as, with much of education research, pigeon holing a piece of captured data can be confusing when it arrives from an unexpected source or in an unfamiliar manner. Journal entries are often made following a certain activity or a new activity is trialled. The decision as to whether this is an experiment, the result of an experiment or an observation, lies with the researcher but Plowright's FRaiM does at least prompt one to consider the intrinsic nature of the data concerned.

Balancing narrative and mathematical data is helpful because it is too easy to become absorbed in either and lose track of the research question. As an educator, I have an overarching duty of care to those whose learning I am fortunate enough to lead. Their experience is almost entirely in my hands and the burden can drive a practitioner/researcher to purely rely on student voice. As previously mentioned, such voice may not be as reliable as one may wish so the balance of hard, numerical data helps to guard against the sentimental bias that can so easily occur.

3.Identifying themes and relationships:

At this juncture in Denscombe's process it may be appropriate to consider the concept of themes alongside Plowright's Claims and Evidence flowchart boxes.

It is in the evidence that the tacit, 'between the lines' factors may reside and it may be those nuanced responses that need to be examined to ascertain the relationships which lie at the heart of this research.

The Deweyan experience is at the fore of this research this is never more evident that in the written responses on the student feedback slips and in the 'thank you' cards and emails of students.

The multiple journal entries I have made when students comment along the lines of "I've learnt more here in one lesson than all the lessons at school", may be seen as indicative of an emerging theme that learner perception is that learning succinct, manageable amounts of explicit knowledge is preferable to trying to navigate a vast field of multiple topics and trying to commit that to memory.

These suggest that a main theme arising from the research is that of cognitive load having a bearing on the quality of the experience of the learner. By managing the experience of the learner so it is not burdened with inconsequential periphery of the overbearing rules and bizarre rituals of schools, the main purpose of being in a maths class is learning how to succeed in a maths GCSE exam. It is not the extraneous pressure of dressing in a certain way or sitting in a certain place.

Refining this process further, the proposed concept of teach less to learn better emerges as something that appeals to the learners in the Essential 8 mastery programme.

4.Develop concepts and generalise statements with reference to the literature.

The final part of the analysis relies upon developing concepts. The hybrid of Dewey's collateral learning through experience and Dweck's mindset theory is proposed through the concept of Collateral Growth. The proposed theory is that learners will have an improved learning experience with more resilient knowledge recall when learning is conducted in a community setting underpinned by a teacher who creates the ideal situation for learning to occur in. The group dynamic allows for a rich learning environment to give enhanced meaning to the skills and knowledge being learnt.

Polanyi's tacit learning theories may be extrapolated when seen in the context of experience to offer far more than accelerated, efficacious learning techniques. The growth element embraces viewing the learner as a holistic entity; explicit knowledge is retained and established through a process of the implicit security which is embodied within a carefully crafted learning situation. Experience is at the heart of collateral growth, the skill and knowledge to succeed in maths exams becomes a by-product of being a satisfied learner, safe in the knowledge that each learner has value, potential, ability and security.

The journal entry made after Anita (Appendix 14) was quite agitated when she considered that she was not being taught in the traditional sense whilst also being of the opinion that she was learning more than ever before in our maths classes was the catalyst for the concept of collateral growth as this particular learner has progressed far more than any of her indicators from school suggested she would.

The iterative process Denscombe discusses relates not only to the practice of converting emerging research findings back into the classroom but also the pairing of inductive observation into accepted theory (such as in Anita's case) and the deductive nature of looking to pair theory with observation (as per the account given surrounding Nasim in the exam room). There is a to-and-fro of observation to theory and theory to observation at play within this research. Rather than identifying the research as belonging to either an inductive or deductive approach, it may be viewed as spiral which

has one half of it circumference as inductive, the other being deductive. Perhaps something like the illustration below...
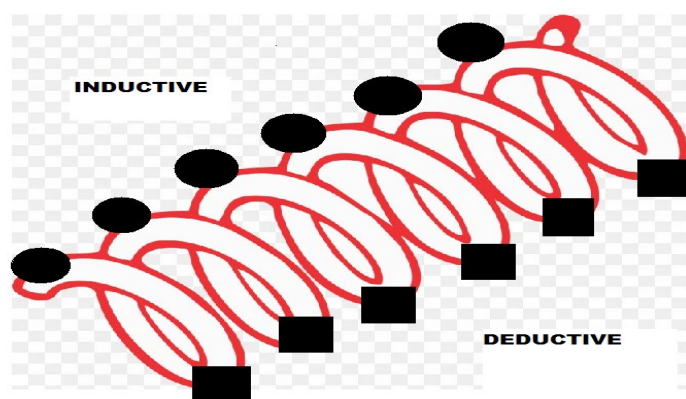
As the inductive events occur (as per the black circles) theory examined (the black squares) are the iterative process returns that theory back to further inform the research. Very much in the grounded theory tradition "the discovery of theory from data systematically obtained from social research" (Glaser and Strauss 1967) the level of coding does not exist in this research in the manner of that of Nuttall's (2007) huge research project for example. Nevertheless, the iterative process is evident as can be seen from the feedback which shaped the amended survey questionnaire.

My personal journal offers an insight into the thought process throughout this research and the entries I offer are often in response to many of the occurrences that I have considered to be the critical incidents that I have used in this research. In a Deweyan sense these are those events which have caused a disturbance in my thinking and my appreciation of what it means to both teach and learn maths in an FE setting.

Denscombe believes the memos in journals "are valuable in the way they provide a documented record of the analytic thinking of the researcher as they refine the codes and categories. In this sense memos are a note pad on which the researcher records how and why decisions were taken in relation to the emerging analysis of the data. They provide a permanent and tangible record of the researcher's decision-making which, in principle at least, other researchers could inspect. In effect, they render the process of

analysis explicit and accountable, and can form part of the 'audit trail' (see below). It is not surprising, therefore, that the use of memos is generally recommended as good practice in relation to the analysis of qualitative data." (2007, p295)

Denscombe supplements the arbitrary organisation of Plowright by linking the narrative and numerical data sets which are separated in Plowright's FRaiM and recognizes the way in which they interact and become interdependent. In a mixed methods context, this suggests that qualitative and quantitative data, when used together to inform the process. In itself this lends weight to the inductive/deductive iterative process and suggests that a similar synergy can exist between rounds of narrative and numerical emerging findings.

Saunder's Research Onion

In order to see where that proposal resides within the context of research methods reference can be made to Saunders et al 'Research Onion'. It can be useful to plot a rough path through the diagram to assist with keeping research techniques.

I have drawn an ellipse over the onion diagram to show the methods I have considered as being the most appropriate for this research. I find this a good starting point to begin to understand where the research question lies within the methods available. Within the ellipse are the concepts and approaches that one may wish to consider as viable and suitable for the study in point. Generally, if a philosophy, approach or design lie outside the ellipse, it can probably be removed from the general research plan. It is a process of elimination which is simple in its construction but effective in its execution. The ellipse shape allows for a wider path when considering research strategy but forces one to commit to a position on the research philosophy, in my case this has been somewhat shaped by my own ontological position. Once one has admitted that the research is always the product of the researcher (in Dewey's terms, I am interacting with the research, which is my, perfectly valid, version of the reality of the research) then the decisions made regarding the rest of the process sit naturally within the scope of the study. It is somewhat crude but not without the benefits of clarity and brevity.

CIT resides throughout the internal area of the ellipse and should be considered as a broad route, an ethos perhaps, through the research, which may include many of the criteria for each classification along the way to final data collection and analysis. Whilst surveys are used the respondent group of around 450 is too small to be seen in the context of 'survey' as it is listed here so that sits just outside the ellipse.
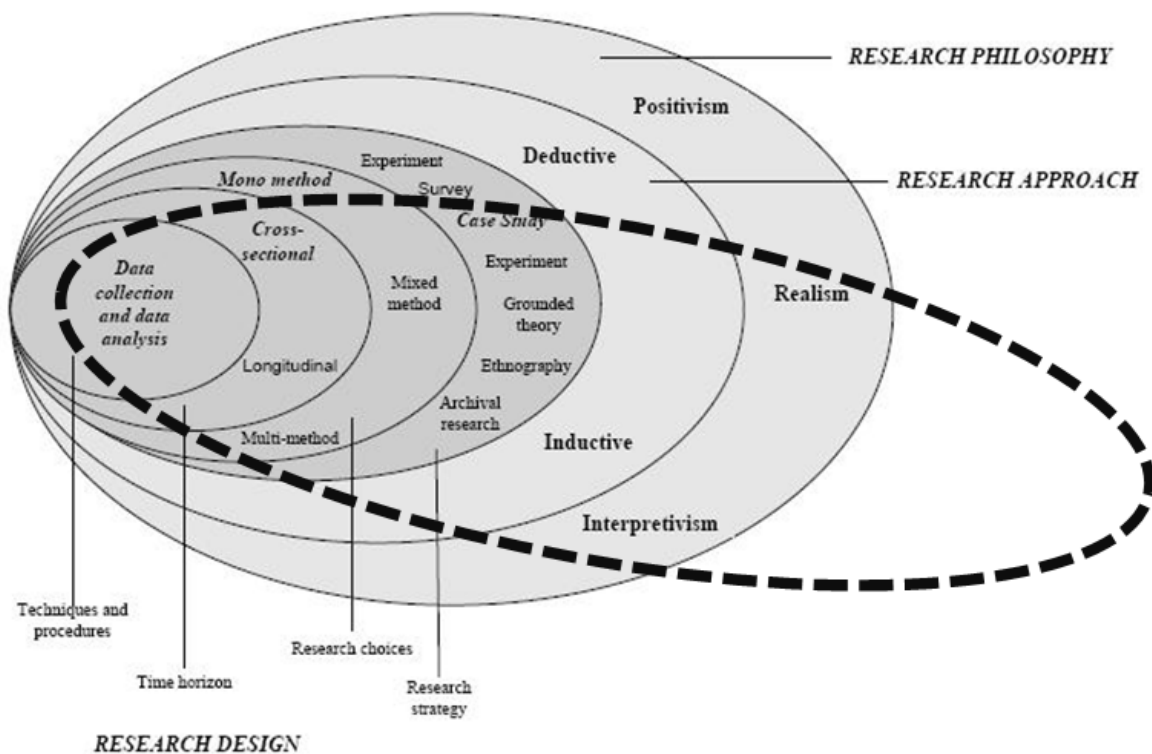

Fig 3. Saunders et al (2007) Research Onion.

The data in context

The analysis of the data has been addressed piece by piece in the previous chapter but it needs to be drawn together and put into context. The data is very much a series of brief snapshots, small windows to peer through, each presenting their own image. These need to be synthesised together to form a complete picture.

There are the broad brush strokes, defining the horizon, the texture of the post-compulsory land and the light in the sky. These are the findings regarding exam grade boundaries and the societal and governmental restrictions regarding the use of maths GCSE as a backdrop in which the learners exist.

Small figures, each telling their own story assume a place within the picture and it is often theirs which changes the overall feeling of the entire view. In the same way Hieronymus Bosch's 'The Garden of Earthly Delights' (Appendix 8) appears to portray a simple set of three landscapes, two by day and one at night, it is only on closer inspection of every small figure within those landscapes that the full meaning of the triptych becomes clear as man progresses from the Garden of Eden on to the activities of life then on to the dreadful day of reckoning. It could be pressed into action as a somewhat tenuous metaphor to the progress of a school learner from the gentleness of primary school, onto the blossoming experiences of secondary school and adolescence then finally to the nightmare summative assessment and the realisation that their future hangs in the balance.

The point of this metaphor is to see the data in the context of hundreds of individuals existing within a landscape drawn by others and doing the best they can within it. The learners are the data and, as Dewey suggests, their interactions have an effect upon the landscape in which they exist. The situation that Hildebrand speaks of is moulded by those interactions and the learner becomes part of the experience of the whole cohort. Each learns from the actions of the other and collaterally grows their knowledge accordingly.

I have divided the summation of the data into three branches so that each dataset from Plowright's FraIM (2011) forms part of this 'balcony view' of maths in FE from where an educator may be able to see the FE Maths sector from a more objective position than they might when they are in the thick of the business of teaching and learning.

'the skill is getting off the dance floor and going to the balcony- an image that captures the mental activity of stepping back in the midst of action and asking – What's really going on here?' (Linsky,M & Heifetz, R.A 2002 p54)

The three branches of conclusion:

I.   Cognitive load.
II. Teach less, learn better.
III. Collateral growth.

(I) Cognitive load:

The interview with Yasmin **(FraIM 8)** produced this piece of student voice:

"I don't think you get it yet. It's really important that you understand. It's about how much your brain can hold; if all your head is taken up with anxiety then there is no room left for the stuff you're meant to be learning. And if you do learn anything, it's too painful to try to remember it because it's kind of tied up with bad stuff too, all the learning is jumbled up with feelings that you want to forget. I like this environment because you are willing to listen. It makes me want to be included. It's like a safe space. Being able to choose where you sit is great too – I can sit anywhere in here."

At this point, there is a temptation to go off on a tangent and cite Cowan's (Cowan N. 2010) description of short term, long term and working memory in order to challenge Yasmin's theory that anxiety takes up the room needed to store information for what Dewey termed 'bits of cognition' (Biesta and Burbules 2003 pp44-45) relating to maths. However, pragmatism suggests that whatever the objective truth regarding the capacities of the areas of the brain where memory actually resides, all that really matters here is Yasmin's subjective opinion that her mind 'fills up' with anxiety, preventing the maths from having any brain space to go in to. The image she has created, the mental picture she has painted of learning maths, is all that matters. If Yasmin is to learn, then Yasmin must find a situation that allows her to find meaning in the lesson.

As stated earlier, Dewey considers meaning not in the way a concept is perceived but as a *"property of behaviour"* (Dewey 1925 p.141). Yasmin has adopted behaviour which prevents her from learning once she feels her mental capacity impeded by anxiety. For her it has become a binary response; calm allows learning to occur, anxiety prevents it.

Perhaps the core-concept-curriculum which restricts the taxonomy of maths topics to those in the Essential 8 is not enough to address the issues surrounding cognitive overload. Despite mastery teaching having deep topic learning before moving on at its heart, just adopting pedagogy and waiting for the results to occur is obviously folly. In

the same way that Nuthall refutes the idea of a 'recipe' for 'good' teaching, (2007 p.14) it is ridiculous to consider a resource led mastery pedagogy (such as the Essential 8) becoming a magic bullet to fix FE maths education. Whilst such a pedagogy may allow learners to develop in-depth skills and confidence, it must be conducted within situations geared to allow effective, meaningful learning to occur; it must provide a learning experience conducive to Dewey's "experiential continuum" (1938 p33) whereby an individual lives and enacts the teaching and learning process as a whole which will transcend the limits of mere memory and actually change behaviours to allow meaningful learning to occur and build the confidence to tackle problems presented in the following lessons.

The situation created in classrooms must become the catalyst in order for a core-concept-curriculum to be employed to full-effect. Consider what happens when that nurturing situation is abandoned, even for those negatively affected by the time-limited, arbitrary testing of largely irrelevant mental numeracy skill that were immediately put off by an activity that tested them until failure. Failure testing may be fine when testing kitchen cupboard doors to destruction but it is at best a questionable method of assessing young people.

This is the inherent danger of randomly introducing incongruent activities into an established pedagogical approach. There is equilibrium, a trust relationship between teacher and learner that lies at the heart of an effective learning environment. The power of an ineptly planned activity or unsuitable resource should not be overlooked. Detractors from the approach that I use in our own classroom often claim that the Essential 8 is merely a resource and as such just one of many without any greater particular merit than any other set of questions. On paper the resource is just that: a set of questions. However, when considered in the correct setting, with the numbered posters for reference and in an environment where students are encouraged to help each other and ensure no-one is left behind, the resource actually becomes an integral element of the entire pedagogy.

Just as importantly, the assessment surrounding a GCSE maths course has to recognise the final destination which is the summative national assessment in May and

June each year. The assessments used which limit the topics assessed to those 8 within the programme (as a reminder they are Transformations, Area and Perimeter, Probability, Angles, Percentages, Ratio, Algebra and Straight-line graphs) occur 3 times throughout the year and prove to be a slightly more accurate predictor of final grades than the January mock exams which are simply past papers. Nuthall believes that a more in-depth and accurate assessment of a learner's understanding of a topic can be gained from interviews than merely testing them with questions (2007 p.39). Perhaps cognitive overload might be address by turning the cognitive load burden into a whole discussion that might alter the nature of the knowledge from being purely discrete and explicit into a cohesive narrative. This may be the 'hook' that a learner requires to hang their learning on, so they might remember its whereabouts when it is called for in the terminal exams.

It is probably fair to say that young people will never be required to recall such a broad spectrum of knowledge as they do in the few weeks in the summer of their last year in secondary school when the GCSEs descend upon them. Pressure is ramped up throughout their final year with mock exam and after school interventions which may put further pressure on learners who are already in a heightened state of anxiety. Many subjects require a vast amount of explicit knowledge to be regurgitated on demand and the settings for the exams present learners with a clinical formality they may never have previously experienced. It is somewhat telling that the advanced qualifications within higher education have no such summative assessment attached to them as the value is recognised as laying within a deep understanding rather than remembering facts which are likely transient in nature and without particular importance beyond the realms of a test.

When coupled with the established school regime of students being told when and what to drink, when and what to eat and what to wear basis age and gender, the situation created is far from conducive from one of effective learning for many young people.

3 realms of cognitive load

John Sweller (2019) proposes 3 realms of cognitive load which may be explained as follows:

1. ***"Intrinsic Cognitive Load***

   *This type of cognitive load refers the demand made of a learner by the intrinsic quality of information being learnt. The load exerted on a learner depends on the complexity of the task set or concept being presented, and a learner's ability to understand the new information. The intrinsic nature of such a cognitive load makes it difficult to eliminate: you will always find a difficult, new activity (e.g. solving a complex equation) more challenging than a simple task (e.g. adding two small numbers together). However, the cognitive load resulting from a complex task can be reduced by breaking it down into **smaller, simpler steps** for a learner to complete individually.*

2. ***Extraneous Cognitive Load***

   *Extraneous cognitive load is produced by the demands imposed on learners by the teacher, or the instructions that they are asked to follow. This type of cognitive load is extraneous to the learning task, and is increased by ineffective teaching methods, which unintentionally misdirect students with **distracting information** or make a task **more complex** than it needs to be.*

3. ***Germane Cognitive Load***

   This third type of cognitive load is produced by the construction of schemas and is considered to be desirable, as it assists in learning new skills and other information. A memory schema is a conceptualisation of a particular idea or object which tells us what to expect when we encounter it in the future. We hold schemas for people, household objects and 'script' schemas for routines and events such as our morning routine, as well schemas for particular 'roles' that we find people enacting, which tell us what kind of behaviour to expect of them." (Sweller 2019)

The mastery approach this study examines tackles these three types of cognitive load by respective means of resource, situation and curriculum.

Firstly, the intrinsic cognitive load is mitigated by the Essential 8 resource which presents the learner with a step-by-step approach to obtaining the skills needed to pass their GCSE. The nature of the resource incrementally builds in complexity and design to inspire confidence and lessen the impact of new information by ensuring a 'primer' has been introduced in the form of prior questions.

Secondly, extraneous load is reduced by having the compassion and empathy required for an ethos which dictates that 'no one gets left behind'. The demands of secondary school that so many learners find too constrictive and controlling to allow room for learning to occur are removed by carefully constructing the physical and emotional learning environment to be as conducive to learning as possible. The situation created forms the experience of the learner.

Lastly, by carefully sequencing the information and always ensuring the topics are presented in the same order, learners are familiar with what to expect and when to expect it. The drama of unexpected and feared topics cropping up unannounced is removed and a clear set of 3 cycles of 8 topics is presented with similarly sequenced posters displayed to assist with autonomous learning and dispel any anxiety surrounding the 8 topic areas.

Teaching just 8 topics invites and attracts criticism from some areas but the approach has worked and is working for thousands of young people. Learning less doesn't means knowing less however. Offering an opportunity to understand topics in-depth can allow learners to find the confidence to tackle unfamiliar problems with greater enthusiasm than they might have.

(2) Teach less, learn better.

Shamelessly borrowed from the German designer, Dieter Rams' design maxim of "Weniger aber Besser" (Less but better) employing a core-concept-curriculum does mean much of the peripheral intricacies can be largely dispensed of, or at least seen in

context as the essential topics are brought to the fore and comprise the very essence of the GCSE re-sit course.

Obviously such a pared-back approach invites and attracts criticism from those educators and stakeholders urging students to achieve beyond their aims and assist in scaling the heady heights of league tables for the benefit of their schools.

By teaching less and thus enabling learners to have the clarity and manageability of core concepts in maths that have previously eluded them, the cognitive load can be balanced with the knowledge that is created as a by-product of the learning itself. Moreover, by reducing learner anxiety through carefully planned activities and resources, a suitably conducive situation may be engineered where learners, as a complete group, may become confident with a whole topic before moving on to the next. Such is the central tenet of mastery. The collateral learning that occurs as a result may become the tacit knowledge required to retain and recall the implicit mathematic skills and abilities necessary to obtain the grade 4 GCSE that eludes re-sit learners. Perhaps the implicit cognition of learners forms the hook on which to hang the explicit maths knowledge.

Much of the informal feedback from students is personal toward the teacher. This puts a certain amount of learner success down to the personality and rapport that the teacher has with their students. A by-product of teaching a restricted curriculum is that the teaching staff are naturally encouraged to work together in the planning, execution and delivery of each topic. It also gives confidence to the teachers that they are not alone in their quest to deliver the very best opportunities to their learners to attain the grade 4 pass in their GCSE exam.

Teaching less also allows students a chance to use their skills to tackle related problems. When a child learns to read, it doesn't need to be taught every single word in the English language to read unfamiliar words, the skills are transferable, as are the skills in maths. For example, if a maths student understands linear sequences, then they are likely to immediately understand linear equations. Providing they are presented in a logical order, topics can dovetail together to actually follow a meaningful

216

progression, almost providing a narrative themselves by having their place in a cyclical scheme of work that is designed purely to cater for re-sit students. Fewer subjects presented in a logical cycle. *Less but better*.

In is vital to bear in mind that FE maths learners are re-sit students, just as Nuthall states that around 50% of what is taught in lessons is already known to learners (2007 p.35) then it *should* be the case that 100% of what is taught in FE is vaguely familiar to the students in the classroom. The crucial word here however is *'should'*. Much of what has happened in secondary school is completely forgotten by some learners as the conditions in which it has been presented are now too unpleasant, stressful or boring to promote effortless recall.

What happens around the learning of explicit mathematical knowledge is bound to affect its recall. The woman in her early 30s from the college marketing department that inexplicably burst into tears when entering my maths classroom to take some photographs bears testament to just how much the emotions surrounding an academic subject remain attached to that subject for ever and are completely inextricably linked for some people. Just like Chloe, the student whose primary teacher prevented her from going to lunch until she had finished her sums; she would often eat snacks in maths as she associated the subject with hunger. The process of learning is so much more than simply ingesting factual knowledge, it is the whole experience of watching, listening, discussing, writing, reacting and interacting. Attempting to separate the implicit from the explicit is not only futile; it is a practice devoid of any humanity whatsoever.

(3) Collateral growth.

The tacit discussion in this study has become increasingly prevalent and relevant as the research evolves. Just as Dewey talks of *"bits of cognition"* (1938: 43) being learnt in isolation and therefore devoid of meaning, when a random topic appears in a scheme of work and is then presented to the student, it is likely to have the same meaningless impact; it has no story, no sequence, no relevance.

The overwhelming majority of feedback from the research cohort concerns itself not with the maths skills themselves but in the way they are offered and acquired. Working

together as a cohort and discussing with a common language is at the heart of Dewey's conjoint community concept (Biesta and Burbules 2003 p29). and this is where the development of young people into proficient learners can be seem most obviously. Whilst Wiliam twists Nuthall by citing that 80% of what learners discuss is wrong, when seen in the context of the whole book, Nuthall (2007 p.43) classifies the 'three worlds of the classroom' as the public, semi-private and private; respectively that which the teacher or observer sees, that which is shared among peers and lastly, that which happens inside the learners' mind.

What Nuthall actually states is that *"peers are a major factor in student learning"* (2007 p.104) and asks what should be done *"if a significant part of what a student learns is through informal, often spontaneous peer interactions"*, suggesting one way might be for *"the teacher to become more involved in the peer culture and subtly work with it to manage each student's learning opportunities".* (2007 p.105)*.* He goes on to note that what is needed is the development of a classroom learning community with a shared set of attitudes and beliefs.

This is the heart of the classroom *situation* that Hildebrand discusses and possibly why so many 'magic bullet' schemes fail as they ignore the huge power of peer interaction and centre on the one way didactic, teacher-fed stream of knowledge. Just as 'quality' departments and OFSTED inspectors want to see less teacher talk and more work being done by students, this is a gross misunderstanding of moving away from didactic methods as there is rarely any recognition of a classroom community that has established a learning culture which may include much peer discussion, which is usually misconstrued as 'low level disruption'. As Nuthall suggests, most of the knowledge peers exchange is 'wrapped inside' personal relationships. (2007 p.92).

When my student Anita asked why I didn't ever teach her anything simultaneously conceding that she was learning a lot, the concept of tacit knowledge transfer has to be broached, albeit an area fraught with pitfalls from the psychology disciplines. This study of education has to look beyond the maths; considering Katie's comment of *"if I can do maths I can do anything",* it is clear that maths may well be a barometer of self-confidence for some learners.

218

Measuring collateral growth is not ever going to be an easy task as it would mean attempting to quantify that which can only really be witnessed in action, in the everyday tasks of social exchanges, vocational confidence and the willingness to ask for help when it is needed without fear of ridicule. Sennett's shame of dependency was at the fore when Nasim forgot his pen in the exam he was late for. That same dependency needs a learner to have the confidence to ask for help when needed. It is no small request for some learners.

Perhaps caution should be exercised when considering Dweck's (2006) growth mindset, as there is an inference that such a thing could be taught or instilled in learners. Whether this is the case is a matter for conjecture but the learning of any skill with relevance, without the hook to hang the learning on, is at best, unlikely to be something akin to meaningful learning. More likely is that the experience of a carefully structured situation where learners are encouraged to ask questions, of peers and their teacher, will provide the reassurance and necessary confidence to try, safe in the knowledge that there s no shame in failure, no shame in dependency, just the chance to exist in a supportive community that will show the way, similar to Wittgenstein's London tour guide (Gasking & Jackson 1952) and navigate to the correct solution to a problem.

Dewey's *habits* (discussed in Chapter 2) that he suggests lead to meaningful learning are part and parcel of the learning experience. In the survey (FraIM 16) the collective sentence suggesting the Essential 8 is perceived as being valuable as "To practice the topics helps you get it, remember and learn more". This suggests that the whole cohort have a desire to repeat the skills needed to master topics, it suggests they are forming the habits needed to achieve the success they seek and that are growing through the collateral act of learning. Not just learning explicit mathematical facts but obtaining knowledge greater than the sum of that which is being offered to them. Dewey talks of 'collateral learning' and makes the point that the act of learning, the physical interactions of the actual process are what gives meaning to the knowledge, consolidating it within a whole process in which the explicit knowledge is a memorable part of the whole experience.

Collateral growth requires the correct resources, a suitable situation which has been engineered to allow a peer group community to share their thoughts and an overarching supportive ethos of honesty and trust. This cannot and does not happen in secondary education because of the preoccupation with perfect behaviour, unfair differentiation methods and high grades for performance tables. Further Education can be the saviour of those learners denied a maths qualification by the school system but only if the factors that prevented school from working are not repeated in FE.

As Nuthall suggests (2007 p.26), it is important to be wary of recipes for good teaching, if it were that simple then a robot in front of the class would suffice but there is far more than mechanics at play in the complex interactions between teachers and learners, as well as between learners and learners. Collateral growth is the product of situations which engender meaningful learning experiences. It is the effect which passes exams, changes self-perception and allows students, and teachers, to become more complete and therefore more confident and useful to society as a whole. Maths may be the catalyst needed to start the growth process purely through gaining the implicit knowledge that perhaps sometimes, it feels good to learn.

Reviewing the landscape

A design of a whole approach to teaching GCSE maths which adheres to the Dieter Rams design maxim of "Less but better" allows for a curriculum which is specifically constructed to ensure the highest possible chance of a young person reaching a grade 4 pass in the maths GCSE whilst requesting an amount of learner effort and commitment which is suited to as many learners as possible. As many great artists throughout the ages have made it a rule to only put their signature to a painting once it has achieved its purpose and, once signed, add nothing to it whatsoever, perhaps it should be the case that once an approach is settled upon and deemed to be 'good enough' that it is adhered to, understood and established as a model which serves its purpose. If that purpose is to redress the balance imposed by

governments, schools and exam boards which preclude a section of the community from bettering their quality of lives then that must surely be a positive outcome.

The FE sector is now starting to have an impact on the secondary education GCSE maths pass rates that were traditionally used to engineer the fates of school leavers and the role of the FE College in GCSE academic subjects of English and Maths is becoming more influential. The 2019 EIF for OFSTED reflects the importance of the FE sector as if it is becoming recognised as having a bearing on the future of our society more than ever before.

Whether a mastery approach which is designed to allow learners a positive experience of learning mathematics is seen as a means of raising the aspirations of a generation which may be passed on to the next or it is seen as cheating a system designed to ensure a percentage of people as set aside as failures, is entirely a subjective matter.

Those detractors from the Essential 8 mastery approach that is under scrutiny in this study generally have a vested commercial interest in scaring people into spending money to pass their maths GCSE. The UK maths tuition market, whether school based, home based or online is worth £6 billion per annum (Tutorhunt 2019); as a result, there are many stakeholders who view the 40% fail rate with avarice rather than dismay.

It should be noted that the grading system for which the boundaries exist are not only there for the pass/fail grade 3/4 but there for all the grades right up to the highest grade 9. In a secondary school setting the grade a learner achieves may be an important factor in their future studies. In the 16-19 FE sector the outlook is far more binary, very few learners will achieve a grade 5 pass for instance, so the only option is effectively to either pass or fail. Whether the GCSE is a suitable exam for FE learners is hotly debated and were the outcome of the 2019 UK General Election to have been different, all opportunity for post 16 re-sits would have

disappeared, denying a second chance to those for whom school did not work. High achievers in schools may relish the idea of getting the highest grade possible and they should not be denied that opportunity but the grading system in FE may well be better served by a qualification designed for allowing employers to have the reassurance of a person's ability to appreciate the conceptual rigour of passing a maths GCSE without the grade boundaries issue being quite such a draconian cut-off. If an alternative GCSE which still held the standing of a grade 4 GCSE were offered, it may be a sensible option. The current practice of using a Functional Skills level 2 as an alternative to GCSE is far from satisfactory as it has little currency with many employers.

The data paints a picture full of learners in great detail against a possibly alien landscape of Further Education. Many students are for the first time really questioning why they have not passed their GCSE, what they are trying to learn and how their teachers are going about the process of offering them the chance to pass their exam. Relationships of honesty and trust are built among learners as they rediscover skills that they thought impossible and find a confidence that had previously eluded them. Their response to learning maths changes as they find themselves responding to a pedagogical approach which is focussed on success, not just in exams but in the act of learning.

Overall there are few huge surprises. The fact that there is a correlation between students' impression of maths and school as a whole shows just how important a subject it is in the minds of some students and the weight placed upon it from a societal view point. Above all, critical incidents show the evolution of pedagogy, the minutia of conversations and interactions which serve open tiny windows onto the world of maths education as viewed by the learners themselves. The data does not paint a picture of despair. Young people have a desire to do well if they can find the correct situation in which to learn.

One of my students found school almost impossible to attend. Constantly in trouble at school, a worrying history of substance abuse and with no support from home, he came to our college in September. He wrote this email after his first 3 months at college:

"Hi John it's me from your maths class,

I'm really panicking about taking my GCSE's and I feel like I really need some extra support, is there anything you could do to help? Even if it's extra revision for me to do on a regular basis to keep me busy, or extra classes like instead of 2 days a week maybe 4/5? I need to pass to get the job I want for my career. If you could get back to me ASAP that would be great. Thank you ever so much for your help."

This young man has found purpose in his studies, possibly for the first time. He may not recognise it as success as such but it may be the first chapter in a successful story. His story.

Whilst he is at the start of his journey, I received another email from Janey, a student I taught 3 years beforehand in the first incarnation of our mastery pedagogy:

"Hello John,
Hope your well ?! So I got my results from my maths GCSEs that I re took
in November and guess what I finally passed !! Only like 10 times of taking
it. But didn't give up !! "

Janey left school with no qualifications and is now a mother with 2 children and has continued with maths for years until she passed. It is testament to what can happen when a learner is given a positive and supportive situation in which to learn and leaves FE with a mindset and experience borne from honest care and concern and a carefully crafted curriculum. She carried on because the paradigm shift she

decided to undertake changed her mind set. That change may indeed go so far as to re-frame the very meaning of success in maths as Megan suggests in her email...

"Hi John !

Thank you so much for all your help with my maths! I didn't get the 4 I wanted but I still got a 3 which I am so pleased with, to come up from an 1 to a 3 is such an improvement for me and I couldn't of done it without your help! Thank you so so much!

Megan."

Dweck's growth mindset (2006) maybe at play here but this learner had no lessons regarding acquiring a growth mindset, instead she learnt through the process of learning, the process of doing maths in a community of learners. Similarly, Janey has changed from hating maths to seeing it as something to be achieved and proud of. Most heartening is that she will impart this message to her two daughters; a message which she learnt through the tacit transfer of an ethos which has changed her personal mindset. This is evidence of the 'collateral growth' that this study proposes as a concept which could be used as guide to shape the curriculum, delivery and nature of maths in FE.

The pass rate paradox

Having firmly established that exam boards admit the maths GCSE pass rate is influenced by the government, it is reasonable to accept that every one of the half a million learners sitting the exam each summer are in competition with each other, regardless of their educational setting (secondary, FE, adult provision etc).

The salient point being that the effort being poured into maths by many stakeholders will always be pegged to a finite quantity of learners passing. Maths tuition is a huge industry in the UK with multinational companies trading on the struggle of young people to the attain grades necessary to continue their education or vocational choice.

Whilst there are millions of pounds of public and private funding being given over to improving maths, how that improvement is to be measured should be put under a critical spotlight or all the financial input and commercial ventures purely exist for the sake of their own benefit. The plethora of maths teachers professing to have the magic-bullet answer to cracking the secondary maths success crisis are ploughing a futile furrow; no matter how much 'improvement' their podcasts, books, conferences, software applications and interventions create, if the quantity of young people allowed to pass remains at 59.9% as it has for the last 3 years, the question of the purpose of maths for the sake of maths must be broached.

What the data means for life after maths.

All the time maths experts are focussing the gaze upon curriculum content and avoiding examining the experience of the learner, the reputation of maths will remain as a subject that is reserved for well behaved, punctual people with fully stocked pencil cases.

The data actually paints an overwhelmingly positive attitude towards learning maths with a mastery pedagogical approach from learners who have left school without the academic success in the subject. The only negativity surrounding the project comes from students when poorly planned activities interrupt the cyclical 8 topic schema and from FE leaders when their outmoded perceptions (that all FE learners are destined for blue collar vocations) are challenged.

If maths can indeed offer learners an opportunity to overcome crippling self doubt and lack of confidence in their everyday lives then may find the permission to assert that they are "not the dumb one anymore."

Empathy, not just reflection.

Student voice may not be totally reliable but the way we use that feedback as educators is just as open to misguided decision making. The 'reflective' model that is drummed into trainee teachers asks educators to look at themselves and adjust their practice accordingly. I argue that we should look to our learners' perception of their learning experience and adjust accordingly to it, but only once we are sure that our interpretation of their feedback is as they intended. Reacting to feedback requires us to understand

that those offering their opinions may hold a different set of success criteria to that of the educator.

A classroom practitioner has to ask whether they are doggedly going to press on demanding their version of good teaching or adopt a model which their students consider to be their version of good learning. In the same way TVs 'River Monsters' famous angler, Jeremy Wade titled his book "How to think like a fish" perhaps educators need to learn how to 'think like a learner'.

Just as the master angler realises he will be most effective if he learns to 'think like a fish' then surely teachers should be instructed on how to 'think like a student'. It is only when educators become 'busy' in the classroom that any semblance of empathy, and therefore understanding, of learning can take place. By 'busy' I mean moving around tables, sitting with learners, trying to see the whiteboard, hear a video, not be distracted by the window, ignore a flickering fluorescent tube or write at a wobbly desk. Being 'busy' is the key to our mastery programme as it allows the teacher to stop looking at themselves in the mirror and start experiencing learning as their students do. When I play guitar in my band, how I sound to me is so much less important to how I sound to the audience so I periodically pass among them to check everything is as it should be and the music sounds good. Teachers are not being encouraged to do this regularly and perhaps that must change. Part of the problem is the quality of teacher training and the lack of academic rigour within the FE sector.

The clarion call for all educators to adopt reflective teaching practices is a constant source of concern given that it doesn't seem to be improving the quality of learning. Amazon currently lists over 2000 books regarding reflective teaching. It may be improving the quality of teaching but there can be little justification of honing a skill until it becomes increasingly less relevant to its intended purpose. Initial teacher training appears to be missing the point somewhat as it trains teachers to be skilled in the areas deemed important for teaching but largely irrelevant for learning.

School Centred Initial Teacher Training (SCITT) courses allow individuals to become teachers without an overseeing university which in turn reduces the number of

applicants to the university route of entry and the academic rigour available for teacher training is continually eroded. Without the innovation and progressive research of academia, teaching will not evolve but learning will. The gulf between teacher and learner will widen as learners are shaped by their surroundings and their world tends to move faster than that of their elders. This is especially true with the way in which they access resources and interact with each other using rapidly evolving technology. That peer interaction in the classroom is less subject to change but it still evolving as learners adapt and change to the situations educators create. 'Thinking like a learner' allows the teacher to become part of the learning, not just the teaching, acting for a catalyst of the tacit knowledge transfer, facilitating the collateral learning that can be transformative in the experience and enjoyment of the learner. The power of that enjoyment, or 'fun' should not be overlooked.

Shaping the horizon.

For all the data which exist within this study, there is no huge revelation beyond that which suggests that some students care about their experience of learning mathematics and use it to shape their opinions of themselves and their attitudes towards the subject.

The next and final chapter addresses what a mastery pedagogy means for stakeholders in the learning process and suggests practical ways in which the practitioners within FE classrooms can build upon the inherent nurturing safety net that the sector offers to learners that have fallen from the trapeze of secondary education as they lose their grip on what it means to succeed and how they deal with the shame of failure which may have been instilled by their secondary school settings.

FE is a sector which is changing the way in which maths can be presented to offer a learning experience which will change generations of young people's attitude towards mathematics. Changing learners' perception of maths is why I joined the profession in 2011; a video (Cooper, J. 2011) exists online that continues to sporadically solicit responses from around the world from educators who want to know more about changing the teaching and learning for the better.

'Teach more faster' must change to 'teach less better' if the full potential of learners is to be unlocked by the doing of learning maths and the collateral growth which blossoms from that experience.

Managing Risk.

It would be naive and irresponsible to overlook the risks of employing a mastery based, core concept curriculum without considering the risk associated with such a pedagogical approach. This again is where the teacher must expect and aim to be 'busy'. This is not necessarily what an external observer would like to see. A common criticism and euphemism used by dyed-in-the-wool inspectors to admonish busy teachers is that their response towards a class full of eager learners is akin to 'herding cats'. The idea that a teacher should be busy in the classroom is an anathema to many observers of classroom practice as they consider themselves to be able to achieve the pinnacle of education teaching excellence whilst sat in a chair in the corner. The initial risk is to the educator as they will be judged as inefficient, talking too much and not allowing the learners to struggle. These traits are admirable in GCSE learners in secondary education but they are not the default abilities of the learners in FE (else they would have passed maths exams and not be there) and the FE teacher must be prepared to accept the danger of his or her classroom practice being alien to the likes of OFSTED observers, few of whom come from an FE background.

Another, far more concerning risk is that of presenting too narrow a curriculum to the learners, resulting in boring and repetitive lessons. The data from learner feedback does not support this negative possibility but just because it doesn't for the small scale response group in this study does not mean that it actually might be the case for a different cohort in a different setting with teachers less familiar, or even new to the Essential 8 programme.

Teaching students fewer topics more deeply and expecting learners to use that depth of understanding to tackle other topics independently (that is, without being discretely taught) is that recurring leap-of-faith that occurs throughout this study. A leap for both teacher and learner. In my experience, the learners adopt such an idea very swiftly and are quite flexible in attempting new things using established skills; teachers however,

understandably feel guilt and anxiety when considering the fate of their learners when they are faced with a question which requires mathematical skills that they have chosen not to teach them. This again is where a gaping chasm opens up between teaching and learning however. There is a useful humorous device that illustrates this chasm which has been used to promote ideas surrounding Assessment for Learning, often depicted by a cartoon strip of questionable origin which centres on a boy, a girl and a dog:

Boy: Look. I taught my dog to whistle... Whistle Rover. Whistle!
Girl: (Listening) I can't hear him whistling.
Boy: I said I taught him to whistle. Not that he *learned* to whistle.

Whist AfL uses this as a metaphor to justify making learners perform like animals on demand in response to quick fire questions directly after they have been taught, it is more relevant to the situation surrounding the idea that teaching a topic means it can be ticked off a to-do list (as is the way with many schemes of work) whilst assuming that having been taught, the same thing has been learnt.

The graphical scheme of work (Appendix 1) that accompanies the Essential 8 approach relies on allowing students to see a graphical representation of what was done when, what topic is coming up next and how far through the year they are. Learning becomes a linear process whereby learners can see their efforts rewarded by gently improving outcomes to low stakes questions in their Essential 8 workbooks, safe in the knowledge that any issues of concern they have will be addressed further down the road of the academic year. This adheres to the central mastery tenet of no learner being left behind.

Mitigating the risk of missing out topics can be achieved with exam practice for students, much of which can be achieved online with limited educator input thus making it ripe for extra curricula study or even traditional 'homework'. As, unlike in schools, FE college functions largely without sanctions or behaviour points, homework is difficult to employ as an activity which all participate in and it should not be viewed as a way of learning which entirely removes the risk of learners not seeing everything they will need prior to their exams, however past paper practice, either online or on paper, can be

229

used in classrooms as a tool to give learners a flavour of what may occur. It is also vital to remember that the FE course is a re-sit course, suggesting many learners will have had exposure to some of the topics not specifically covered in the Essential 8.

Offering a curriculum that is narrow but deep, rather than skimming over lots of topics does come with an inbuilt jeopardy that maths is reduced to a set of topics, taught in a formulaic manner and learnt by rote. It is imperative that breadth is a watchword for all lessons planned for within a mastery approach.

Achieving breadth within a core curriculum.

Depth of learning is the domain of the experts, in Sennett's terms, the currency of the craftsman. When experts in niche areas are portrayed in books, films and the media in general, they often have attributes attached them to make them appear as socially inept introverts, geeks or loners. Whilst this makes for an entertaining stereotyped character, it also hints at the notion that breadth of knowledge creating the opposite type of person. Individuals with wide ranging interests and skill generally find it easier to enter into conversations and social circles with a large cross section of society; their usefulness in helping others and meaningful interactions with others lead to rewarding and fulfilling lives.

Breadth of knowledge must not be allowed to suffer due to educators' dogged determination to stick to a core of topics with no regard for the setting they are presented in. Breadth equates to well-rounded learners, capable of debate surrounding where certain skills may be used, recounting prior experiences (e.g. "I've always hated fractions") and actively discussing the wider implications of what could be left as a narrow subject. That breadth is the lifeblood of human development; it is the spreading out of ideas in groups and the extrapolation of theories into arenas that may initially have no connection to the topic but, through discussion, argument, assertion and retraction of opinion; learners become able to ably hold discussions, see others' views, postulate their own theories and arrive at decision. Breadth can be engineered into a situation in which collateral growth can occur. That same situation can allow for learners to experience a clarity of thought and ease of understanding that may otherwise not be present. This breadth of understanding, the knowledge that is cemented by the events

around which the discussion and the business of *doing* learning is happening, is concerned with communities of learners. The uncomfortable truth is that no such community exists within the restrictions placed upon students when they are seated in the exam hall at the end of the academic year. The exam hall is the learner's time to shine, they have moved from the doing of learning to the doing of performance. This is a very different skill and, any musician, actor or sports person will attest to, it is the purpose of all that practice and all the learning. Moving from pedagogy, the study and execution of education, exams require a completely different set of skills to be understood. As stated beforehand, Csíkszentmihályi's *Flow (1975)* is a worthy concept to consider in the light of the emerging themes of this study. Bearing in mind that the underlying desire to everything Csíkszentmihályi considers has it foundation in the happiness of the human spirit, there is an irony to pitching Flow as a phenomena that may be at play during exams week, a time when students feel largely unhappy, but it should be considered as a desirable attribute when summative assessments are upon the learner.

Discussed earlier in this study (and extensively in my masters degree research) Flow is the state of optimal experience which learners might find themselves in when performing a demanding task with a high degree of proficiency. Such a state is often seen in dancers, solo musicians, jugglers and the like. It is the performance of practice but it has to be seen within context.

When I engineered situations in the classroom in order to encourage Flow to occur I was in secondary school, teaching a talented year 9 class. As previously stated, a little knowledge can become an issue if not seen in context however. The students could do difficult topics, perhaps trigonometry, but they began to only find interest in the trickier topics in which they excelled. This came to a head when I found myself with a class full of talented geometers, many of whom couldn't recall the seven times table.

Flow may be interpreted as the pursuit of getting good at 'tricks' and therein lies the tension between encouraging Flow in a mastery situation where there is a atmosphere of collaboration, tolerance, help and empathy. It is unclear whether Flow in the classroom is desirable, no matter how advantageous it may be in the exam hall. In

Chapter 2 concerns regarding drawing parallels between musicians and academic learners are voiced and musicians can be a useful example of the caveats that should possibly be attached to Flow. Many guitarists will try out instruments in music shops and it has become something of a standing joke among shop owners that the well-known songs learnt in back bedrooms are aired by budding rock stars in the high street music shop. One such song is the Led Zepplin classic; Stairway to Heaven and in many music shops across the world there hangs a sign forbidding potential customers from playing it during their try-outs. The problem is that once a technical feat requiring high skill levels is mastered then the mindless repeating of it does not constitute progress, indeed it may stifle creativity and original thought. Flow during practice is a questionable attribute whereas Flow in the performance gauge of an exam is a genuinely valuable asset for a learner to have in his arsenal when battling with maths GCSEs.

My own position has shifted from actively encouraging lesson situations where flow is likely to occur to actually disrupting those conditions of quiet, contemplative, totally immersed solitude because I am not convinced that any real learning can occur during such times and only the repetition of practice is likely to occur. Yes, there are times when such a period of quiet, dogged hard work may be productive in terms of sheer output in a classroom but I am concerned that those educators espousing such situations as being some kind of evidence of learning occurring are merely seeing it through their own, reflective viewpoint. A quiet class is one where it is assumed that the teacher is 'in control' which would be the nirvana of many educators as they are approaching teaching as a teacher, imposing their will on a group of people because they honestly believe such a scenario to be a truthful measure of how well learning is going. It may well be the subjective truth of the adult educator but not necessarily the subjective truth of the learner. If an educator wants their learners to actually grow in confidence, knowledge and skill then they should start to think like a learner.

If you want to catch fish, think like a fish.
Returning to Flow and the positive benefits of such an optimal experience leading to happiness, could it be that, whilst it is nearly always considered in terms of personal performance (athletes, musicians etc), Flow may be happening in the small groups of

232

learners that I teach? I am minded of Taylor, Charley, Kade, Abdul and Cleo. They sit on a table at the front of my class and are always talking, always questioning and always arguing. They are also incredibly happy to be doing so. It is rare to find a group of people so engaged in the subject and the work at hand whilst being so content and at ease in the classroom. They complain because lessons are over too quickly and are largely oblivious to the extraneous events surrounding them whilst they learn. They are loud, argumentative, remonstrate freely and give an outward appearance that would suggest that no learning is happening. However, as Nuthall suggests (2007 p.25) what the observer of a lesson sees and what is actually occurring may be deceptively poles apart.

Abdul has impaired vision; the others tell him what is on the board or on a video whilst it is playing. Cleo was so petrified of maths she hasn't been into a maths classroom for years, finding any excuse not to at school. Charley has a quick mind, and she has learnt not to blurt out the answer without others trying first and has learnt to let them make mistakes. Kady has had trouble accessing her vocational course as she finds it boring so has asked whether she can just come to college to do maths. Taylor cannot stop asking questions, he is so passionate about understanding the topics that he continually checks the other answers. I have never seen such a committed group of learners and yet to any observer of my class they would appear unruly and generally not engaged in the lesson.

I asked them on video what they thought of their maths lessons and they were typically happy and fun-loving in their responses but they also recognised that as an educator I have allowed and promoted their behaviour. The rest of their class have also formed groups. Friendly rivalry has sprung up during quizzes and when marks are returned for assessments. All in all, they are a class full of happy, productive, relaxed learners who are having a positive experience of learning maths.

If I think like they think, I too would like to be in that learning situation. I would like a teacher that allowed me the space to *do* learning. I would look forward to my lessons with my friends that I only get to see in maths. The time would go quickly and I would remember the topics I had learnt because they would exist in a memory of shared

233

experience where other events, arguments, jokes and discussions had attached themselves to that particular knowledge or skill. It would be a hook for me to hang my learning on.

Whilst still thinking like a learner, I would be happy, time would pass quickly and I would be having the optimal experience whilst tackling difficult tasks, safe in the knowledge my group and I would be able to solve and perform the actions necessary to complete the questions. That sounds a lot like a Csíkszentmihályi's definition of Flow. The question is, does our mastery approach engender flow within learning communities? Indeed does Flow in groups exist and is it happening in our classrooms?

When an individual is in a state of Flow, the collateral growth discussed earlier is precluded from occurring. Part of identifying Flow is looking for the evidence that all external factors are shut out; the skill of doing is the aim, the practice and the reward. The best a learner can hope to achieve in Flow is becoming the best they can at a task which they are attempting to master. In maths, especially re-sit GCSE maths, the requirement for Sennett's craft to come to the fore is a debateable requirement. A solo cellist or figure skater may well benefit from the fine motor skill or immaculate balance that Flow may lead to but knowing that the cube root of 8 is 2 requires no such delicate skill, it's just a typical exam question that a learner needs to know how to approach. That knowledge will be learnt and have to be recalled in the exam. If it has been learnt in a situation that promoted happiness, the happiness of optimal experience, then recall may well be forthcoming.

A small amount of research into Group Flow sees Keith Sawyer (a former student of Csíkszentmihályi) emerge as a key proponent of the idea. He asserts:

"Group flow requires constant communication. It's more likely to happen in freewheeling, spontaneous conversations in the hallway, in social settings after work or at lunch." (Sawyer.K 2017 p.32).

The key themes in the context of the Essential 8 programme.

- Cognitive load.

- Teach less, learn better.

- Collateral growth.

So can the Essential 8 workbooks, the graphical scheme of work that repeat the same eight topics three times over the year and our mastery approach that ensures no-one gets left behind really lay claim to having a positive effect upon the three key themes?

Cognitive load.

Certainly cognitive load can be reduced by ensuring a classroom situation exists whereby learners are not subjected to activities that will cause them anxiety and not just given harder and harder work until they fail, as it is the premise of differentiation. Offering success in 8 main topics gives learners the sense of success they have not previously experienced. Much of the 'missing' knowledge exists from prior learning in schools but has obviously not been pertinent enough to actually pass exams with. Cognitive load is one of the key themes that is directly improved by the Essential 8 programme.

Teach less, learn better.

Teaching fewer subjects to allow for deeper learning to occur appears to be helpful in young people to discover the actual physical and mental processes of learning can be 'fun'. This is in contrast to their expectation of FE maths and a departure from what occurred in their secondary school experience. The repetitive nature of the topics allows for deeper learning to occur and it marks a huge departure from the 'teach more, faster' ethos of the secondary schools attended by many of our students.

Collateral growth.

If the concept of collateral growth is considered to be a genuinely positive factor for young learners studying maths within a mastery pedagogy then that factor should be explored a little further to warrant its worth to a young adult. Opposite of collateral learning is explicit knowledge for the individual. This means that the maths they learn

will be the same but it will not include the contextual richness that gives the learning the *meaning* that Dewey proposes when discussing the very essence of acquiring knowledge. Collateral growth is fed by tacit knowledge transfer and acts to enrich the learning experience far beyond the *doing* of learning maths. When young people realise that there is more than knowledge to be gained from learning then they may go on to seek new learning experiences for the sake of the personal fulfilment that accompanies learning and encourages others to do so. This may well link to the pinnacle of Maslow's hierarchy of needs (1943). The power of learning in a group harnesses the entirety of the situation created by the educator and allows so much more to be learnt than the explicit processes and procedures of maths. If learners can indeed grow through learning maths then the life-long benefits to learners may even outweigh the ultimate goal of the terminal GCSE assessment. Unlike the national exams, the collateral growth a young person may experience is not controlled by the external decisions of exam boards and the government of the day.

SUMMARY

This chapter introduced the concept of the spiral of inductive and deductive reasoning, where the investigation of what is suspected is compared to what is discovered by virtue of what has been established.

Sweller's (2019) theories on Cognitive Load are considered as the study is further guided by the data toward the experience of the learner being paramount how teaching might add empathy to its established maxim of reflection.

Consequently, the theme of teaching less explicit information and doing so with more care for the situation in which the learning occurs with is summed up by teaching less to make learning better.

The situation that is created requires the whole cohort including the teacher (or perhaps more precisely the leader of learning) to see learning in the context of the whole rather than the individual. Borrowing from Dewey's theories surrounding collateral learning and Dweck's growth mindset work, a theme of Collateral Growth is proposed as a pertinent emergence from the analysed data.

Chapter 6: Conclusions and Recommendations:

This chapter is divided into two halves:

The first half evaluates to what extent this study answers the questions it set out to address. 'Impact' has become a far more nuanced concept than when this research project was embarked upon and the term far extends beyond GCSE exam grades. Such is the result of the norm referencing deployed to set grade boundaries; If FE pass rates improve then secondary pass rates must suffer, providing more failed students for FE colleges.

It would be a gross misunderstanding to view FE maths education as futile, adopting a negative perspective however. This study is about breaking the failure cycle for young people. From the vignettes and personal accounts provided within the data, it is clear that the grade 4 exam does not have to be the defining criteria for maths success.

The second half of the chapter makes recommendations as to how the experience of FE maths learners may be enhanced to undo some of the negative effects they perceive to be at play from learning, and failing, maths in their education so far. The blame for legacy of a difficult and sometimes painful experience of maths should not necessarily be laid solely upon secondary school policy and decision makers; neither should it be squarely heaped onto the shoulder of 'lazy' learners. As ever, education is a bewilderingly complex and highly unpredictable conundrum with no universal answer. When attempts are made to make the act of teaching easier, such as may have occurred with Assessment for Learning over the last 20 years, there are going to be casualties that fall outside of the learning populous that find the practice provides a suitable environment in which to learn. Those individuals have shaped the direction of this research and subsequently the recommendations herein are intended to improve the experience of those young people; those who deserve a chance to re-evaluate their experience of learning maths so they might pass on their positivity to future generations.

Recommendations for each of the three main themes (cognitive load, teach less to learn better, and collateral growth) are presented separately to each of the main stakeholders in the FE maths education process and maintain a practical approach to what individuals involved in the FE maths sector can do to improve the experience of young people learning in the environment.

What is the impact of a mastery approach to teaching maths on Further Education re-sit students?

From the research data it is fair to say that the impact on some learners has been profound and reaches far beyond the realms of passing maths exams. Looking at the way in which some young people have completely altered their lives because of the confidence they have gained and the lives set to be the richer for being exposed to this particular pedagogical approach to learning, it is also feasible to claim that this mastery approach is getting more people to a grade 4 pass than anything else that has been tried at the colleges involved in the programme.

The interviews and critical incidents which have caused the programme to evolve in the way it has and enjoy the limited success it has found are revealing in their seemingly unimportant relative contexts. Just as Flannagan (1956) would investigate an air crash by finding the initially inconsequential turning points that lead to tragedy, the critical incidents such as the comment questioning whether a student had improved as a result of her learning maths or as a result of her increased confidence are telling in the extreme. This is where the stress placed upon achieving the perfect mix of subjects for the core curriculum eased, as it started to become clear that the subjects taught are less important than the environment in which they are presented. Similarly, the schadenfreude displayed by the college leader was a stark reminder of the legacy issues surrounding the FE sector and the struggle that learners might have to overcome when they enter into a sector which until 2013 was almost devoid of GCSE maths rigour within its vocational departments. The introduction of compulsory maths and English GCSEs has come under scrutiny from the Mathematics Education Innovation group (MEI), claiming that GCSE re-sit isn't working and that a new curriculum and qualification should be introduced but this could reinforce the tiered system like functional skill qualifications, which their report (MEI 2020) confirms employers do not favour. The students in this research cohort seem not to all agree, with many finding the process to be among the most effective education they have ever received.

The data which are derived from the various feedback methods within the scope of the data collection see learners describing their overarching experience of maths in FE as

239

actually being 'fun' and deriving pleasure from the learning process. This should not be underestimated as today's learners are parents of the future and it will one day be the opinion passed down to a child when they turn to their parents regarding understanding why maths is being taught to them in their classrooms.

An increasingly occurring outcome that is emerging from this study's data is that students who leave FE (either having achieved a grade 4 or not) are changing their mindset regarding maths and seeking ways to continue their studies even after they have attempted many maths exams because the stress and pressure of study have ebbed away. This may well bear out Dewey's theory regarding experience providing a relative truth for each individual. Perhaps the biggest impact that studying post-secondary maths with this pedagogical approach is having on learners is their ability to re-write their experience of maths education as being futile and frustrating, to being worthwhile and rewarding. These young people will re-tell their story and it is in that re-telling that the true value of the impact on learners may lie.

Many of the research cohort are finding their experience of studying maths to be more important than the outcomes in their exams (as in Megan's account in the previous chapter). For some it is a vital part of learning and it is healing some legacy damage that had been done to them by a system that did not suit the way in which they ideally learn. Offering a learning experience which allows learners to grow through collaterally absorbing the true nature of learning new skills and knowledge may far outweigh any exam or grade. There is so much more at stake than a graded exam; the entire future of the young person and all the lives they will influence is inextricably linked to what happens in their classrooms. That is the impact that deserves the focus of this study and influences the conclusions and recommendations herein.

What is the current experience of learners and teachers of experience of learning/teaching maths?

The experience of educators.
When talking to teachers that are currently practising in the FE sector there is often a resignation to maths being a subject which is there to keep learners out of trouble for a

few hours a week, all in the knowledge that the true national average (Impetus 2017) means that just 1 in 20 will be likely to pass their GCSE the next time they re-sit.

During the writing of this study the FE landscape for mathematics has improved dramatically and the sector is being recognised as a viable and credible provider of opportunities for young people to obtain a pass grade in maths. The decision to extend compulsory maths and English GCSE to 18 if not already passed was shrouded in cynicism at the time (2013) but has since seen FE rise to the challenge, now delivering more pass grades in maths than any previous years.

Teachers are supported and engaged in learning communities who recognise and empathise with colleagues facing common issues, similar learners and the, thankfully diminishing effects of legacy policies and archaic SLT attitudes. There are resources (The Essential 8 now has more than 27,000 downloads) on TES which are now starting to be aimed at re-sit learners and the whole sector has an increasing vibrancy. TES now have annual awards for the best FE colleges for many different aspects of furthering GCSE maths.

The teachers I work with report feeling connected to more than just another set of learners to process; a common pedagogical approach which is forged in a collaborative furnace of experience, theory and a genuine desire to make a positive impact on young people's lives.

Researching the workbooks I authored with my colleague and then self-publishing them created so many opportunities to engage with educators from all over the world, culminating with the invitation to the EAPRIL conference in Finland in 2017. Since then contributors from all over the world have added their input to the Essential 8 programme and some colleges have adapted the programme to fit with their own settings to great effect. Both South Thames and Exeter spring to mind but there are others too whom have developed their own versions of the programme.

The experience of learners.
From the data obtained by the rounds of research, the emerging picture suggests that learner experience in secondary schools does not correlate directly with their maths

ability. Was it the case that it did, then this research could have been heralded as the embodiment of the theory that a better learning experience leads directly to better grades; as with most things in education the truth (if such a thing exists) is far more nuanced and complex.

The survey suggests a link between learners' feeling towards maths and their feeling towards their school education in general, so it is fair to say that maths lessons play a large part in the overall experience of young people. The learners report that they find their maths lessons decidedly agreeable and use overwhelmingly positive adjectives to describe their lessons and their experience in maths classes. They also tend towards using plural pronouns ("our lessons...", "we feel that..." etc) suggesting they feel that they are in a learning community.

Perhaps more importantly than everything else, some question how they learn; Evangelia asking whether her confidence or her ability was causing her maths to improve. Then there was Anita asking why she was never taught anything and yet finding it a fait-accomplis that she was learning lots of new maths skills. Even the disturbing reaction of being subjected to a rapid-fire numeracy test that caused Callum to angrily voice that he had been made to feel useless, these reactions show just how much some learners care about the approach taken toward their learning. Dewey may suggest that the situation they are learning within is being shaped by their reaction to the learning they are doing and the teaching they are receiving; their own subjective truth being more valid than the actual teaching and learning that is intended to be occurring.

What impact does a mastery method of teaching maths have upon learners' experience and achievement in maths?

In terms of achievement it is apparent that the Essential 8 mastery approach to teaching maths in FE is enabling increasing numbers of young people to pass the exam and move on to the next stage in their lives. Since the inception of the programme some 4 years ago approximately 60 extra students are now passing their exams each year (a

pass rate of 11% has risen to 27%). This may not entirely be down to the mastery programme itself however; many of the effects of the approach carry their own payload of positivity and cohesion which in turn affects the surroundings of the entire FE setting. Engaged and interested teachers make for engaged and interested learners.

One unforeseen result of adopting the approach is the accuracy with which learners can predict their results from the very short assessments which occur 3 times throughout the year. The results from the Essential 8 assessments, both online and the more in-depth paper versions, correlate with only slightly less significance than the mock exams sat in February. This allows a learner who is serious about passing the exam the ability to quickly assess their chances and act accordingly. Rather than teachers telling them what to work on they can work on it themselves, at their own pace.

Because the programme is supplemented with access to online resources, a really determined learner can opt to learn outside the classroom using a wide variety of applications, videos and interactive GCSE tests but sadly this option is only taken up by a very limited number of learners and the lasting effects of online, one way instruction, is debateable as there is no collateral learning happening within that instruction as the learner is unable to interact with or have an effect upon the situation in which they are learning.

What are the wider impacts on learners of adopting a mastery approach to teaching maths in FE?

The wider impacts on learners are quite difficult to predict because they may last long into their adult lives. I personally harboured a desire to become a teacher after a conversation with a teacher when I was thirteen and yet it was thirty years later that I trained to become a teacher.

From the student feedback it is evident that the learning process far exceeds getting better at maths. Lives are enriched and the shackles of low self esteem are eschewed through the process of mastering a skill. The 'less but better' approach (as inspired by Dieter Rams' approach to product design) extends beyond curriculum design into what is actually learnt by students. Rather than having a scant knowledge of lots of topics,

they find security in becoming highly proficient in a few. That proficiency allows them to 'have a go' at unfamiliar questions because they have seen, often for the first time, that success is within their capability; as Katie put it – they are no longer the 'dumb' ones.

Although the very essence of maths is entirely conceptual, the act of 'doing' maths is most definitely a tangible pursuit. The fine motor skills that Sennett (2009) discusses are employed as the confidence of Csíkszentmihályi's Flow (1975) becomes evident as demanding tasks are tackled with a substantial degree of competence. Repeated practice (the 'Grit' of Didau 2013) secures a lasting memory of facts as proposed by Ebbinghaus (1913).

The 'have a go' attitude is very much in line with Dweck's (2006) mantra of changing "I can't do it" to "I can't do it *yet*". Whilst I think it may be contentious to claim that a growth mindset can be learnt as a discrete entity, the data suggests that students are adopting such an ethos as a by-product of learning, and succeeding, at maths. To quote my student Katie again; "If I can do maths, I can do anything!"

In terms of the wider impact upon learners, this mastery programme and its associated delivery is providing students with a spring board to see over the fences they have built through years of failure. There is a tacit transfer of knowledge and confidence at play which enables students to develop their perception of their abilities beyond the 'pass or fail' mentality of their previous learning environments. The intangible notion of collateral growth can be given form and substance by the interactions of young people as they learn, grow, do, and in turn, affect the situation surrounding them and their peers in their learning community; that may be viewed as the 'conjoint community' at the heart of Dewey's interpretation, use of language and communication. If the relatively minor act of getting better at maths can achieve such individual gains, then it may prove to be effective far beyond a 'grade 4 GCSE'.

What are the challenges and limits of adopting a mastery approach to maths?

Adopting a mastery approach is unlikely to happen with any immediacy. There are also many forms of mastery despite some 'experts' in the field who claim to have proof that only one form of mastery exists and that anything different is inferior. Elements of

mastery can be introduced and as teachers and learners experience the benefits of such an approach, further parts of the curriculum and teaching structure can be aligned to the mastery concept. Resistance to change can often become an issue and adopting mastery practice may represent a considerable challenge to those that have been used to 'teaching to the middle', allowing some students to fail so they can focus on those who they consider salvageable whilst letting the high achievers coast along at the top.

In FE maths the cohorts are of less mixed ability than secondary schools and the FE is the safety net, the last chance for learners not to be branded as one of the 40% deemed to be second class citizens suitable only for lowly jobs. The main and overriding mantra of mastery, any form of mastery, is that *no one gets left behind*.

This has to include the disruptive ones that apparently don't want to learn. Also the seemingly 'slower' ones that have learnt that failure is their default state. For teachers this means being busy, moving among the class, checking work, encouraging with a quiet word or physically opening a book and putting a pen in a learners hand. This 'close quarters' spoon feeding will not sit well with those used to a less active lesson where a class is given a worksheet and expected to work in silence.

Through all his research, Nuthall concluded that a teacher has to allow a community to form among peers if teaching and learning are to be as effective as possible. That extends way beyond the widespread practice of telling learners to discuss a topic for 60 seconds with their neighbour so that an 'active learning' box can be ticked on a lesson plan.

Educators also need to be brave and very resilient because observers in quality teams, SLT and OFSTED may not have any appreciation of the 'situation' that is being engineered in a classroom. This is not their fault per-se, merely a reflection of the attitudes ingrained over years of demanding evidence of visible progress in a short period of time. A learner talking to another or in a group is often dismissed as 'low level disruption'. A student drawing pictures to answer a maths question can be misinterpreted as being disengaged. Learners getting angry with their lack of ability and venting their frustration to their teacher can be construed as showing a blatant lack of

245

respect. All these things have happened in my class and I frequently face criticism as a teacher for allowing them to occur. The saying 'you can't make an omelette without breaking eggs' is useful when appraising this scenario; being brave comes at a price but as educators we need to be brave for the sake of our students. Educators need not be maverick loose cannons but should be assertive, informed practitioners, ready to defend their methods with academic theory and a passionate belief in their own professional judgement.

What original contribution does this study make?

Much of this study relies upon the data provided by the learners within FE education in a single college. It does not have the scale or diversity of a respondent group suitable for sweeping generalisations, but it offers views through little windows into the lives of just a few hundred learners out of the hundreds of thousands in the same situation. Their accounts have made it increasingly impossible to separate them from the education itself. Because Dewey's lens allows the research to consider that all action is interaction and that the only real 'truth' is that of the individual, borne of their experience; the learner is as much a part of the education as the teacher, the content, the schema and the situation the learning occurs in.

Not entirely originally but stated with possibly more conviction than previously is the conclusion that it may be time to question the adherence to Assessment for Learning and its associated differentiation in FE maths classrooms because there is a different goal, a different destination for the learners FE look after. It is unlikely that students in re-sit classes are going to pursue a career in mathematics, not because they are stupid but because they have talents and interests which may transcend the purely conceptual world of maths and instead excel in the arts or other vocational area of industry. Moreover, the training of FE maths teachers should perhaps not follow the same training as secondary teachers if it is considered that replicating a system of which resulted in failure at school will merely result in failure at college.

The 2017 'Essential 8' (Appendix 6) data suggests there is but a small difference in the way young females and males perceive their own ability with marked differences between different topics. Gender bias is not the focus of this study however and the

results should be viewed in the context of a medium size respondent group from a similar regional location. It may not be prudent to spend time on tailoring courses for gender as the practice may only produce small gains and is also somewhat dated and inappropriate in its approach. The apparent lack of connections between maths topics made by learners is something of a surprise. Commentators and leading lights in maths education repeatedly insist that learners must be made to see the connections within maths in order to fully appreciate the nature of the subject and yet the successful re-sit learners in this study made no obvious patterns of linking their perceptions of topics together. The inextricably linked topics of algebra and linear equations showed no correlation in their likelihood to be misperceived by learners when matching student ability to student performance. Similarly, the notion that certain vocations will benefit from extensive contextualisation sounds logical but the data suggests that it may be time to cease attempting to judge good lessons by the amount contextualisation therein as it is possibly another ruse which makes teachers think they are teaching well yet has no benefit to the business of doing maths. This is as controversial as teaching 'less to learn better' but it is no less pertinent when searching for a way to break the failure cycle in which so many young people are caught.

The intervention of the Department for Education in setting grade boundaries for maths is a conundrum which pervades all sectors of society – far more reaching than just the education sector. Whether the public would be worried if the public services such as the police and fire service had no entry requirements regarding maths is a matter for wider debate. Nursing is another profession which currently demands that its recruits have a suitable level of numeracy ability. Because maths is a prerequisite for so many careers and access to higher education courses, it proves to be a highly effective initial screening method.

OFQUAL base their recommendations on the National Reference Test which is issued to 10,000 maths year 11 learners across 300 schools. Note that FE colleges are not included in the test. (OFQUAL 2018).

It may therefore be prudent to address this issue and instigate an overhaul of the grade boundary system.

Rather than merely criticise and ask stakeholders and academics to reconsider AfL methods, the grade boundary system and exams as a whole; this study has made an original contribution to thousands of young people and practitioners by means of the Essential 8 mastery programme which is in use all over the UK. The positive emergent message of this study is that perhaps, for some learners, it is the experience they perceive to have undergone in their maths learning that is more important than the maths itself. Carefully created learning situations allow individual learners to create their own 'truths' regarding learning, gain confidence in their abilities, retain more explicit information and learn in a community rather than in isolation.

The recommendations for each of the main themes should be seen as possible attempts to improve the lot of maths FE learners rather than definitive solutions.

Experience of maths and school.

The significant correlation of experience of secondary school and experience of maths suggests that entire learner opinion of school might be improved by simply improving the way in which maths is delivered. The ramifications of this should not be underestimated; by reconsidering the nature of maths pedagogy in isolation from other subjects may be a cost-effective and highly measurable way of improving learner outcomes across all subjects purely by addressing what is happening in maths classrooms.

The lack of correlation between school experience and maths attainment is somewhat disappointing as a poor school experience leading to poor results would have been a flag-waving opportunity to claim that satisfied learners get higher grades but as with most elements of education, the reality is far more nuanced than a simple survey is likely to produce.

The uncomfortable attendance issue.

The lack of any significant correlation between passing maths GCSE and how many college lessons have actually been attended was a huge concern as the data analysis emerged but rather than make excuses for the seemingly discouraging piece of

information, my personal opinion of the finding has softened from disappointment to consideration of what the effects are that are being experienced by learners in classrooms if their maths ability is not improving in tests. Perhaps attendance does correlate with another aspect of learners' experience that is harder to measure than an exam paper is.

When I grow tomatoes, I don't assess how well the plants under my care have done by counting the tomatoes on each plant but by how sweet is the taste of the fruit.

What if the collateral growth is not making the shape of learners' experience bigger but merely rounder? The jagged edges of school classroom memories may be smoothed over and the experience they pass on to others generally less severe. It is unclear whether the assumption is that because maths isn't getter better that nothing else is getting better. What should a teacher make from this comment overheard from a student in the classroom?

> *"I don't know if I want to pass or not this year. I can't imagine college without maths lessons"*

As an educator I cannot fail to be moved by this comment that one student made to another. It wasn't during an exceptional moment of merriment or a revelationary moment of a 'penny dropping' that this comment occurred but just as the class was quietly working through some questions together. It came from just *doing* maths.

To further isolate what might be done to improve the FE maths landscape each of the four main themes may be presented from the perspective of individuals involved in the process.

The three main themes:

From the previous chapter, the four branches of conclusion are repeated here to structure brief recommendations for the three main stakeholders, learners, teachers and managers. Recommendations are offered using direct address:

- Cognitive load.
- Teach less, learn better.

- Collateral growth.

Cognitive Load:

It is clear that reducing the amount we expect learners to remember is an obvious way to reduce anxiety, boost morale and increase confidence. Allowing time and space for maths

For learners:

You need to realise that there is nothing to be scared of. Learning in FE does not carry the same high stakes threats of punishment and embarrassment that you may have experienced in school. This is a safe environment; you will know what topics are coming up next and your teacher won't move on until everyone understands the topics. Be confident, ask questions, make friends and enjoy doing maths.

Trying to tackle too many things at once will often result in none of those things being done properly. Placing high demands on the quantity of things you can do might not be the best way forward. It might be better to learn a few things really well. This will increase your confidence and ability to tackle new ideas using the skills you have developed.

It is unlikely that you are being paid to sit in your classroom and learn but your teacher is. It is their job to ensure you understand what is being taught to you. Don't be tempted to say you understand when you actually don't and always make sure you know how to do one thing before moving on to the next. Your teacher is not a mind reader so ensure you let them know when too many things are happening at once. If your surroundings or the expectations placed upon you are causing you to be anxious or uncomfortable there is little point in trying to complete difficult maths tasks. Tell your teacher why something isn't working for you and explain that if your head is full of anxiety there is no room for any maths to go in.

Learning with others will help you to remember what you are learning and set it in a situation which will enable you to recall it in the future. Being positive about what you are attempting will make your experience richer and as your confidence grows your concerns about maths will ebb away. Constantly questioning when you might need the

skills you are learning is pointless because none of us can foretell the future. The act of doing learning is something that will stay with you forever and if you can find a way to enjoy the process you will discover that learning maybe something to enjoy rather than endure.

For teachers of FE Maths:

Embrace the leap-of-faith to use a programme where you teach a few topics really well. Use your judgement to decide exactly how much is being taught against how much is being learnt. If there is ever less learning occurring than there is teaching being offered, then something needs to be adjusted. Stop looking at yourself in the reflective mirror and see yourself through the eyes of your learners. Just as great fishermen think like a fish, leaders of great learning think like their learners.

Cognitive load includes the demands you place upon your learners that cause them anxiety. If you are demanding certain behaviours that have no established link to improving learning and merely because it reinforces your controlling authority it may be a good opportunity to re-evaluate this practice. Reviewing the Sweller article (2019) may be of assistance.

There will be resistance from decision makers within your college to changing teaching methods and this should be met with compassion and understanding as change is rarely less than painful. Understanding that teachers and managers have ideals entrenched in blaming everything on the person under them (managers blame teachers, teachers blame students) is imperative and should be openly explored and discussed if at all possible. Quality teams and OFSTED can also be made aware of mastery centred pedagogical approaches but care must be exercised as the concept may be alien to them or they may have differing views to yourself regarding what constitutes mastery pedagogy.

Above all read some articles, parts of books, blogs or watch online videos of academics that know about core concept curricula and try to apply it to your FE setting. Remember that the secondary school gurus only managed to get 60% to pass, if they claim otherwise then they caused others to fail because that is the way our exam system

works. Do not be fooled by those who claim to have 'turned around' a situation or cohort in maths with their own brand of maths teaching wizardry. Their criteria reference may be purely based on maths performance and not on learner experience. Exam grades at the expense of the well-being of young people's mental health is not acceptable today, nor ever should it have been. Teaching vast swathes of knowledge for the sake of it may not be as effective as is logically assumed.

Above all, become busier in your classroom whilst avoiding the temptation to teach more, faster. There has been an expectation that great teaching should be done at arm's length. This is derived from teacher training concentrating of control and student behaviour rather than becoming an inspiring leader of learning. Moving around your students and attempting to capture and understand the actions and interactions that occur in a classroom can give great insight into the workings of a cohort. Differentiation on a personal basis is obviously beneficial to students but this is far more complex than simply giving harder work to those that finish first. Encouraging stronger students to support those who take more time to understand concepts will be far more productive and improve the learning experience for the whole group. Recording your activities in a journal may be of great value when developing your ability to lead better learning.

For managers:

Understand that your job is not to tell teachers how to teach, primarily because you may not be qualified to do so. No matter what your experience in classrooms it may be dated and potentially irrelevant. What you do have is the chance to allow great learning to happen by ensuring teachers and learners are not overloaded purely to justify your own position. A skilled manager can lift a whole teaching and learning cohort to achieve great results in a collaborative setting. Aim to reduce the workload of teachers and learners to fulfil that which is strictly necessary and no more. Every extra requirement you place upon a learner, whether it is removing a hat, sitting in silence or performing by giving answers on demand, is another addition to their cognitive load and less marks on their exam paper. A great leader of people in education can change thousands of lives for the better by trusting those around them to be the best they can.

The initial impression offered by a silent classroom full of studious learners may appear to be the ideal, but it is vital to understand that learning in isolation may not me the most conducive method for retaining that knowledge. Silent learning does not allow tacit knowledge transfer to occur and a silent class is actually missing out on the rich interactions which are the foundation of accelerated learning and recall.

Teach Less to Learn Better.

If ever there was a mantra that sums up the approach offered by the Essential 8 programme it is this. Learning better is not the same as learning more. Learning better is setting narratives around the teaching so the learning actually becomes more relevant, more enjoyable and more memorable. Just better.

For learners:

Embrace this opportunity to truly become an expert at some maths topics and use them to fill in any gaps you have in other areas. It is not cool to sit in a classroom and not learn because you are wasting precious resources by doing so when you could be learning how to communicate with others, find your voice in a group and know what you need to do to enjoy being good at something. It is a rare opportunity to find yourself and get good at maths at the same time.

You should be able to take time to consider answers and work with others. If this is not happening in the classroom you are in, you can ask your teacher about 'mastery' teaching and learning techniques. Teachers want to do the best they can and want to hear what works best for you as learners. Learning less topics will not mean the work is any easier, but it will mean you will find the confidence to be really good at something that you struggled with in the past. Use that confidence and that of those around you to tackle new stuff that you may have avoided before. You have a right to a solid maths education and a GCSE qualification can be incredibly valuable in your future life and careers. There should also be time to enjoy the experience of learning. The more you are there in the classroom, the more you will realise that the experience you are having is shaping your exam results as well as your confidence. Find your voice in the classroom and share in the experience with others. Maths lessons really can be

enjoyable if you make the effort to learn and grow your knowledge with the help of others. You are not alone so make the most of the teachers and students around you.

For teachers:

You need to be brave and trust your learners. Bravery is not usually an attribute that is obviously associated with teaching, but it must be so if you are to consider a mastery approach with a core concept curriculum. Many will claim that you are doing it just so you can teach less but the opposite is true. Imagine your most challenging learner; now imagine that you have to get them to understand a concept before the whole class can move on. You will have to become busier than you are, lose a little control over the class as they experience the collateral growth of the situation you create and allow your learners the space to *do* learning. When it works, which it will, you will see the reason that you don't need to teach so many topics is that your learners will be able to tackle those untaught topics through their increased skill and confidence.

For Managers:

There is an ever-present temptation to look for the areas where it is perceived that improvements could be made and focus on those when observing lessons or advising OFSTED on what to look for during inspections. Whilst it may seem logical to do so, were emphasis placed on improving the aspects of teaching and learning that are already excellent, the entire platform of transactional exchange can be lifted above the mediocre, raising those less-than-perfect issues along with it.

A reduced curriculum can allow teachers and learners time to find depth and meaning in their time in lessons rather than simply learning some skills which may or may not be useful to them. Most importantly, recruitment and teacher training must be informed, relevant and in line with current academic theory. Expecting secondary school methods to work in an FE setting is unrealistic as those methods are the reason students end up in FE. External agencies trying to impose unsuitable ideals upon FE classroom practice should be met with a robust and informed response.

Collateral growth.

Collateral growth may be the ultimate outcome for the maths learners studying with our mastery programme. Passing the final exam may be a by-product of their confidence, attitude and understanding regarding what success actually means, how learning in a group can be more rewarding than learning alone and why learning to *do* maths may result in learning a lot more than that which they have been taught.

For learners:

Learning maths in college can be one of the highlights of your week because you get to work with people from all other vocational subjects and they will offer their own views and opinions on the way in which to go about the business of learning. The maths will allow you a common point of reference and you can discuss things that are relevant to you which may not be to others. All the skills you learn in maths lessons go way beyond just learning maths skills. Listen as much as you speak and ask others for help. In asking for help you are identifying yourself as a member of a group that is there to help one another and that is probably the best group you could ever be in.

College is also a really good time to practice working with others and remember, your teacher is a great person to ask for a reference when you are applying for jobs or university.

For teachers:

If you find yourself in the habit of stifling interactions between learners because they are inconvenient to you then you need to ask yourself why such interactions are occurring. There is a tendency to assume you know why a certain student is disengaged or disruptive. Because you are neither a mind reader nor qualified psychologist, you actually have no idea why they are behaving as they are. What is available to you however is the distraction of making the teaching so attuned to the needs of the entire group that the entire group wish to learn how they can best achieve your joint goals. Finding goals that both you and your learners' desire will necessitate discussion, empathy and understanding between everyone in the classroom. This collateral growth is the most useful thing you can offer your learners and it is through maths that such an opportunity can occur.

Working with colleagues by visiting each other's classrooms (should time permit) allows for some informed debate to take place in the staff room and you will see them teach how their learners see them. The knowledge you gain from quiet observation will tacitly inform your own practice and improve the experience of your students.

For managers:

Whilst learners are the subjects of data for college principals, OFSTED and spreadsheets in general, they are also young people embarking on lives that will likely exceed your own. The learners that leave your college are the future of the world and the experience we offer to them, the respect we pay to them and the role models we are to them, will affect their futures. They can only experience collateral growth if those around them allow them the space to be young whilst providing a safe, nurturing environment in which to exist. Ensuring the funds needed to offer them the best staff, in the best classrooms with the best equipment is one way in which you can confirm to them that they are the most important people in the organisation and that their growth is a direct effect of your resource management.

For collateral growth to occur, students and teachers in classrooms must be allowed the freedom to discuss, interact and learn from each other. If internal or external assessors are being invited to give their opinions of lessons, then they should be briefed as to what to expect to see and not to judge efficacy of learning on anything other than the situation which is being created in the classroom.

Summing up with Dewey's help.

In trying to close this research study it may be fair to say it has produced more questions than answers. In trying to discover why this mastery pedagogical approach has worked, it appears that no ultimate truths have been uncovered but that many relative truths have emerged. Bearing in mind that it has been viewed, conducted and analysed through a pair of John Dewey's spectacles, perhaps that should come as no surprise. It is no failure though, it may fail to herald a mastery approach as a magic bullet for maths success but, like ultimate truth, that is a holy grail that only the foolish seek and only the arrogant claim to have found.

Instead, returning to the metaphor of fine art that has curiously interspersed this account, the landscape of FE maths has been shaped by the tiny characters in its background, each with his or her own story bringing life and detail to a picture which, from a distance, seems to be a gross depiction of fact which is crudely recorded by the artist. Upon closer inspection a very different picture starts to emerge with personal journeys, obstacles, success, failure and even salvation. These are imposing themes to be suggested by small details, but they are the very essence of learning maths in FE. There are many individual stories, each affecting the other and each changing the landscape, no matter how small they may seem upon the whole canvas.

It seems only fitting to examine the outcome of this study with reference to the pragmatism tradition from which this research is cast. Some of the first few chapters in Dewey's Democracy and Education are now used as a framework to chronicle the aspects of this study to give an overview of the essence of its outcomes.

Education as a necessity of life:

When considering this research under such a grand heading it is a sobering thought to realise that everything we say in a classroom, every task we offer, every facial expression we adopt, goes to form an indelible imprint on the experience of the each and every learner in our care.

40 years ago my maths teacher said "if you ever earn enough money, you need to give it all up and become a maths teacher". When I met up with him some 30 years after the event, he had no recollection of his five second comment, but it changed my life. I worked flat out to earn enough to be able to afford the wage reduction necessary to enter into teaching and now have the most rewarding job I could ever imagine.

Education is not just learning facts; it is the *doing* of learning in a community of like-minded people. Helping others, accepting help from others, disagreeing with others, finding connections with others. There is a lot of 'others' in the learning that our approach endorses.

The fact that the learning occurring just happens to be maths is neither here nor there. A steam engine needs water to make its pistons move and give it life. Whether it is

heated with firewood, coal, coke or peat is by-the-by; it is the act of learning which enables people to move forward through life with purpose and intent. The subject that fires that learning is largely immaterial, but some may be more effective than others.

In maths, learners often find a seemingly irrefutable truth that is there to be conquered; often it has become their own personal nemesis to vanquish, their own mountain to scale. In their lives they may encounter many mountains to climb but as Katie said when she sparked our plans for adopting a mastery approach *"John. If I can do maths – I can do anything!"*

Dewey goes to the trouble to distinguish the term of 'life' meaning the act of just living from the higher definition *"to denote the whole range of experience"* and suggests it *"covers customs, institutions, beliefs, victories and defeats, recreations and occupations." (1917, p4)*

If ever there were a few words chosen to represent the possibilities than can happen in a FE maths classroom; surely there are none better than these.

Education as a social function:

The way in which learners interact with each other and their teacher in classrooms is fascinating. Just sitting in a noisy class; learners arguing, agreeing, copying, laughing, writing, thinking, and then for no reason, silence. Stunned silence. For no obvious reason a class of twenty or so learners fall quiet and just work. Why this happens, and it doesn't happen very often, is something that has ever really been explained. There is mystery in social interaction. The mathematician may claim that the probability of silence could be calculated for one student then multiplied by the number of students. Perhaps the psychologist might suggest that each learner had got to the end of their maximum time for human contact and turned back to individual pursuits. Some teachers claim it is because they have mastered 'the look' as if it were some kind of existential state of being like levitation that only they could achieve through years of practice. The truth, as if there were one, is much simpler; they just fell quiet for a while.

But that happens in an environment that has been created by the teacher and the learners. The situation had been engineered to permit silence to happen, even if only for

258

a few seconds. One of my students that I have taught for two years now shares my amazement when this occurs and looks over to me with a smile and a questioning shrug, the moment is not lost on her either.

Socially, this is an impossibly complex set of interactions to assess as it is fleeting but not enforced by threat of punishment if anyone breaks the peace as has been their experience in school. Without verbal communication or any explicit cues, the entire learning community suddenly chooses silence. In the act of learning maths an entire community, made up of pairs, groups and individuals have communicated in a tacit way and understood what is needed at a certain time to make the most of their learning opportunity in joint recognition of the right thing to happen. This tacit language is the powerful tool of the 'conjoint community' that Dewey speaks of and that concept is a thread that runs through this entire study.

From the young man that called our maths classroom his "safe haven" to the learner that said that maths had simply become "a fun place to be", socially the act of the learner had moved from being the potentially lone pursuit of secondary school to a joint combination of lots of different ways of interacting, being part of something bigger than just studying and affecting the environment in a positive way.

Having taught in secondary schools, the policies of uniforms, behaviour points and various draconian sanctions, utilise fear to ensure an acceptable level of compliance exists. Once this is removed and the school day has finished, what happens to those individuals once the fear is removed? If the only reason to behave in a socially acceptable manner is removed there is no motivation, no reward to be found in behaving in a nice way and correspondingly, no threat of detention if they want to behave in a generally, obstructive or unpleasant manner. Only when learning is not occurring are social skills practiced in the relatively 'lawless' playground so learning and social interaction become mutually exclusive. This is a sorry state of affairs and does not bode well for young people entering the world of work where collaboration and teamwork are to be highly prized in industry.

In the freer, less inhibited situation afforded by a mastery approach where no one get lefts behind, the FE maths classroom could be viewed as a prime model for collaborative learning and exemplifies this study's proposed tenet of 'collateral growth'. Not just for the learner, but for the society in which they exist now and the societies in which they will be a part of for the rest of their lives.

Dewey proposes that what someone does and what they can do *"depend upon the expectations, demands and approval and condemnations of others"* (2017, p7). If as educators we choose to be 'the others' then we are creating a false society in the classroom. Few individuals operate in an autocracy, those that do tend to work in oppression, hating their surroundings and dreading pursuing their labours. We should have no desire to impose such expectations upon young people and offering them such a dystopian view of their future could so easily become a self-fulfilling prophecy. In the FE maths classroom, a microcosm of society, a community of learners can exist if it is allowed to and it can project an image of the future that is full of meaningful collaboration and a desire not to work to live but live to work. If that can be offered by a subject as arbitrary as maths, then surely engineering a situation by which it can do so is an opportunity that should not be passed by.

Limitations of this study:

It must be borne in mind that this is a not a particularly large-scale study conducted over a relatively short time span with a particular demographic of learner. It should not be extrapolated in its entirety to higher education or seen as a suitable set of suggestions for highly academic learners in other educational settings. However, many of the theories proposed herein, particularly that of collateral growth may well find resonance outside the rarefied atmosphere of the FE maths classroom.

Much of the narrative data has arisen from people who are directly affected by me personally; I am their leader of learning as well as the sole researcher so such bias must not be overlooked.

Consequently, my optimism and commitment to the positive impact maths lessons can have on learners as whole entities undoubtedly gives deductive bias to much of the subjective interpretation of the results.

Extensive statistical modelling has not been employed, mainly as it would be relatively meaningless given the sample size but also because this study is not solely about how many get what grades but about how much a learner can grow and what an educator can do to engender that healthy growth. Reframing success, not as a goal but as a way of being, does seem to produce outcomes which can actively reset young people onto paths of learning and growth. The limitations of this study serve to deter those only willing to adopt its recommendations to further getting good grades at any cost. The study values the experience of the learner in priority to the eventual grades of the learner. In that, this study has achieved its desired limitation.

Areas for subsequent research:

The possibilities for further research arising from this study are many. Investigating the link between countries with high maths success and high suicides rate may be of interest to a researcher with an international perspective who was looking at maths education across all sectors and social demographics.

A national audit of the qualifications of FE Maths teachers and their immediate managers may be prudent. This could provide missing information regarding what training to deploy for FE and how it should be delivered.

Examining the efficacy of contextualisation in FE maths settings should become a priority as it appears that it may not hold the value currently thought. Similarly, the apparently vital connections that learners should be making between topics could also benefit from re-evaluation.

The grade boundary system would benefit from an overhaul to increase its transparency and the OFQUAL national reference test should be updated as it may not possibly reflect the curriculum upon which exams are now based. The concept of normative referencing to decide who passes should be re-appraised and a possible criterion model considered.

261

FE colleges are spending a significant amount of their allocated budget on non-teaching activities. Possibly the most alarming is the amount spent on marketing, given that attendance should be viewed as compulsory and that the supply and demand for places is suitably balanced. The need for colleges to advertise should be examined and the cost of their marketing analysed accordingly.

The viability of separation of 6th form colleges from FE vocational colleges should be examined. Mixing national average grades, teaching methods and conventions between the two sectors is misleading and confusing. The practice of external examiners advising cross sector appears to provide questionable benefit.

In conclusion:

Dewey's writing is hard to access; ironically it is made up of short stabbing sentences of truth. It feels like they are intended for the reader to accept rather than consider. It is soon clear however that the entire book is a stream of consciousness that needs to be understood in its entirety. It is sequentially written, after a fashion, but the more one tries to understand Dewey's assertions the more it feels like a huge piece of work that needs to be consumed at once. In the same way zooming in on elements of Rembrandt's "The Night Watch" (Appendix 8) (proportioned at no less than 14 feet wide by 12 feet tall) cannot strike the same awe into the heart of the observer that is presented with the whole picture, paraphrasing Dewey's work does not do it justice but nevertheless, his work has helped to place some of this study's data, or more accurately this study's learners, in a landscape that I hope now has a little more colour, a little more light and remains unsigned, waiting for others to add their brush strokes; adding more light, more shade and more detail.

And as for the learners involved with this study, I owe them a debt of gratitude along with any other stakeholder in education that looks at this research in the positive light in which it is intended. It is in the stories of the individual learners where the truth of subjective experience lies, and as Morwenna Griffiths (2009) states of these stories:

"They show us other aspects of our world and in doing so illuminate our own small part of it. They help us question what we have taken for granted, to broaden our comprehension, and to deepen our insights."

References

Adams. R (2019) *"10000 pupils disappear from English schools at critical stage of gcses"* Avaialble at: https://www.theguardian.com/education/2019/sep/06/10000-pupils-disappear/ (Last accessed 19/08/19)

Alexander, R. (2006). *Towards dialogic teaching: Rethinking classroom talk*. Cambridge: Dialogos.

Alexander, R. (2013) *Essays on pedagogy*. Routledge London. p122

Alexander, R. (2017). *Dialogic Teaching In Brief*. [online] Robin Alexander. Available at: <http://www.robinalexander.org.uk/wp-content/uploads/2012/10/Dialogc-teaching-in-brief-170622.pdf> [Accessed 21 February 2018].

Anderson, B (2016) *Philosphy for Children Theories and Praxis in Teacher Education*. Abingdon. Routledge. Pp27.

Askew. Proceedings of the 24th Biennial Conference of The Australian Association of Mathematics Teachers Inc. *Mathematics: Launching Futures.* Ed. Herbert,S. Tillyer, J & Spencer,T.

Atkinson R.C. & Shiffrin, R.M. (1968). *'Human memory: A Proposed System and its Control Processes'*. In Spence, K.W. and Spence, J.T. *The psychology of learning and motivation*, (Volume 2). New York: Academic Press. pp. 89–195.

Ball, S (2013) *Free schools: our education system has been dismembered in pursuit of choice.* Available at: https://www.theguardian.com/commentisfree/2013/oct/23/education-system-dismembered-choice (Accessed 29th September 2019).

BERA (2011) (British Educational Research Association). (2014). *Ethical-guidelines for educational research*. Available at: https://www.bera.ac.uk/researchers-resources/publications/ethical-guidelines-for-educational-research-2011. Last accessed 15th May 2018

Biesta G and Burbules N (2003).*Pragmatism and Educational Research.* Lanham: Rowman & Littlefield Publishers Inc. Pages 31-42

Biesta, G and Burbules, N (2004). *Pragmatism and Educational Research (Philosophy, Theory, and Educational Research Series)* . Lanham: Rowman and Littlefield Publishers Ltd.

Biesta, G and Burbules, N (2004). *Pragmatism and Educational Research (Philosophy, Theory, and Educational Research Series)* . Lanham: Rowman and Littlefield Publishers Ltd. p44 p29

Black P and Wiliam D (1998). *Inside the Black Box*. London. Kings College.

Blaxter et al (1996) *How To Research*, Buckingham: Oxford University Press.

Bloom, B. S.; Engelhart, M. D.; Furst, E. J.; Hill, W. H.; Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals*. Handbook I: Cognitive domain. New York: David McKay Company

Boaler J (2009) *The Elephant in the Classroom.* London. Souvenir press

Britzman, D. (1991). *Practice makes practice: A critical study of learning to teach.* Albany, New York: State University of New York Press. p.23

Byrne, D (2002) *Interpreting Quantitative Data.* London. Sage Publications Ltd. pp14-15

Clandinin, D. J.et al (2016). *Engaging in Narrative Inquiries with Children and Youth — Developing Qualitative Inquiry* (Vol. 9). New York: Routledge

Clandinin, D.J. and Connelly, F.M. (2000) *Narrative Inquiry: Experience and Story in Qualitative Research.* San Francisco. Jossey-Bass. pp.121,123

Claridge, J (2021) *Target Grades for Sixth Form Entry.* Get the Right School (Online). http://www.gettherightschool.co.uk/targetgradesforsixthformentry.html (Last accessed 18/02/2021)

Coffield, F. (2008) *All You Ever Wanted to Know about Learning and Teaching But Were Too Cool to Ask*. London: Learning and Skills Development Agency

Connelly, F M and Clandinin, D.J (1990) *Stories of Experience and Narrative Inquiry.* Educational Researcher. Vol19. No 5. Washington DC: American Educational Research Association. 2-14

Cooper J and Kazimierczyk L (2017) *The Essential 8 book 2*. Sussex. Cooperstutors

Cooper J and Kazimierczyk L (2017) *The Essential 8 book 1*. Sussex. Cooperstutors

Cooper, J. (2011) *Subject Knowledge Enhancement* (SKE University of Brighton) https://www.youtube.com/watch?v=7jgK7ilk_o4 (Last accessed 25/01/20)

Cooper, J. (2018) *The Essential 8 programme. An allusion to mastery for UK GCSE mathematics resit students.* European Association for Practitioner Research on Improving Learning. Issue 4 – March 2018 ISSN 2406-4653, pages(s) 285-293.

Cowan, N. (2010) *Current Directions in Psychological Science* Vol. 19, No. 1

(FEBRUARY 2010), pp. 51-57

Crown Copyright (2017) *Oftsed inspections: myths* Available at:
https://www.gov.uk/government/publications/school-inspection-handbook-from-september-2015/ofsted-inspections-mythbusting (Accessed 30th December 2018)

Csikszentmihalyi, M (1992). *The Psychology of Happiness*: The Classic Work on How to Achieve Happiness. New York: Harper Row

Csíkszentmihályi, M. (1975). *Beyond Boredom and Anxiety: Experiencing Flow in Work and Play*, San Francisco: Jossey-Bass.

Csikszentmihalyi, M. (1992). *The Psychology of Happiness*: The Classic Work on How to Achieve Happiness. New York: Harper Row

Davis, B. & Simmt, E. (2003). *Understanding learning systems: mathematics education and complexity science.* Journal for Research in Mathematics Education, 34, 137–167.

Denscombe, Martyn. (2007). *The Good Research Guide: For Small-Scale Social Research Projects.* London: Open University Press.

Dewey, J (1938). *Experience and Education*. USA: Kappa Delta Pi. Pp.33-48

Dewey, J. (1910)*"The Postulate of Immediate Empiricism",* Chapter 9 in The Influence of Darwin on Philosophy and Other Essays. New York: Henry Holt and Company (1910) : 226 – 241

Dewey, J. (1916) *Democracy and Education* p 73.

Didau (2013) *Grit versus Flow*: Available at https://learningspy.co.uk/featured/grit-vs-flow-2/ (Last accessed 12/02/20)

Didau. D (2014) *Why AfL Might be Wrong*: Available at
https://learningspy.co.uk/myths/afl-might-wrong/. (Last accesses 3/1/20)

Drury, H (2015). *How To Teach Mathematics for Mastery*. Oxford: Oxford University Press. 1. P8.

Drury, H (2018). *How To Teach Mathematics for Mastery*. Oxford: Oxford University Press. 1.

Drury, H. (2018) '*Try the mastery approach to improve a grasp of maths'.* InTuition issue 31-spring-2017 page 24.

Dunlosky (2008) *American Educator*, v37 n3 p12-21 Fall 2013 p20

Dunlosky et al (2013) *Psychological Science in the Public Interest.* January 2013 *vol. 14 no. 1 4-58*

Dunne, J. (1993). *Back to the rough Ground: Practical Judgment and the Lure of Technique.* USA: University of Notre Dame.

Dunne, J., & MacIntyre, A. (1997). *Back to the Rough Ground*: *Practical Judgment and the Lure of Technique*. Notre Dame: University of Notre Dame Press.

Dweck C 2006 book *Mindset: The New Psychology of Success. Ballantine press.*

Ebbinghaus H (1885) *Über das Gedächtnis.* Leipzig: Dunker.

Ebbinghaus, H. (*1913*). *Memory: A contribution to experimental psychology* (H. A. Ruger & C. E. Bussenius, Trans.). New York: Teachers College Press.

ESJSNA (2019). *Indices of Deprivation 2019*. Available at: http://eastsussexjsna.org.uk/JsnaSiteAspx/media/jsna-media/documents/localbriefings/ESiF/Indices-of-Deprivation-2019-final.pdf   (Last accessed 25/12/19)

Flanagan, J. (1954). *The Critical Incident Technique*. Psychological Bulletin . 51 (4), 327-358.

Freire, P. (M. B. Ramos, Trans.) (1996). *Pedagogy of the oppressed* (2nd rev. ed.). Penguin. Miller, L, (1957). The Philosophical Review Vol. 66, No. 4 (Oct., 1957), pp. 451-465. 452 Duke University

Gasking, D.A.T and Jackson, A.C (1952) *'Wittgenstein as a Teacher'*, in K. T. Fann (ed.), *Ludwig Wittgenstein: The Man and His Philosophy*, New Jersey: Humanities Press; Sussex: Harvester Press, p.52, 1962.

Griffiths, M. (2009) *Using personal narrative and other stories in educational research: Issues of validity and truthfulness*. Morwenna Griffiths Keynote presentation at First International Conference on Educational Research for Development College of Education, AAUMay13th– 15th, 2009

Harkin et al (2003). *Recollected in tranquillity?* Learning and Skills Development Agency (Online). https://www.lsda.org.uk/files/PDF/1439.pdf (Last accessed 24/11/2020)

Hildebrand, D.L. (2018) "*Experience is Not The Whole Story: The Integral Role of the Situation in Dewey's Democracy and Education*". Journal of Philosophy of Education 52 (2): 287-300

Hurst, G (2016) *'Chinese rote learning to transform maths lessons'* Available at: https://www.thetimes.co.uk/article/chinese-rote-learning-to-transform-maths-lessons-vbmtmj6xz (Accessed 8th July 2019).

Impetus (2017) "*Life after School*" p3. Available at https://impetus.org.uk/publications/reports (Last accessed 18/02/20)

Institute for Learning (2018), based on techniques suggested by David Tripp (1993) *Critical Incidents in Teaching*, London: Routledge.

Jones, K. (2015) *"Teachers, Researchers ... and Teacher Researchers"*. Available at: https://www.bera.ac.uk/blog/teachers-researchers-and-teacher-researchers (Last accessed 28th August 2019).

Lather, P. (1991). *Getting smart*. New York Routledge.

Linsky,M & Heifetz, R.A (2002). Leadership on the Line. Massachusetts, Harvard Business Press. p54

Lovejoy, A.O. (1908) *The Thirteen Pragmatisms.* The Journal of Philosophy, Psychology and Scientific Methods, Vol. 5, No. 1 (Jan. 2, 1908), pp. 5-12 Published by: Journal of Philosophy, Inc

Maslow, A. (1943) *A Theory of Human Motivation.*

MEI (2020) *A new mathematics GCSE curriculum for post-16 resit students.* (Online) https://www.nuffieldfoundation.org/wp-content/uploads/2020/01/MEI-Main-Report-Maths-GCSE-post16.pdf (Last accessed 20/12/20)

Noddings, N (1986) *Fidelity in Teaching, Teacher Education, and Research for Teaching.* Harvard Educational Review: December 1986, Vol. 56, No. 4, pp

Nuthall, G. (2007) The hidden lives of learners. Wellington: NZCER Press, p14, p39, p.35. 104, 105. 43

OFQUAL (2018) Setting GCSE Grade Boundaries. Available at https://ofqual.blog.gov.uk/2018/07/20/*setting-gcse-grade-boundaries-this-summer/* (Last accessed 12/01/20)

OFQUAL (2019) Setting GCSE Grade Boundaries. Available at https://ofqual.blog.gov.uk/2019/02/22/*national-reference-test-2019-10-things-you-need-to-know*/ (Last accessed 18/01/20)

OFSTED (2019). *Research for EIF Framework.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/813228/Research_for_EIF_framework_100619__16_.pdf

Plowright, D. (2011). *Using Mixed Methods.* London: Sage.

Rams, D. (2014). *Weiniger aber besser / Less but better.* (2nd Ed). Berlin: Die Gestalten Verlag, 2014.

Rogers, L. (2016). Disengagement from Education. IOE Press. London. p129

Savage, M and Helm, T. (2019) 'We will scrap Ofsted: Labour makes radical election pledge' https://www.theguardian.com/politics/2019/sep/21/labour-we-will-scrap-ofsted-radical-election-pledge. (Accessed 1st August 2019)

Sawyer. K 2017. *Group Genius. The creative power of collaboration*. 2nd ed. Basic Books New York

Schluter and Chaboyer (2007). *Critical Incident Technique: A users guide for nurse researchers.* J Advanced Nursing. 2008 Jan;61(1):107-114

Schraer, R (2019) *'Is young people's mental health getting worse?'* BBC News (online). https://www.bbc.co.uk/news/health-47133338 (Last accessed 12/12/20)

Scott, D &Usher, R. (1996). *Understanding Educational Research.* New York : Routledge. p17

Sennett, R (2004) *Respect: The Formation of Character in an Age of Inequality.* London. Penguin p103

Sennett, R (2009) *The Craftsman*. USA. Yale University Press. p287 p238

Staufenberg, J (2019) *'Academic resigns as Ofsted advisor'*. Schools Week (online) Available at: https://schoolsweek.co.uk/academic-resigns-as-ofsted-adviser-over-senior-officials-twitter-activity/ (Accessed 7th May 2019).

Staufenberg J (2018) *Isolations rooms How swathes of schools are removing pupils from their classroom.* Schools Week (online) https://schoolsweek.co.uk/isolation-rooms-how-schools-are-removing-pupils-from-classrooms/ (Accessed 17th August 2020).

Stewart ,W (2017) Think you've implemented Assessment for Learning? Available at https://www.tes.com/news/think-youve-implemented-assessment-learning (Last accessed 21/12/19)

Strode, H (1940) Sisu: *A Word That Explains Finland*. New York Times.

Sweller, J. (1988). *Cognitive load during problem solving: Effects on learning*. Cognitive Science.12(2). 257-285.

Sweller, J. (2019). *Cognitive load theory.* Psychologist World . https://www.psychologistworld.com/memory/cognitive-load-theory (Last accessed 20/10/20)

Teaching times (2019). OFSTED costs 5000 teachers. https://www.teachingtimes.com/news/ofsted-cost-5000-teachers.htm (Last accessed 21/10/20)

Tripp, D (1993). *Critical Incidents in Teaching*. London: Routledge.

Tripp, D (1993). *Critical Incidents in Teaching*. London: Routledge.

Tutorhunt (2019) https://www.tutorhunt.com/research/post/uk-tuition-market-size/ (Last

accessed 27/01/20)

Uni Guide (2019). *How important are your GCSE grades?*
https://www.theuniguide.co.uk/advice/gcse-choices-university/how-important-are-my-gcse-grades (Last accessed 05/08/20)

Van Mannen (1988) *Tales of the Field: On Writing Ethnography*.1988, Chicago: Chicago University Press

Walesonline (2019) Available at https://www.walesonline.co.uk/news/wales-news/entire-welsh-level-class-received-17602269 (Last accessed 01/02/20)

Whieldon, F. (2020) *'Labour calls out 'pitiful' underinvestment in college estates'* FE Week (online). https://feweek.co.uk/2020/10/09/labour-party-calls-out-pitiful-underinvestment-in-college-estates/ (Last accessed 19/12/20)

Wiliam, D. (2013) *Example of a really big mistake: Calling formative assessment formative assessment and not something like "responsive teaching"*. Twitter blog available at: https://twitter.com/dylanwiliam/status/393045049337847808 (Last accessed 25/06/18)

Wiliam, D. (2018) Twitter blog available at:
https://twitter.com/dylanwiliam/status/977723425698361345?lang=en (Last accessed 25/08/18)

Willingham, T et al (2015) The Scientific Status of Learning Styles Theories. *Teaching of Psychology*, Volume: 42 issue: 3, page(s): 266-271.

Wilson, L.O (2018) Three Domains of Learning. Available at:
https://thesecondprinciple.com/instructional-design/threedomainsoflearning/ (Last accessed 12/06/19).

Zeni, J. (1998). *Guide to ethical issues and action research*. Educational Action Research, 6 (1), 9-19.

Zeni, J. (1998). *Guide to ethical issues and action research*. Educational Action Research, 6 (1), 9-19.

Appendices

Appendix 1: Graphical Scheme of Work.

From page 13

This is the poster that is in every classroom that runs the Essential 8 scheme in our college. It is about 1.5 metres long when put on the wall

There is a week number on in a red circle sign that is displayed alongside it on a whiteboard so it can be updated with the correct week number.

We have jokingly called it the 'Fisher Price' scheme of work because it looks like it is meant for primary age learners but the non-threatening and humorous nature of the format helps to remove some anxiety and remind students of a time when learning was actually fun. Many learners use the term as well.

On a serious note, students are very quick to inform when the week number has not been changed and they appreciate that they can see their progress, how many times they have covered the same topic (each appears 3 times along with some 'specials' thrown in as an aside to keep the course interesting).

It has been successful in allowing learners to see their place in the academic year, flip learning to some extent as some will revise prior to the nest week and it appears less threatening than a formal document.

The road speed limit signs link to the highway code which many students are studying so it also serves to associate maths with some practical learning for some.

The full research findings are available on from the EAPRIL website:

https://www.eapril.org/sites/default/files/2018-03/Download%20File_0.pdf   (p.285)

The findings from the 2017 research start on page 285 of the EAPRIL proceedings.

.

From page 178

Yasmin is one of the students studying within our mastery pedagogy approach.

Interview after lesson 10:30am 12/11/19. Initiated by John Cooper (JC), permission for reproduction agreed to by Yasmin (Y) (alias).

Yasmin

JC:

"How are you finding the experience in maths lessons?"

Y:

" Compared to School it is so much more fun. I love the way you make the learning fun. You have a general way of putting it – it's really good. The metaphors, analogies and examples make it all real."

Me:

"What do you think about working together?"

Y:

"It's good because we can help each other out. We can show each other a bit and then they figure it out for themselves. Personally I prefer working quietly on my own with 1to1 tuition but it depends on the group. It depends on the other people around the table but it can be better than 1to1 if the group has the right people in it."

JC:

"Can I ask if you think you have had any anxiety around maths in the past – you don't have to discuss it if you would rather not?"

Y:

" No, no that's fine. At school it did get to me, I worried about being singled out or put on the spot. Here though it was so welcoming. It is so welcoming , to everyone. And humour; humour just makes everything relaxed and it's not bad to be wrong, it doesn't matter because we just put it right."

JC:

" Do you think that our mastery approach where no one gets left behind reduces anxiety?".

Y:

"John, I revised every GCSE subject for 14 hours and I still failed maths. I came into maths here in a really worried state but it's all about the teacher. The fact that you look after everyone, no matter how often you have to help them, it makes it a nice environment. I failed geography because I hated the teacher. She was really strict and horrible to us so I didn't like geography and I failed the exam. The teacher is SO important!"

JC:

Thank you so much for helping me with that Yasmin.

Y:

"I don't think you get it yet. It's really important that you understand. It's about how much your brain can hold; if all your head is taken up with anxiety then there is no room left for the stuff you're meant to be learning. And if you do learn anything, it's too painful to try to remember it because it's kind of tied up with bad stuff too, all the learning is jumbled up with feelings that you want to forget. I like this environment because you are willing to listen. It makes me want to be included. It's like a safe space. Being able to choose where you sit is great too – I can sit anywhere in here."

JC:

This is so helpful Yasmin, thank you for giving up your time for me.

Y:

Really, I mean it, you need to stop saying thank you for things that people should be thanking you for John.

Excerpts from this interview are used verbatim and referred to within the main study text.

These simple assessment devices have proved to be more accurate in predicting student grades in the summative national exams than mock exams sat in exam conditions.

They are self-marking and provide immediate feedback to learners.

Electronic Essential 8 (2)

A set of 8 questions to reassess how well the Essential Eight approach is going.
* Required

1. Please enter your 6 digit student number *

   _____

2. Please click on which best describes your course *

   Mark only one oval.

   ◯ Hair and Beauty, Complimentary Therapy and Floristry
   ◯ Construction
   ◯ Electrical Engineering
   ◯ Motor Vehicle
   ◯ Sport or Public services
   ◯ Information Technology
   ◯ Creative Arts or Music Studies
   ◯ Health and Social Care, Early Years Education
   ◯ Catering
   ◯ Mixed Programme

3. Please tell us whether you are male or female *

   Mark only one oval.

   ◯ Male
   ◯ Female

Question 1
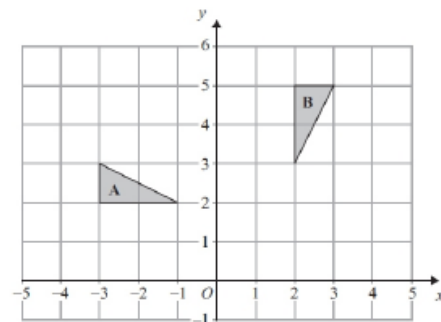
Describe fully the single transformation which maps triangle **A** onto triangle **B.**

4. Click the correct answer *   1 point

   Mark only one oval.

   ◯ A reflection in the line y = -x
   ◯ A rotation of 180 degrees anticlockwise about the point (1,2)
   ◯ A rotation of 90 degrees clockwise about the point (1,1)
   ◯ A translation by vector (3 over 1)

Attendance (y scale) against total marks awarded on 2019 GCSE Maths (out of 240).

.

Pearson correlation of ability against experience rating of maths in secondary education.

Note that the only r value suggesting significant correlation is that linking experience of school to experience of maths.

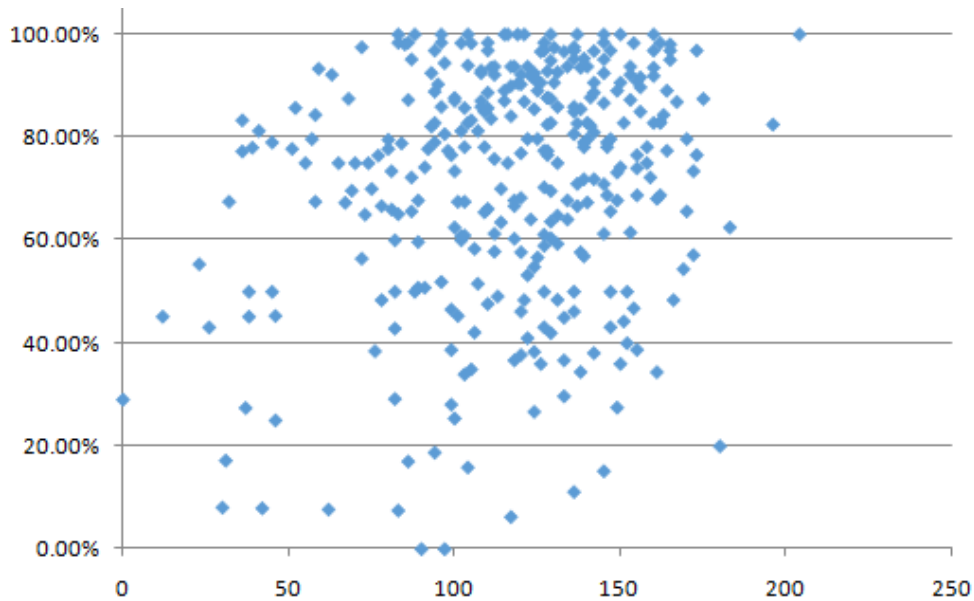|								
0.443422	correlate maths experience to school experience							
0.16346	correlaate maths experience to self assessment							
0.172009	correlate school exprienc to self assessment							
trans	area	prob	angle	perc	ratio	alg	graphs	
0.278994	0.079639	0.028006	0.046396	0.156416	0.145976	0.152786	0.032318	sch exp
0.195486	0.105707	0.055687	0.104679	0.188017	0.158728	0.189874	0.027513	maths exp
-0.02337	correlate diff between school and maths experience to self assessment							
-0.04869	0.114286	0.055628	0.11603	0.204488	0.183514	0.203941	0.059897	maths exp
0.06196	correll score to secodary exp							
0.125949	corrll score to math exp							
0.012436	correll score to self asseess diff to ma							
0.040954	cooolrrel diff to exp in sc							

Appendix 6: Plotting perception of ability against performance 2017.

From page 173
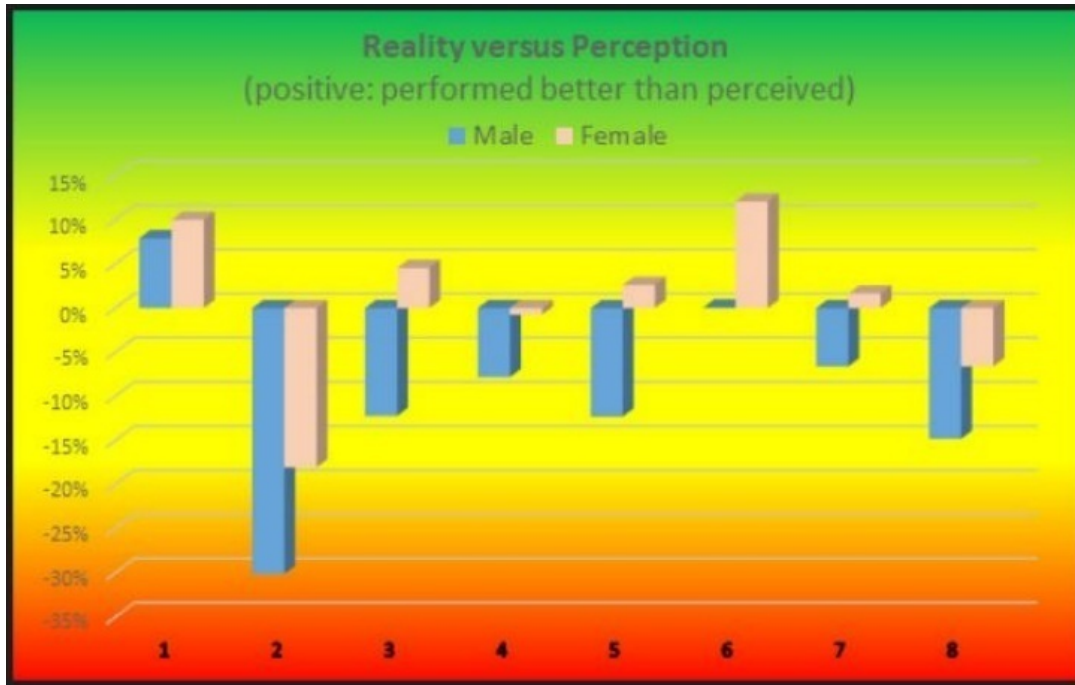
Subject Key (x scale)
1. Transformations
2. Area
3. Probability
4. Angles
5. Fractions
6. Ratio
7. Algebra
8. Linear graphs
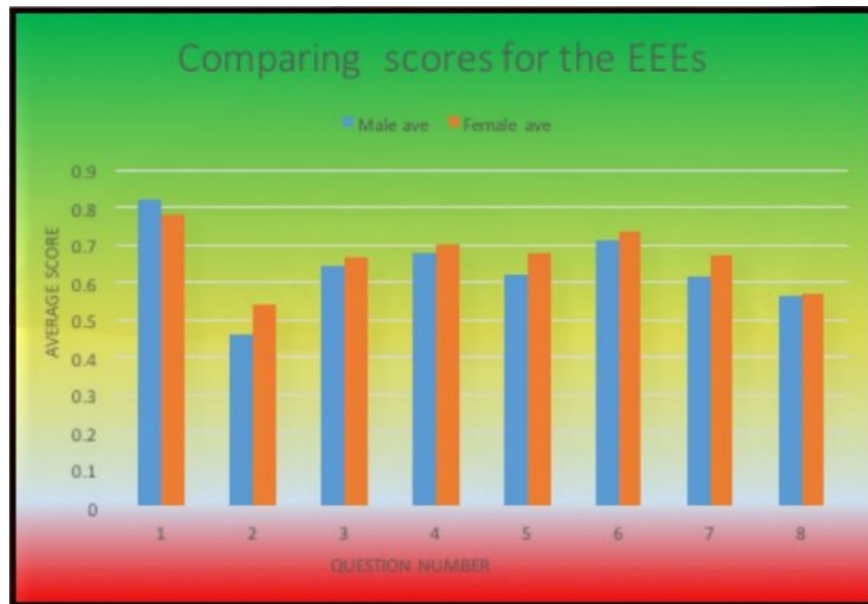
Appendix 7: OECD suicide rates per 100000 (x scale) against PISA Maths scores (y scale)
From pages 68 and 167

PISA maths scores against suicide rates
36 countries (OECD 2015)

R² = 0.428...
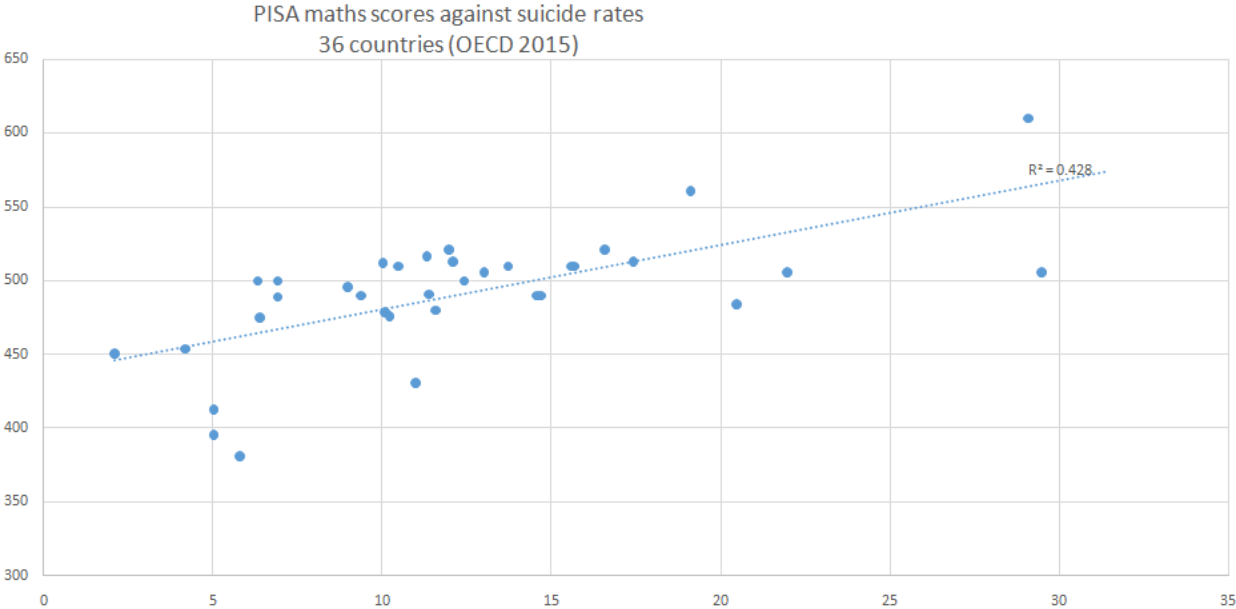
Appendix 8: Fine art paintings used to illustrate concepts within this study.
From pages 143, 210 and 262

Botticelli's "The Adoration of the Magi" (1510)   (The artist's self portrait is arrowed)

Heironymus Bosch. "The Garden of Earthly Delights." (1510)

The scale of Rembrandt's "The Night Watch" (1642)

Appendix 9. Grade 4(C) Boundaries by UK Exam Board.

From page 178

Grade 4(C) Boundaries by exam board
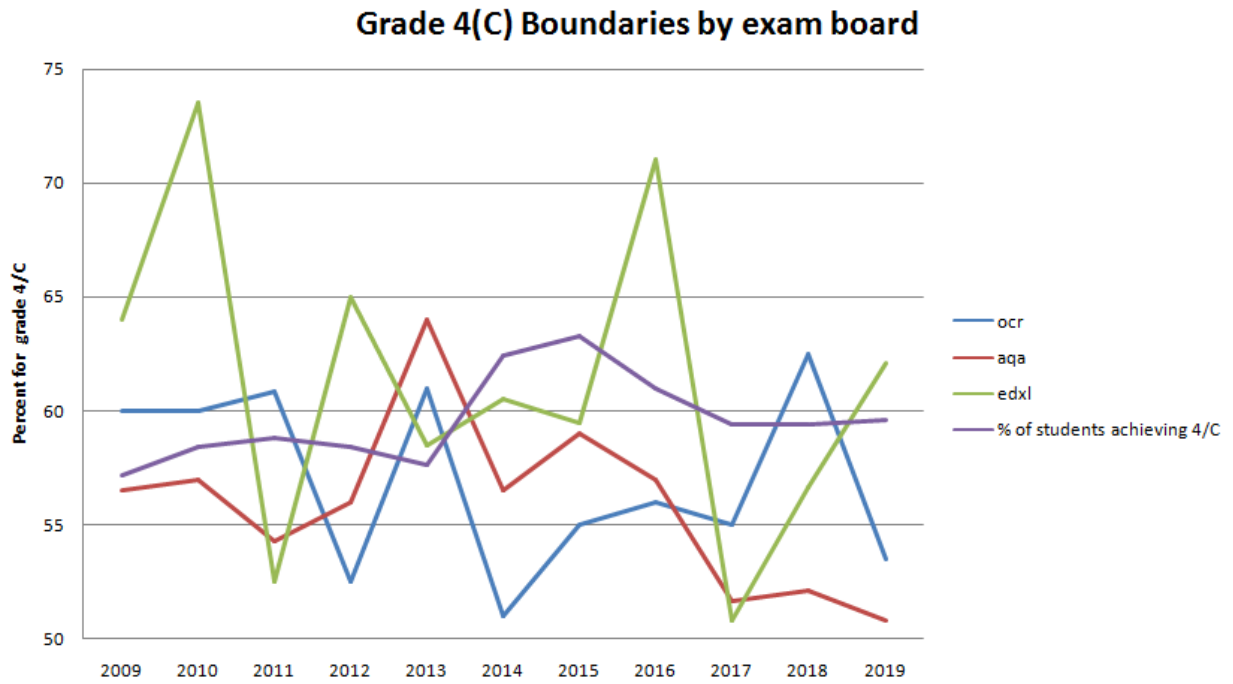
Appendix 10. Attendance correlated against final grade.

From page 175

lation exam score to attennace(2).xlsx

G	H	I	J	K	L	M	N
	grade	score	attendance		Correl attend to exam score		
DE R	2	100	73.44%	73.4375			
	3	124	85.48%	85.4838	0.225955		
	2	89	67.74%	67.7419			
	4	150	36.00%	36			
IIN	3	112	75.81%	75.8064			
I	3	124	26.67%	26.6666			
AL XAI DI	2	105	98.28%	98.2758			
	3	114	70.00%	70			
	3	147	65.63%	65.625			
	4	152	40.00%	40			
	3	130	90.63%	90.625			
	3	128	87.69%	87.6923			
	4	172	73.44%	73.4375			
	3	128	82.50%	82.5			
	3	122	93.75%	93.75			
	1	58	84.38%	84.375			
IL IA 1	1	69	69.64%	69.6428			
J/ E	1	39	78.00%	78			
H LA RE	4	158	78.13%	78.125			
	3	131	64.81%	64.8148			
	4	164	89.06%	89.0625			
H	2	87	65.63%	65.625			
	2	103	78.13%	78.125			
	3	124	91.67%	91.6666			

Appendix 11. End of term assessments (PLCs) correlated against GCSE results.

From page 172. Personal Learning Check (PLC)

Mock (2 mock exam papers sat in exam conditions)

GCSE (Actual grade awarded over all 3 Edexcel papers in 2019)

NAME	URNAME	DOB	GR OU	PLC 1 MARK	PLC 2 MARK	JAN MOCK ATTE	JAN MOCK SCO	JAN MOCK GRA	PLC 3 MARK	MAR MOCK SCO	MAR MOCK GRA	TIER ON	EXAM CA	EXAM CA	EXAM TO	EXAM GRA	REMA	plc1 vs gcse	plc2 vs gcse	plc3 vs gcse	mock1 vs gcse	mock2 vs gcse
an Adam		####	A1C	32	27		28	2	29	23	2	44	29	27	100	2		0.46	0.49	0.60	0.70	0.66
ly Adam		####	G1A	32	38		32	3	40	37	3	41	43	40	124	3						
an Addis		####	F1B	31	41		38	3	44	49	4	52	46	52	150	4						
ie Addis		####	E1E	11	13		34	3				40	ABS	49	89	2						
jar Albro		####	F1B	19	20		23	2	36	34	3	41	38	33	112	3						
nar Alexa		####	F1B	37	31		19	2				46	35	43	124	3						
isa Alves		####	D1F	24	30		28	2	34	35	3	36	30	39	105	2						
ub Amer		####	B1D	33	0		25	2	23	23	2	45	32	37	114	3						
Andre		####	D1F	35	35		48	4	17	38	3	53	47	47	147	3						
1 Andre		####	G1A	28	31		33	3				53	58	41	152	4						
in Anil		####	C2D	0	32		28	2	39			42	44	44	130	3						
e Asbur		####	C1A	15	33		27	2	34	24	2	37	47	44	128	3						

Appendix 12: Correlate over school experience to experience of maths in school.

From pages 151 and 179

Copy of JC's questionnaire data (003) (1).xlsx

	A score/8	B/C diff	C score	E Exp in sec sch	F Exp ma in sec sch	G diff between	H trans	I area	J prob	K angle	L perc	M ratio	N alg	O graphs	P total	Q average/2	R CORRELATIONS
2		0	53	1	1	0	5	6	4	7	8	9	7	7	53	3.313	0.443422 correlate maths experience to school experience
3	5.375	26	43	2	4	2	6	3	3	4	4	3	3	4	30	1.875	0.16346 correlaate maths experience to self assessment
4	1.625	22	13	1	3	2	3	4	6	3	7	3	5	4	35	2.188	0.172009 correlate school exprienc to self assessment
5	0	55	0	2	2	0	6	9	9	7	8	2	5	9	55	3.438	trans area prob angle perc ratio alg graphs
6	4.25	5	34	2	2	0	1	5	5	3	5	5	3	2	29	1.813	0.278994 0.079639 0.028006 0.046396 0.156416 0.145976 0.152786 0.032318 sch exp
7	2.375	23	19	3	2	1	6	8	5	5	5	5	2	6	42	2.625	0.195486 0.105707 0.055687 0.104679 0.188017 0.158728 0.189874 0.027513 maths exp
8	5	24	40	4	4	0	10	10	7	6	9	7	7	8	64	4	-0.02337 correlate diff between school and maths experience to self assessment
9	5.125	17	41	5	4	1	10	7	10	8	4	7	5	7	58	3.625	0.995401 0.114286 0.055628 0.11603 0.204488 0.183514 0.203941 0.059897 maths exp
10	1.5	23	12	5	5	0	5	4	4	5	4	4	4	4	35	2.188	0.06196 correll score to secodary exp
11	4.75	7	38	5	5	0	5	5	6	6	5	4	9	5	45	2.813	0.125949 corrll score to math exp
12	2.5	8	20	4	2	2	5	0	3	0	0	4	0	0	12	0.75	0.012436 correll score to self asseess diff to ma
13	3.375	26	27	5	3	2	4	3	8	4	9	5	10	10	53	3.313	0.040954 cooolrrel diff to exp in sc
14	3.125	24	25	4	4	0	6	8	6	5	7	5	4	8	49	3.063	
15	3.25	14	26	4	1	3	5	5	5	5	5	5	5	5	40	2.5	
16	0	22	0	3	2	1	1	5	3	1	3	4	1	4	22	1.375	

Appendix 13. Sample of questionnaire as designed by students

From page 112

GCSE maths questionnaire 2018/19.

Please put your student number here → 477903

Please tick the statement that best describes your answer.

How was your experience of secondary school in general?

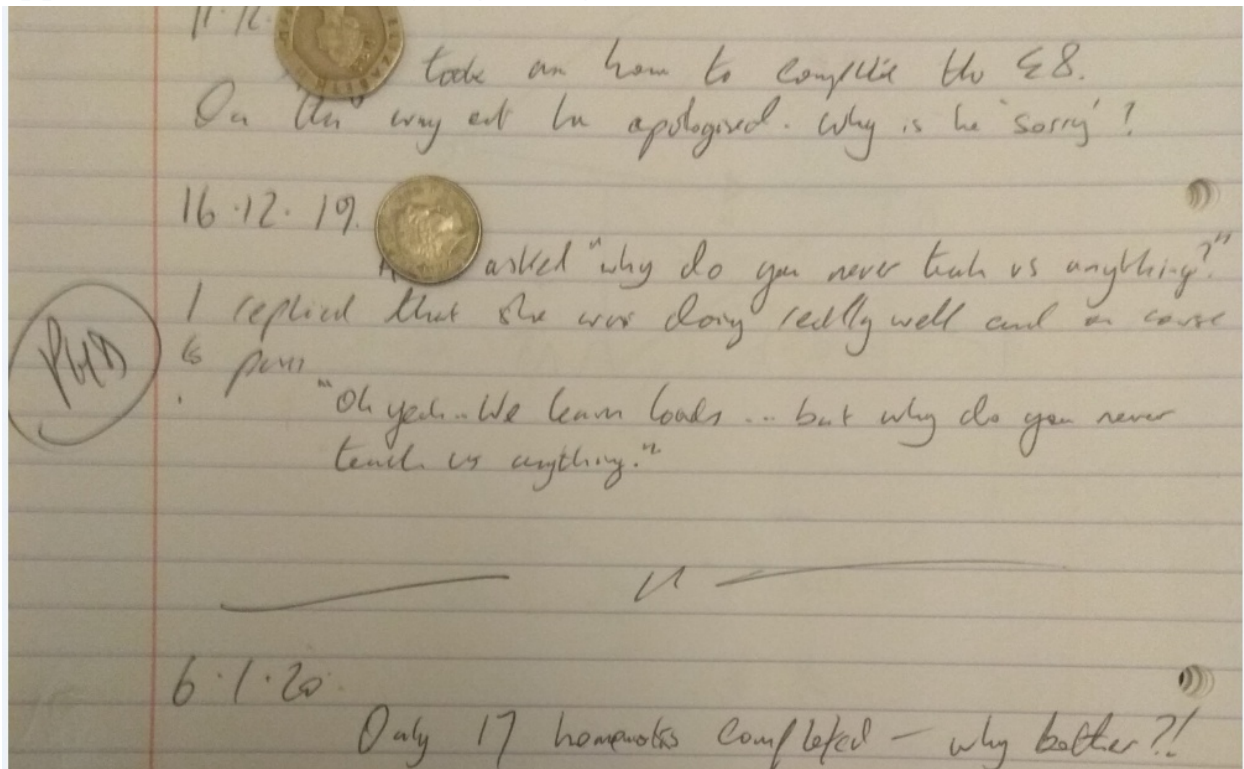| It was terrible	It was not good	Neither good or bad	It was OK	It was really good
✓				

How was your experience of Maths in secondary school?

It was terrible	It was not good	Neither good or bad	It was OK	It was really good
		✓		

Out of 10, how confident are you at the following maths topics?

Transformations	Area	Probability	Angles	Percentages	Ratio	Algebra	Graphs
Dont Know	5	5	5	5	5	5	5

Appendix 14. Journal Entry regarding 'Anita'

11.12. ...took an hour to complete the E8. On the way out he apologised. Why is he 'sorry'?

16.12.19. ...asked "why do you never teach us anything?". I replied that she was doing really well and of course is passing. "Oh yeah.. We learn loads... but why do you never teach us anything."

6.1.20. Only 17 homeworks completed — why bother?!

Appendix 15. Shane's response when asked his experience in our maths classroom.

From page 188

John's classroom is a lovely haven; this is where I come in my breaks to do work and relax. John has influenced me the way I imagine a dad would if I had one. He has taken me from a D to a B.