Study of the effect of whole-school versus intensive mindset intervention on mindset scores and teacher-rated effort in English and Mathematics.

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Abstract

Research by Carol Dweck and colleagues has been widely debated in educational institutions and academic studies. Dweck contends that people can be placed in one of two categories reflecting their personal theory of intelligence – fixed mindset or growth mindset. Those classified as, "fixed mindset" tend to see intelligence as "fixed" and unchangeable, whereas those with a, "growth mindset" perceive intelligence as something which can be "grown" or developed (Dweck, 2000, 2012). Dweck contends that students with a growth mindset can increase their academic achievement through their understanding of the malleability of intelligence and knowing how to persevere with, and overcome, difficulties in learning (Blackwell, Trzesniewski, & Dweck, 2007).

The current thesis reports an empirical investigation into the effect of a whole-school approach to developing a growth mindset using methods such as, whole school assemblies and teacher training. All participants (*n*=42) were exposed to the whole-school approach. The study then investigated the effect of an additional intensive mindset intervention (*Brainology*) on students' mindset scores and teacher-rated effort in English and Mathematics, over and above the whole school approach, and compares the experimental group exposed to both the whole-school approach and the additional intervention (*n*=22) to a control group (*n*=20), which only received the whole-school intervention. Neither the whole school, nor the intensive approach were found to have a statistically significant effect. Implications are discussed.

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I declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References.

Chapter One

Context for study

Carol Dweck's research into the malleability of intelligence (Dweck, 2000), based on mastery versus goal orientated learning, underpins the popular educational construct of 'mindset'. Dweck contends that people with entity (fixed) mindsets perceive intelligence and ability to be static, whereas those with incremental (growth) mindsets consider these traits to be alterable through hard work and challenge. Other studies appear to confirm that fostering an incremental mindset can improve student performance (Aronson, Fried, & Good, 2002; Blackwell et al., 2007; Donohoe, Topping, & Hannah, 2012). This body of research has generated a seductive argument for incorporating strategies that are believed to develop a mastery approach to learning in the classroom, in order to raise achievement (Good, Aronson, & Inzlicht, 2003), academic confidence, motivation (Dweck, 2012; Dweck & Leggett, 1988) and self-esteem (Robins & Pals, 2002). Consequently, this has led an increasing number of educational establishments, such as the school participating in this study, to seek tangible methods of fostering a growth mindset culture.

Much of the research done into the impact of growth mindset is based in the USA, with the UK-based Educational Endowment Foundation (EEF) recognising in its own study on mindsets, "Despite the growing interest in mindset theory and approaches, we are unaware of any rigorous trials assessing the impact of growth mindset approaches in the UK." (Rienzo, Rolfe, & Wilkinson, 2015, p. 6) . To date there is no data which definitively quantifies how many UK schools have adopted a growth mindset culture; however, schools across the UK are increasing their use of social media and school websites to demonstrate and disseminate their use of incremental mindset strategies. Additionally, this increased focus on the pedagogy of growth mindset is reflected in the growing number of training companies offering British schools Continued Professional Development (CPD) and teacher training inset days specifically in growth mindset, suggesting there is currently still strong demand. These include: "Growth Mindset Workshop - Developing independent and resilient learners to make more progress" (Waterfront Education Training) ; "Mindsets - How to promote and embed growth mindsets in schools and classrooms (Osiris Training) and Mindsetworks™, which includes Dweck's own on-line *Brainology* workshop that can be accessed by parents, students and teachers.

Despite this ostensible surge of schools adopting growth mindset approaches, there is little coherence in the methods used to implement and apply Dweck's research. School websites and pedagogical blogs disseminating good practice and accounts of their "journey" to developing growth mindset are widely available (https://growmindsets.wordpress.com/) and there is also limited evidence that the adoption of Dweck's philosophies are researched before implementation (Lambert, 2013). However, Dweck has recently expressed concern that educators are contaminating the mindset message by creating a "false mindset" (Paunesku et al., 2015) wherein teachers claim to have a growth mindset, but their practice reflects a fixed mindset. Additionally, she criticizes those who have misapplied her messages about praising students' effort (Mueller & Dweck, 1998) when they are not learning anything. Dweck argues that these can entrench children's fixed mindsets about their intelligence, thus undermining the incremental mindsets they are trying to develop.

It is possible that the high prevalence of educational blogs and training providers offering educators advice on how to foster a growth mindset risk the research underpinning Dweck's theories becoming increasingly diluted in schools. In a recent article in the *Times Educational Supplement,* Tom Bennett, founder of *ResearchED,* contends, "Almost everyone who talks about growth mindset hasn't read Carol Dweck's research. It's the most unread book in educational dialogue, and it's the most widely discussed." (https://www.tes.com/news/school-news/breaking-news/weekend-read-growth-mindsetnew- learning- styles). Many of the English schools which purport, online, to be developing a growth mindset culture among teachers and / or students appear to be using student assemblies, growth mindset displays, motivational posters and single inset days for teachers as ways of conveying the growth mindset concept. However, while this may explain mindset theory to students and educators there is no evidence, to date, that any of these methods have any long-term impact on embedding a growth mindset culture in schools, staff or students. In a recent blog on his school's website, Alex Quigley, Director of Learning at Huntington Research School, York UK, notes, "Our introduction to 'growth mindset' became much more 'stealthy' and subtle than bombastic assemblies and corridor displays…We moved to having an underpinning framework for supporting the complex factors, like attitude and motivation that attend learning." (https://huntington .researchschool.org.uk/2017/02/01/what-can-we-learn-from-dwecksgrowth- mindset- theory/).

While many training providers supply schools with resources and advice about how to implement a growth mindset, it is unlikely that this will have any impact without schools making structural changes to ensure teachers are familiar with the research and confidently know how to implement it to help foster a growth mindset in classrooms. Carol Dweck has also challenged the impact these methods have in embedding growth mindset concepts within the school environment. In a recent interview with the *Times Higher Education* (*THE*) magazine, she explains that she considers one of the biggest misconceptions about growth mindset theory to be, "That it's easy to implement. It isn't. It's really hard to pass a growth mindset on to others and create a growth mindset culture. It's not about educators giving a mindset lecture or putting up a poster – it's about embodying it in all their practices." (https://www.timeshighereducation.com/people/interview-carol-s-dweck-stanford-university). Although this does suggest that the way to embed a growth mindset culture is to engrain it into the foundations of the school, it also reveals just how “hard” it is for schools to truly foster a growth mindset in both staff and students.

Additionally, in England, recent curriculum and exam changes as well as increased pressure on workload mean that teachers may not have sufficient time to fully research, disseminate and embed growth mindset practices in the classroom. A recent report published by the Department for Education (Higton et al., 2017) shows that classroom teachers who participated in the survey worked an average of 54.9 hours a week (with 20.7 of these spent teaching). Most staff in the survey also cited workload as problem, “Over three-quarters of staff were dissatisfied with the number of hours they usually worked. Most staff disagreed that they can complete their workload in their contracted hours, have an acceptable workload and that they can achieve a good balance between their work and private life.” (Higton et al., 2017, p. 9). In this context, it may be that teachers do not have enough opportunity in their working day to study Dweck’s research, due to other professional time demands.

Despite this possible limitation, momentum is building towards developing and increasing evidence-based teaching strategies in England, which are underpinned by robust research. Since September 2016, 22 research schools have been set up in England, including 11 of which have opened in “opportunity areas”. These “opportunity areas” were chosen by the government as locations which required additional support to develop social mobility. Research schools are hubs based in existing schools, whose remit centres around three key aims: communication, training and innovation. Although these do not directly include conducting research studies, their role includes: offering advice on existing research evidence; delivering CPD to schools; supporting schools in developing and evaluating their own ways of improving teaching and learning and helping them to apply for research grants. This focus, together with the work done by institutions, such as the Education Endowment Foundation (EEF) and the Institute for

Effective Education (IEE), is ensuring that research-based learning is becoming an increasing priority within schools. Research projects, such as The EEF's *Changing Mindsets* study (Rienzo et al., 2015) are also engaging in evaluating the effect of growth mindset interventions in the classroom, involving English schools in their research. It is possible that this shift in emphasis, which places more value on research-based practises, may give teachers the opportunity to understand and engage with Dweck's research in more depth, which may lead to it becoming more fully embedded in classroom practices.

In their literature review on the impact of non-cognitive skills, Gutman and Schoon note that, "young people can develop a growth mindset as a result of intervention" (Gutman & Schoon, 2013, p. 13). However, although there is evidence that a growth mindset intervention can initially change student perceptions about the malleability of their own intelligence (Blackwell et al., 2007; Donohoe et al., 2012; Paunesku et al., 2015),it remains unclear whether school-based growth mindset intervention can have a long-term impact on attainment and effort. As Gutman and Schoon conclude, "there does not seem to be one non-cognitive skill that is the "silver bullet" that predicts positive outcomes for young people. Rather, there are many skills that are inter-linked and the enhancement of one of these skills without improvement of the other is unlikely to lead to lasting changes."(Gutman & Schoon, 2013, p. 43). To date studies which have used short, intensive mindset interventions in the United Kingdom (Donohoe et al., 2012; Rienzo et al., 2015) have demonstrated no statistically significant increase in students' attainment or mindset scores as a result of participating in short-term intervention. Donohoe's 2012 study found that initial increases in student mindset washed out after three months and it may be that mindset interventions need to be longer if they are to have any long-term impact.

As a non-cognitive skill, it is difficult to evaluate any specific and measurable progress that teaching a growth mindset has on academic achievement, because any effect will be indirect.

Target setting, in the school based in this study, is predicated on projected GCSE grades, which means that teachers report Year 9 grades based on a prediction of how they judge the student will perform in an exam in nearly 3 years' time, at the end of Year 11. In this context, it is difficult to show immediate, quantifiable impact. Some schools have reported an initial gain in GCSE results, which they perceive to be as a result of adopting growth mindset strategies in the classroom, such as a school in Yorkshire which reported a rise in GCSE grades at the end of their first academic year of formally teaching growth mindset. However, it is difficult to specifically attribute such improvements to growth mindset.

Finally, when studying the impact of UK schools fostering a growth mindset culture, it is important to consider the tension between this ethos and the country's educational system. Schools are increasingly pushed towards, and measured by, goal orientated (entity mindset) performance, such as league tables, 100% terminal exams and target setting, which are dichotomous to the learning orientated, incremental mindset. Furthermore, many school systems exacerbate this by creating contradictory messages through their use of target setting; streamed classes and relentless pressure on students to pass GCSE at a grade 5 or above. Although students need a grade 4 to pass, this is considered to be a "weak pass" and schools are also judged by the Department for Education (DfE) on how many "strong pass" grade 5s students achieve. Furthermore, the new GCSE system now contains a higher grade reserved for students achieving exceptional attainment. It is anticipated that the top two percent of students across the county will achieve the new grade 9, which is a grade higher than the A* in the previous GCSE system.

Jo Boaler notes that ability grouping "is not as prevalent or severe" in the USA where Dweck and their colleagues have focused much of their research and that many Asian countries, such as Japan, do not set students by ability. She argues that placing students in sets based on ability, as practiced by many English schools, not only contrasts against growth mindset concepts, but that it can also entrench entity mindset beliefs, "Ability grouping as a practice rests upon fixed mindset beliefs -- it is implemented by schools and teachers who themselves have fixed beliefs about learning and potential and it communicates damaging fixed ability beliefs to students." (Boaler, 2013, p. 149). An earlier study by Boaler and her colleagues (Boaler, Wiliam, & Brown, 2000) contended that placing students in higher sets also placed a high degree of pressure on them, whereas lower sets typically showed teacher and student expectations were lower and students in these sets did not believe they could move into higher sets. The EEF toolkit evaluated streamed teaching as having a negative impact and is currently conducting a research project into the *Best Practice in Grouping Students*, which is investigating the effectiveness of embedding mixed attainment groups in schools taking part in the study. The evaluation report for this project is due in summer 2018 and the study involved 130 participating schools.

Within this context, the use of the term "ability" is problematic when referring to students, as well as conflicting with growth mindset concepts. Placing a student in a "low ability" set, connotes a perception of them as lacking in skill or proficiency. Furthermore it can also have the effect of labelling or categorising some students as not being as good as others, sending a clear message to them that ability, and intelligence, is fixed. While "prior attainment" is a more appropriate term that does not limit students as much, if students are placed in a "low attainment" set, where they have little opportunity to move into a higher attainment group, but are being told by schools that by having a growth mindset they can achieve, then a conflicting and potentially damaging message is being sent to them. In the school participating in this study, the majority of classes, including Mathematics and English are set by prior attainment at Key Stage 2 (although some humanity GCSE subjects do teach mixed attainment groups). Following a progress review at the end of the autumn term in the core subjects, there is generally little movement between groups; thus, a student placed in a set 4 (a low attaining group) in English at the start of year 7 will probably remain within that group until they leave at the end of year 11. Additionally, setting in other Key Stage 3 subjects are predicated on where they are set in English, so a student placed in set 2 in English is also placed in set 2 for History, Geography, French and Life lessons. This also affects the other subjects students can take, as students placed in set 3 English and below are currently unable to study a foreign language and have extra English lessons instead. Thus, students are being communicated a growth mindset message that by working hard, persevering and learning from their mistakes they can achieve and grow their intelligence, yet, some students will not be able to study a foreign language because they did not achieve a high enough grade in their Y6 English SATs. In part, the use of mixed ability classes may ameliorate this and one Yorkshire school is trialling this, along with not reporting GCSE targets to either students or parents in order to establish structures that are more aligned with a growth mindset culture.

Chapter Two

Literature Review

2.1 Mindset

Early research by Carol Dweck and her colleagues focused on the classification of students' responses to failure into two dichotomous categories, which they identified as helpless, and mastery-orientated (Diener & Dweck, 1980; Dweck, 1975; Dweck & Reppucci, 1973). In this context, the "helpless" category included all negative reactions students experienced when they failed, such as: reduced belief in their intelligence; decreased resilience and effort, and increased feelings of worthlessness. In contrast, "mastery-orientated" students did not attribute lack of success to lack of intelligence; instead they responded with resilience to failure, and developed different learning strategies in order to become proficient. Carol Dweck further developed these concepts through her research into individual theories of intelligence, in which helpless students are viewed as entity theorists and mastery students are viewed as incremental theorists. Entity theorists believe we have a fixed amount of intelligence whereas incremental theorists see intelligence as malleable, a commodity that can be increased through effort (Dweck, 2000). This body of research underpins the popular educational construct of 'mindset' in which an entity theorist is described as having a "fixed mindset" and an incremental theorist is described as having a "growth mindset". Dweck further contended that people's beliefs about the malleability of intelligence affects the way in which they respond to challenge and failure: those with a fixed mindset see failure as confirmation of their own lack of ability and therefore avoid challenge, whereas people with growth mindsets embrace mistakes as opportunities to learn from, and as a way of developing strategies, which help them, ultimately to become more successful.

In a school context, where students are continually confronted with academic challenges, Dweck's theory suggests there could be benefits to teaching learners how to adopt a growth mindset in order to help them increase both their intelligence, and a constructive approach to managing failure and challenge. This is particularly significant at a time when regular high stakes testing means that students are often faced with academic challenges and when the Organisation for Economic Cooperation and Development (OECD) has reported on the detrimental effect that school work anxiety has on student well-being. These results were published in April 2017 and based on the 2015 Programme for International Student Assessment (PISA). On average across PISA countries, 66% of students worried about poor grades and 55% reported feeling extremely anxious about taking a test, even if they were well prepared (http://www.keepeek.com/Digital-Asset-Management/oecd/education/pisa-2015-results-volume-iii_9789264273856-en#page6). If nurturing a growth mindset can improve resilience in the face of challenge then it is not unreasonable to suggest that it may have a positive indirect effect on pupil wellbeing too.

In their 2007 study , which sought to investigate the effect of implicit theories of intelligence on students' progress in Mathematics, Lisa Blackwell and her colleagues stressed that belief in the malleability of intelligence does not mean that all people are have equivalent levels of ability, or that there is parity in how easily they learn; instead it means that, "intellectual ability can always be developed."(Blackwell et al., 2007, p. 247) In an article written by Lisa Blackwell for a Mindset Workshop intervention, which was used to explain the malleability of intelligence to students using the *Brainology* programme, she stated, "new research shows that the brain is more like a muscle – it changes and gets stronger when you use it" (L. Blackwell, 2002, p. 6). This appears to be a reference to the idea of neuroplasticity the findings that connections in the brain become stronger the more they are used. However, although there is a short video clip linked to the plasticity of the brain in the Science section of the

Mindsetworks™ webpage (https://www. mindsetworks.com/Science /Default), and although Blackwell's 2002 article referred to other research, it did not specifically cite any studies.

Although studies by Dweck et al. (2006) on the effect of growth mindset on pupil attainment have shown some encouraging outcomes, a study by the EEF in the United Kingdom, which aimed to develop students' growth mindset in order to increase their academic achievement, did not find statistically significant results (Rienzo et al., 2015). The *Changing Mindset* study used two different interventions: one consisted of a ten-week pupil intervention growth mindset workshop to year 5 students, the other involved two training sessions delivered to teachers, which demonstrated how to develop a growth mindset in their students. This study was designed and conducted by Growing Learners, a group of educational research psychologists led by Dr Sherria Hoskins, at the University of Portsmouth. At the end of the ten weeks, the teacher intervention demonstrated no statistically significant increases, with students making no additional progress in Mathematics and less progress in English, compared to those of the control group teachers. Results from the pupil intervention group, although not statistically significant, were more promising with them making an average of two extra months' progress in Mathematics and English. As an increasing number of UK schools and teachers appear to be using social media as just one method of promoting and evidencing the adoption of mindset approaches in the classroom, it is perhaps not surprising that the *Changing Mindset* Evaluation Report cited evidence that both treatment and control group schools were already using growth mindset features as a weakness in the potential impact of interventions on pupils. The EEF is currently running a further trial to investigate in more detail the effects of the intervention workshops on student attainment. The trial is due for publication in spring 2018.(https://educationendowmentfoundation.org.uk/our-work/projects/changing-mindset-2015/).

Doubts about the statistical reliability of some mindset studies were raised by Nicholas Brown and James Heathers following the publication of their paper exploring potential inconsistencies in the accuracy of some studies' results (Brown & Heathers, 2016). In order to assess if statistical results from psychology reports correlated to stated sample sizes and number of items, they developed a mathematical system, which they termed the granularity-related inconsistency of means (GRIM). They then used this system to test whether the means presented were mathematically possible in a number of psychological studies, including Claudia Mueller and Carol Dweck's 1998 study (Mueller & Dweck, 1998).

In a group of six small experimental studies with Mueller, Dweck examined the impact of different types of praise on 5^{th} grade students. Their results demonstrated that students who received effort-based feedback were far more likely to attribute failure in a task to lack of effort than those who received ability-based feedback, who typically ascribed poor performance to lack of intelligence – a trait they also appeared to believe was fixed. Additionally, students who were given effort-based feedback selected learning goals over performance goals elected to receive strategy information on how to tackle problems rather than information on other students' performance and demonstrated more enjoyment and perseverance when tackling the trial tasks. Three of the four options were performance related, such as, "problems that aren't too hard, so I don't get many wrong" and "problems that I'm pretty good at, so I can show that I'm smart". The learning relation option was: " problems that I'll learn a lot from, even if I won't look so smart."(Mueller & Dweck, 1998, p. 35). Although not a key focus of these studies, and based on a relatively small sample size of 118 children, Study 1 ostensibly showed promising results for using effort-based praise as a way to increase student performance. After the failure condition of the second task, children who received effort praise (n=41) increased their performance from their pre-failure score by 1.21 (SD= 1.57), compared to the intelligence-based praise experimental group (n=41), which dropped an average of 0.92 (SD= 1.25) and controls who received no feedback (n=46), which rose only slightly (Mueller & Dweck, 1998).

Brown and Heathers applied the GRIM test to the findings in this article and identified a number of inconsistencies in the six reported studies. For example, the control group reported for Study 1 (*n*=46) failed to take into account the five participants who were withdrawn from the study because they did not yet have the ability to solve the mathematical problems used in the study. This meant the actual figure in the control group (*n*=41) was not used for statistical analysis and skewed the results. Overall, the application of the GRIM test demonstrated that 17 of the 50 means reported in the study appeared to be statistically impossible (http://steamtraen.blogspot.co.uk/2017/01/in-which-science-actually-selfcorrects.html). After receipt of this information on the GRIM test findings from Brown, Dweck worked with Mueller and another colleague, David Yeager on re-evaluating their study in order to address these inconsistencies and they produced an annotated copy of the article, which reported their findings and was published online in December 2016 (https://osf.io/tb2cv/). Despite these annotations, and Brown's praise for Dweck's engagement and diligence in the process of explaining and correcting inconsistencies, to date there has been no publication analysing the statistical impact of these changes on each of the six studies. However, given that the original study was published nearly 20 years ago, and some of the raw data is no longer available, and that some of the discrepancies were ascribed to typographic errors in the original transcripts it is likely that this is no longer possible. In January 2017, Dweck also used the Open Science Framework (OSF) to publish online amendments to two other studies: a re-analysis of her 2016 paper (https://osf.io/r8w8u/) about the effect of parents' views of failure on their children's mindsets (Haimovitz & Dweck, 2016), and a reconsideration of the study by Blackwell and her colleagues (https://osf.io/jcnj3/) (Blackwell et al., 2007). Although the publication of such amendments appear to demonstrate that Dweck is committed to ensuring her statistical data is as accurate as possible, and although Brown and Heather's study praises Dweck's rigour in endeavouring to correct the statistical errors in her work (Brown & Heathers, 2016) this does cast into some doubt the statistical accuracy of data and findings reported in these articles, which may include other mindset studies.

A recent study by Li and Bates (2017) have also challenged how easily Dweck's findings could be reproduced. The authors attempted to replicate three of her mindset theory interventions in order to investigate whether student ability is increased by the development of growth mindset traits (Blackwell et al., 2007), and if praising ability has a detrimental impact on student performance (Mueller & Dweck, 1998). In all three trials, they were unable to replicate Dweck's findings, and concluded, "We find no support…that implicit theories of intelligence play any significant role in the development of cognitive ability, response to challenge, or educational attainment." (Li & Bates, 2017, p. 2). Dweck has responded to this by explaining the difficulty of producing an exact replication of a study, "Not anyone can do a replication. We put so much thought into creating an environment; we spend hours and days on each question, on creating a context in which the phenomenon could plausibly emerge." (www.buzzfeed.com/tomchivers/what-isyourmindset?_utm_term_=.phb_ EAq3E#.soyQMomaQ) However, if accurate reproductions of such trials are difficult to replicate in a carefully planned study, it appears it would make them increasingly difficult, if not impossible, to reproduce in the classroom within a normal school environment.

Similar concerns about the value of encouraging students to foster a growth mindset have been mirrored in discussions involving educators in British schools, and have challenged the impact that developing an incremental mindset has on student attainment and motivation. Educators are increasingly using on-line forums, such as educational blogs to express skepticism about Dweck's mindset theories and their application in the classroom. In a 2016 post on his site, *The Learning Spy*, teacher and author, David Didau, debated the limits of what he described as, "the growth mindset myth" (http://www.learningspy.co.uk/psychology_limits-growth-mindset/). He followed this up with a blog in 2017, which offered a further critique of Dweck's theories, citing Li and Bates' 2017 study as clear evidence that students' beliefs about their ability has no connection to their attainment. Although Didau offers the possible explanation that it may be teachers', "false growth mindsets" which cause them to ineffectually implement growth mindset theories in the classroom, he ultimately condemns those who believe, "such appealingly simplistic ideas about making profound changes to children's academic attainment." (http://www.learningspy.co.uk/psychology/growth-mindset-bollocks/). Conversely, Dweck is insistent that mindset theory is a complex concept and another misconception of her research is, "That mindset is a simple concept. It's not – it's embedded in a whole theory about the psychology of challenge-seeking and persistence." (https://www.timeshighereducation.com /people/interview-carol-s-dweck-stanford university).

The concept of the "false growth mindset" was raised in an article by Dweck in which she reflected on the impact of her research into growth mindsets in educational institutions (Paunesku et al., 2015). She described false growth mindset as one in which a person professes to have a growth mindset (perhaps because a growth mindset is perceived as more desirable than a fixed mindset), yet retains a fixed mindset. Consequently, educators with false growth mindsets ostensibly promote the notion that intelligence is malleable, while correspondingly validating fixed mindset practices. In her article, Dweck also cited Kathy Liu Sun's 2014 research (Sun, 2014) into a group of 40 mathematics teachers' mindsets and their classroom research to demonstrate that, "In these cases, their students tended to endorse more of a fixed mindset about their math ability." (Paunesku et al., 2015, p. 21). In order to address and eliminate the false growth mindset in education, Dweck believes that teachers need to acknowledge and promote the notion that every individual demonstrates a combination of growth and fixed mindsets.

Some commentators have even suggested that having a fixed mindset in certain areas may be beneficial as, “it may be an adaptive response, an evolved strategy preventing us from ‘wasting’ effort where we have experienced frequent failure and the opportunity for future success is low, and encouraging to invest effort in areas where it may be more likely to pay off for us.” (Didau & Rose, 2016, p. 126). Rather than countenance a “ban” on fixed mindset thinking, Dweck has advocated that we develop our awareness of our triggers for fixed mindset reactions, such as: negative reactions to mistakes; feeling defeated rather than challenged by poor performance; and not seeking to develop new skills and learning, in order to help us move towards a more growth mindset perspective. It may be that having a growth mindset is only valuable at the point of challenge. If a student is generally successful in their learning then it does not matter if they have a growth or fixed mindset as they are not experiencing difficulty. It is when learning becomes a struggle and a student is not initially successful that a growth mindset may help them achieve, as it seeks to foster a learning-orientated, rather than goal-orientated success. Above all, Dweck stressed that the “growth-mindset journey” is not an easy one and that it remains a continual process. This contrasts starkly with David Didau’s contention of it as an, “appallingly simplistic idea” and may explain why it is such a complex trait to develop in a classroom situation or definitively identify in an individual student.

A 2016 survey of 603 American K-12 educators reported that 45% of teachers perceived themselves to be, “very familiar” with the concept of growth mindset, compared to 4% responding as, “not at all familiar”; 52% “strongly believed” that a responsibility of their job was to foster a growth mindset in their students; however only 5% “strongly agreed” they possessed the appropriate skills and strategies to help students who did not demonstrate this mindset (http://www.edweek.org/media/ewrc_mindsetintheclassroom_sept2016.pdf). Almost all of those who responded (98%) believed that using growth mindset practices in their classroom would increase their students’ learning in the classroom. Ostensibly, this does appear to demonstrate that many teachers are not only are aware of incremental mindset strategies, but also believe them to have a positive influence on student attainment. However, although the online survey was sent to a random sample of classroom teachers and instructional specialists registered nationally to edweek.org, the Education Week website, the survey explicitly stated that these were representative nation's teachers. By registering with an educational website, it is possible that the sample were more likely to be up-to-date with contemporary pedagogical theories than other teachers, and so more aware of Carol Dweck's growth mindset theories, which may explain why 96% of survey respondents were familiar with this concept.

Despite some creeping skepticism regarding Dweck's mindset theories, there does remain a strong interest in exploring the impact of teaching growth mindset theories to improve motivation and achievement in the classroom. As discussed in Chapter One, there are a wealth of external and internal Continuing Professional Development opportunities, on-line forums and school improvement strategies that seek to develop growth mindset processes in both educators and their students. With so much training and so many resources available it has become increasingly difficult to ascertain how much impact such training has on individual students, as they become increasingly exposed to incremental theories explained in a wider variety of ways. For example, students now study Dweck's mindset theory as part of the GCSE Psychology curriculum. The exposure of teachers to information regarding cognitive processes was cited by the EEF in their evaluation report on the impact of teaching students specific metacognitive techniques using the *ReflectED* program (Motteram, Choudry, Kalambouka, Hutcheson, & Barton, 2016). Metacognition and mindset intervention tools, such as Blackwell and Dweck's *Brainology* program also seek to increase student exposure to mindset concepts, with minimal teaching interaction required, in order to help them foster a growth mindset.

2.2 *Brainology*

Inspired by the promising results of research into the correlation between teaching students growth mindset strategies and increased motivation (Blackwell et al., 2007), Carol Dweck and Lisa Blackwell worked together with industry experts in education, media and psychology to develop *Brainology*. Funded by a grant from the William T Grant Foundation, *Brainology* is a computer-based programme designed to allow growth mindset workshops to be supplied on a larger scale with teachers "guiding" students through the modules, rather than delivering them. Targeted at grades 5-9 in the United States (Years 6-10 in England), the aim is to help students to cultivate an incremental mindset with a view to improving their academic achievement.

Students complete the *Brainology* programme through a series of interactive on-line classroom activities where they learn about the structure of the brain and the malleability of intelligence from, "eccentric brain scientist" Dr Cerebus. During four 30-minute sessions they follow animated characters Dahlia and Chris as they learn to tackle different challenges in their schoolwork. The course is designed to teach students, "how thinking occurs, how learning and memory work, how to develop and change the brain and how to improve their study habits and skills in the light of this knowledge." (www.mindsetworks.com).Throughout the course learners have the opportunity to reflect on, develop and record their ideas in an e-journal / student workbook. Teachers are provided with a detailed collection of guides explaining how to deliver each stage of the workbook materials and structure the course, and are advised that best-practise is for the course to be delivered in approximately 15-20 hours over six weeks. Some activities in the workbook are differentiated into two approaches and / or worksheets (one for " On – Level or Advanced learners" and the other for "Below-Level Learners") to support the person delivering the intervention meet the needs of different attainment and age groups. Extra materials are also available in a "Supplemental Guide for High School", which targets "olderlearners or 'at risk' students. An Implementation Guide gives teachers a brief overview of growth mindset and how *Brainology* can help students acquire a growth mindset.

MindsetWorks™ is an American company that provides growth mindset training for educators, students and parents through online interventions, such as Mindsetmaker™ (an online professional development course for educators) and *Brainology*. It was co-founded in January 2007 by Carol Dweck and Lisa Blackwell and aimed to "Translate psychology research into practical products and services to help students and educators increase their motivation and achievement." (https://www.mindsetworks.com/FileCenter/TAW3IWTKZH VSFMIUIRE 8.pdf).

The *Brainology* programme was initially piloted in 20 schools in New York and, according to Dweck, had a clear positive impact, "In the end, just about every child reported meaningful benefits."(Dweck, 2012). Student responses to the question, "Did you change your mind about anything?" included, "I did change my mind about how the brain works…I will try harder because I know that the more that you try, the more your brain works" and " I imagine neurons making connections in my brain and I feel like I am learning something." (Dweck, 2008). Dweck also contended that the programme helped teachers to understand the need for adopting growth mindset strategies so all students could learn and that they noticed students use more explicit "*Brainology* talk" to articulate their learning. However, although testimonials suggest that using the *Brainology* programme increased students' awareness of the malleability of intelligence they cannot provide evidence of effectiveness. Evaluation studies are needed to assess whether *Brainology* has causal effects on either mindset or achievement, and how long any effects are sustained. Results from Dweck's subsequent research into the scalability of mindset interventions through computer-based programmes went further in exploring the association between academic achievement and this type of intervention (Paunesku et al., 2015). However, the paper describing this study does not state whether *Brainology* was the computer programme used in the intervention and it also recognises that further study needs to be done to ascertain whether there is any long-term impact from this type of provision.

MindsetWorks™ attempts to evidence the impact of *Brainology* interventions using three case studies, all presented on its website, which focus on: changing teacher practices; reaching at-risk minorities and shifting school culture. As expected, given that the company's role is to market this intervention, all three studies demonstrated a positive association between the use of *Brainology* as a growth mindset intervention and the increase in growth mindsets in both students and teachers involved in the case studies. For example, Dawn Clemens, Principal of the middle school in the reaching at-risk minorities study, believes the intervention "empowered" her students, "I have watched students completely change their attitude toward the level of effort they are willing to put in. The online portion of this program engages students and makes learning exciting for them." (www.mindsetworks.com/Science/Case-Studies). Furthermore, the school demonstrated an increase in achievement in reading and maths that placed it as one of the top performing schools in the district. After two years of the *Brainology* intervention the school's growth was 86% in iReady Math scores (iReady Math is an American diagnostic, intervention and assessment programme designed to accelerate progress in maths) compared to an average of 67% for the school district. Clemens attributed this increase in student achievement to the *Brainology* intervention, while the study concludes that although, "no formal statistical conclusions" can be made on the specific impact of *Brainology* there is, "reason to believe that a connection may exist."

It is noteworthy that when the provision of the *Brainology* intervention was moved from all 7th grade science classes to an optional "Specials" class that students in 9th grade could opt into, Clemens perceived it to be less effective. This was because she felt that, "the students who could most benefit from this program were choosing other specials" and that all students would gain from learning growth mindset strategies earlier on in their academic studies so they could utilise, “their growth mindsets” in future learning. Consequently, *Brainology* lessons were timetabled in the third year of its use in Stuart-Hobson school so that all 6th grade students were taught it. It may be that, in this case, when *Brainology* was offered as an optional course, students with an incremental mindset were more likely to choose it as an invention, while those, “who could most benefit” from it but chose not to were of a more fixed mindset. However, there is no statistical data from the study to verify this. These case studies and testimonials point to the benefits of *Brainology* but cannot be considered robust evidence of the intervention’s effectiveness.

A research project based in Scottish school, investigated the effect that the *Brainology* intervention had on developing resilience mastery and incremental mindset beliefs in a small group of adolescent students (Donohoe et al., 2012). Thirty-three students in the second year of secondary school (Year 8) took part in the study. Participants were chosen from two similar mid-ability English sets; however, they were not randomly allocated to experimental and control groups. One-way analysis of pre-intervention test score for both experimental and control group revealed no substantial disparity for mindset, resiliency or mastery. Post-intervention, there was a significant increase in incremental mindset for the intervention group; however, three months later, there was no significant difference between pre-test scores and follow-up scores for this group. Additionally, both pre-, post- and follow-up scores demonstrated no statistically significant increases in mastery or resilience for either group that participated in the study. Examination performance data collected on study participants also showed no significant difference between the academic achievement of students in the control and experimental groups. This suggests that while intensive intervention may have a short-term positive impact on student mindset scores, there is no evidence of this being sustained over a longer period. It is also important to emphasise that the lack of random allocation was a significant limitation of this study.

Research into the impact of three different digital resources, including *Brainology*, was undertaken by Choa et al., who sought to explore the role that these technology-based interventions played in motivating adolescent students to learn Mathematics (Chao, Chen, Star, & Dede, 2016). This research used an abridged version of the *Brainology* programme, which was created by Carol Dweck and her colleagues explicitly for use in the study. Although it still focussed its message on the malleability of intelligence, it was a condensed form of the original programme and specifically aimed to offer strategies to reduce student anxiety experienced in schools and espouse the theory, "that the brain is like a muscle – the harder you work it the stronger it grows." The study involved 88 participants from grades 5-8 (Years 6-9 in England), who each participated in a week-long technology-based intervention programme. Students were randomly allocated to either the *Brainology* intervention, a game-based intervention, or a film-based intervention; only *The Game: an Immersive Virtual Environment* was specifically related to mathematically based tasks. *Brainology* was chosen to explore whether targeting only beliefs about the nature of intelligence was enough to have a favourable effect on student motivation in Mathematics. The focus of the investigation was on trying to measure the impact of the intervention on the students' motivation to study Mathematics, rather than measuring changes in Mathematics content knowledge; the researchers clarified that this was due to the brevity of the investigation. All 88 students in the trial also participated in a two-day Mathematical patterns lesson during the second and third day of the intervention.

Results demonstrated that students rated *Brainology* as the most interesting of the three interventions (71% compared to 50% for both the game and video), although they did add that this may be because one teacher running the *Brainology* intervention had allowed students to surf the internet and so, "the *Brainology* resource was not necessarily interesting in and of itself." Teacher interviews following the trials also, "mentioned that the students struggled to engage with the content or connect it to learning Mathematics." Although, for the students who received the *Brainology* intervention, “implicit theory of ability appeared salient to just over 35% of them”, the study was unable to establish a connection between this and an positively improving students motivation in Mathematics. This appeared to be due, at least in part, to the brevity of study’s timespan.

Brainology was also used as an intervention programme in a study by Schmidt et al, which explored whether a mindset intervention could predict students’ daily experience in the classroom (Schmidt, Shumow, & Kackar-Cam, 2016). Unlike other studies, which assessed the effect of growth mindset interventions on a variety of factors through pre- and post-intervention student surveys (Aronson et al., 2002; Blackwell et al., 2007), or laboratory style problem solving tasks (Mueller & Dweck, 1998), this research sought to observe the effect of growth mindset interventions through a comparison of students experiences in the classroom. Three hundred and seventy 7th grade and 356 9th grade students participated in six-week classroom intervention study and were randomly assigned to either a mindset intervention or a content writing task condition. *Brainology* was selected as the mindset intervention programme as it is widely used in this capacity across school districts in the United States; to date over 50 British schools have purchased one or more *Brainology* license, with this number increasing significantly to over 1600 in the United States. They also stated, “there is fairly consistent evidence that students are more likely to endorse growth mindset following participation in the programme.” However, although this paper referenced the short-term impact of the Donohoe study (Donohoe et al., 2012) ,and that few studies have researched the long-term effectiveness of the intervention, it did not comment on the lack of robust evidence in the MindsetWorks ™ research. Instead, it referenced both the introductory material and the evidence of impact summary provided by MindsetWorks™ as examples of studies that demonstrate an improvement in both motivation and Mathematics grades (http://www.mindsetworks.com/websitemedia/brainology_introduction.pdf).

This study also endeavoured to ascertain (though the participation of both 7th and 9th grade students in the intervention) whether the *Brainology* programme was effective in meeting the "structure and challenge that is developmentally appropriate for students across the developmental range from 6th to 9th grades." Results showed that, for 9th grade students, there was an increased perception of control and interest over the school year compared to the comparison group, who showed a significant reduction in these measures during the same time. Despite this increase, there was no increase apparent in the 7th grade students receiving the *Brainology* intervention and furthermore, they demonstrated a bigger decline in perceived learning and interest compared to the content task writing groups. The researchers offered a range of possible explanations for this, including the "considerably higher" levels of learning and interest that the 7th graders in the mindset intervention rated at the start of the study and the possibility that *Brainology* may not be equally developmentally appropriate for all academic year groups. Intervention in this study was delivered by two researchers to both the experimental and comparison groups, in order to ensure the fidelity of the *Brainology* intervention. A previous study conducted by the same research team (Schmidt, Shumow, & Kackar-Cam, 2015), which also used the *Brainology* programme as an intervention tool to teach growth mindset beliefs, observed that the impact of the intervention was affected by the teachers' application of incremental beliefs in the classroom. However, this was a smaller study of 160 students taught by two different teachers both of whom had different teaching experience, different pedagogical approaches and taught in in different schools in the same district. The *Brainology* programme was delivered by researchers with both teachers present at all sessions. The teachers met with the researchers to discuss ways of fostering incremental mindset in the classroom and were each given a manual that included extensive extension materials. Although this paper ostensibly indicated a link between the teacher's application of the incremental mindset messages used in *Brainology* and students' beliefs about the malleability of intelligence, the study was too small to draw robust conclusions on teacher effects on growth mindset interventions.

2.3 Effort

In their 1979 study, Covington and Omelich (Covington & Omelich, 1979) described effort as "a double-edged sword." They noted that teachers in the American educational system generally rewarded more and punished less those students who had applied effort to their work. Consequently, they hypothesised that many students struggled to negotiate a balance between trying hard enough, so that they were not punished by teachers for not applying enough effort in their work, and not trying, "so much as to risk public shame should they try and fail." (Covington & Omelich, 1979, p. 178). Furthermore, they made a case that students tended to offer excuses for failure in order to maintain their self-worth and reduce the shame of their perceived low ability in situations where they had tried hard and failed.

The 360 students in Covington and Omelich's study were each given a questionnaire, which described a hypothetical achievement situation, in which they had failed a recent test. They were given four possible scenarios to explain why they had failed (you studied very little and failed; you studied very hard and failed; you studied very little due to illness and failed; you studied very hard but the test stressed other things and you failed). These were rated using a 7-point Likert-type scale (1= not at all; 7= very much) for four different settings, two of which were related to intellectual responses, and two to affective ones. Their results suggested that high levels of effort, linked to failure, were associated with more negative self-attributions of ability in both males and females. Students also expected others to judge them critically in terms of ability when failure had been accompanied by a high degree of effort. The study observed that a "winning formula" had emerged in the education system, namely, to avoid personal humiliation and shame when risking failure, "Try, or at least appear to try, but not too energetically and with an excuse always handy." (Covington & Omelich, 1979, p. 178).

Many of the negative traits described in this research appear similar to those initially classified by Carol Dweck as characteristics of "entity theorists" (Dweck, 2000), or the "fixed mindset" (Dweck, 2006). These include a focus on goal-orientated, rather than process- orientated learning and the ideas that intelligence is fixed and that effort and failure are linked to low ability. This may have been, in part, because Covington and Omelich's study focussed solely on how students responded to failure, with no opportunity to explore their perceptions of links between increased effort and success.

In contrast, research by Carol Dweck and colleagues sought to understand how students with different mindsets perceived effort and how this affected the amount of effort they invested in a particular task (Dweck, 2000; Dweck & Leggett, 1988; Elliott & Dweck, 1988). Dweck contended that students with an entity ("fixed mindset") theory regarded effort as a measure of intelligence, where the need to try hard marked a clear lack of ability. In part, Dweck's conclusion that students with an entity theory deliberately "*self-handicapped*" (Jones & Berglas, 1978), or suppressed effort in order to maintain self-esteem and the belief they could have achieved far better if they had worked harder, links to the Covington and Omelich study, in which students were perceived to withhold effort in order to maintain their self-worth (Covington & Omelich, 1979, p. 178). However, Dweck's research also categorized another set of students, who worked within an incremental theory ("growth mindset") framework , in which they valued effort and viewed it as a quality which helped them develop their intelligence and ability (Dweck, 2000).

Claudia Mueller and Carol Dweck (Mueller & Dweck, 1997) investigated the importance that entity and incremental theorists placed on effort and ability, as contributory factors to intelligence, by the way in which they completed the following equation: "Intelligence = ______% effort + __________% ability". The original study and its methodology and results remain unpublished; however, Dweck did summarize this study in her book *Self Theories*

(Dweck, 2000, p. 62). In this she stated that incremental theorists responded to the equation: "Intelligence = 65% effort + 35% ability", in contrast to entity theorists who filled in the equation as "Intelligence = 35% effort + 65% ability". Although this could be perceived to demonstrate incremental theorists not only valued effort, but also considered it to be more significant than ability when determining intelligence, these results remain unverifiable as the data remains unpublished

The relationship between motivation and effort was explored in Lyn Corno's study of the function played by volition in education (Corno, 1993). This research focused on the movement between student's pre-decisional thought processes, exemplified by the consideration and determination of a goal, and post-decisional ones, centred around goal implementation (Corno, 1993). Corno termed this movement from pre- to post-decisional thought processes as the crossing of a "metaphorical Rubicon" (Corno, 1993, p. 15); a point of no return, which rendered the goal more firmly established and signalled a transition from a motivational construct to a volitional one. When given an academic context, volition could be viewed in part as, "directed effort in the face of personal and / or environmental distractions, that can aid learning and performance" (Corno, 1993, p. 16) In contrast, motivation was distinguished as pre-decisional as it aided the determination of the goal, rather than an effort - based process, to implement it. Thus, although there seems a clear distinction between motivation and effort, a case can be made that motivation is a prerequisite of academic effort, if not necessarily a predictor of it.

The role motivation plays in instigating student effort was also studied by Brookhart et al. (Brookhart, Walsh, & Zientarski, 2006) who investigated the relationship between student motivation, effort and classroom assessments with a sample of 223 8^{th} Grade students. Effort measures were sub-classified into two separate variables: Amount of Invested Effort (AIME) and Active and Superficial Learning Strategy Use (ASLUE). AIME was a concept developed by Gavriel Salomon, which he defined as mental effort predicated on non-automatic cognitive processes, such as concentrating and studying (Salomon, 1983, 1984). Salomon juxtaposed AIME against automatic mental processes that required little effort and were mainly unconscious. The second variable, ASLUE, was further sub-divided into Active Learning Strategies, that is, being fully engaged in the learning activity by making detailed annotations or revisiting work not fully understood and Superficial Learning Strategies which require no deep thinking and include actions such as copying someone else's notes or ignoring work not understood.

Results indicated that the classroom assessment environment (teacher) had the most significant effect on student achievement but that motivation, particularly self-efficacy, was also a useful predictor of academic achievement. However, effort variables did not add any prediction of achievement over and above motivational ones, leading the authors of the study to note, "It makes sense to focus efforts in the classroom on motivating students- and letting the motivated students take care of effort."(Brookhart et al., 2006, p. 176). However, it also stated that the study's lack of evidence regarding the effect of effort was "probably" due to the lack of challenge in the assessments in addition to the impact of motivation variables, which had already been perceived to have the same effect as effort variables.

One significant aspect of Brookhart et al.'s (2006) study was the observed expectations that teachers had of student-effort, "Mental effort is not enough in classrooms. Teachers want to see students spend effort in a productive manner." (Brookhart et al., 2006, p. 159) a concept they correlated with Covington's notion of "painful strategic" effort (Covington, 1992, p. 203) and links to both Active Learning Strategies and AIME. Although Covington and Omelich contended that low student effort resulted in teacher sanctions, "while student ability level is not particularly salient in determining the degree of teacher punishment, amount of student effort is" (Covington & Omelich, 1979, p. 177), they also noted that instead of increased student effort, it resulted in students who created excuses and did not put in the optimum amount of effort in order to reduce feelings of shame when confronted with failure. However, in the current educational climate, this notion of teacher punishment for lack of effort appears outdated and draconian.

Part of Yan et al.'s 2014 study sought to investigate any relationship between learners' mindsets and the amount of value they placed in the effortful study of, "desirable difficulties" (Yan, Thai, & Bjork, 2014). "Desirable difficulties", a term constructed by Robert Bjork (Bjork, 1994), refers to more demanding learning strategies that require more effort, but increase long-term memory retention, such as self-testing. This contrasts to less effortful methods of study, such as re-reading information, which are less likely to lead to long-term memory retention. Their findings note that while the most significant factor motivating people to study was an approaching deadline, "Our data suggests, however, that growth mindset theorists manage their own learning in somewhat more productive ways than do fixed theorists" (Yan et al., 2014, p. 146) . Furthermore, those with incremental mindsets had higher intrinsic motivation, while those with fixed mindsets had higher extrinsic motivation. If, as some studies suggest (Gutman & Schoon, 2013) intrinsic motivation is a desirable quality, which predicts academic achievement then the fostering a growth mindset in students could be a way to help raise attainment and ameliorate the perception of effort as sometimes being a negative trait. Yen et al.'s study also considers the possibility that one way of developing a growth mindset in students may be to teach them both the strategies and benefits of "desirable difficulties". They contend that if students are taught that effortful learning should feel difficult, but can benefit long-term learning, then it may increase their understanding of the malleability of intelligence. As the current English education system shifts towards a focus on 100% terminal GCSE exams and increased subject content in all Key Stages then a focus on desirable difficulties, whether it encourages a growth mindset in students or not, may provide them with the tools they need to successfully develop their memory skills in preparation for high-stakes testing.

In a 2010 article, Carol Dweck contended that students respond differently to tasks that challenge them, depending on whether they have an incremental or an entity mindset (Dweck, 2010). Dweck argued that students who view intelligence as malleable relish challenges and perceive effort as a valuable process, which enables them to develop their potential. By contrast, students with a fixed mindset see effort as a threat to their self-esteem because they believe ability to be innate and unalterable, therefore, they view trying hard as evidence of failure – if they were able then they would not need to try. If this is the case then, when viewed in light of the Dweck's 1998 study with Mueller, it could suggest that teaching students a growth mindset, could increase their effort levels and, consequently, their attainment. However, there has, to date, been no significant study to establish this link and the impact it may have on academic outcomes for students.

In a recent article written by Carol Dweck, which "Revisits the Growth Mindset" and critiques a concept she terms as the "false growth mindset" she also warned against the belief that the only factor of growth mindset was hard work, "Perhaps the most common misconception is simply equating the growth with effort." (Paunesku et al., 2015). Instead she argued that although effort remains an important element of helping students' achieve, it must be linked with teaching them a range of strategies to develop their learning and tackle new challenges. Given the growth in interest in the impact of metacognitive strategies (Gutman & Schoon, 2013; Lazowski & Hulleman, 2016; Motteram et al., 2016), and Mueller and Dweck's conclusion that effort-praised children in their studies, "demonstrated their continued interest in mastery by preferring to receive strategy-related information" (Mueller & Dweck, 1998, p. 48), it may be that the route to academic success is teaching students the value of effort so that they can then apply and persevere with metacognitive strategies in order to succeed.

2. 4 Research Questions:

Although there is a significant body of literature in this area many gaps and opportunities for research remain. The current study attempts to address some of these gaps by asking the following three research questions:

1. Can a whole school mindset approach increase pupils' mindset scores?
2. Is *Brainology* effective over and above a whole-school mindset approach?
3. Does *Brainology* and/or a whole school approach lead to an increase in teacher-rated effort in English and Mathematics?

Chapter Three

Methods

3.1 Participants

Participating students were drawn from Year 9 of a secondary school in a coastal area of North East England. This school is a mixed comprehensive with 998 Year 7-11 students on roll at the time of the study, 8.3 % of whom receive free school meals, compared with a national average of 12.9% (figures taken from the Department of Education's School Census Data, January 2017). This school converted to academy status in September 2016 to become head of a Multi-Academy Trust (MAT). Although it is currently the only school in the MAT, a primary school will be joining the chain in January 2018, with more schools expected to follow. It was rated by Ofsted as "Good" in its latest inspection (the two nearest secondary schools in the area have been inspected and placed into Special Measures by Ofsted in the last six months).

The Year 9 cohort was composed of 195 students between the ages of 13 and 14, of which 105 are male and 90 female. All students at this school begin KS4 and GCSE study at the start of Year 9 (this is a year earlier than in some schools), having chosen their GCSE option subjects in the previous academic year. A subset of these Year 9 pupils (*n*=45) initially all participated in the whole-school study and then in the experimental *Brainology* study, either as cases or controls. This subset for research questions two and three were selected partly on the basis of timetabling constraints affecting both the school and the principal researcher who delivered the *Brainology* intervention to the experimental group. Participants in the study (*n*=45) were taken from two different attainment sets taking part in timetabled Life lessons (set 1 and set 4), therefore creating mixed attainment control and experimental groups for the *Brainology* intervention. Students for this intervention were randomly allocated to either the experimental or control group by taking names from a hat and placing them alternately on either the case or control list. All 45 participants therefore had an equal chance of being exposed to the intervention.

Students in the school are initially set in groups predicated on prior attainment from Year 6 SATs results and this is reviewed at the end of the autumn term of Year 7 as a result of routine MidYIS testing and teacher recommendations based on attainment in class during this time. MidYIS is a computer-based assessment, which measures cognitive ability. MidYIS feedback measures include: nationally standardised scores (comparing student performance to national averages); individual record sheets showing a record of each student's strengths and weaknesses; predictions and chance graphs, showing likely performance at GCSE, and value-added evidence for students and subjects that show possible progress to GCSE. Students in each half of the year group are allocated to one of four attainment based sets; higher attaining students are placed in set 1, and the lowest attaining students are placed in set 4. Each department meets at the start of the summer term to discuss the current setting of students and to make attainment-based set changes for individual students, which are implemented at the start of the new academic year. However, in practise movement is minimal, especially for KS4 students, so most students remain in the set they were placed into in Year 7.

Of the total (n=45) 19 were female and 26 male. Also, 14 were considered to be disadvantaged (six female and eight male). Disadvantaged students in the school are classified using the Department of Education's current criteria, "used to define pupil premium eligibility prior to April 2014 and includes pupils looked after by the local authority for more than six months. In April 2014, eligibility for the pupil premium changed to include pupils who have been in local authority care for one day or more and pupils who have left local authority care because of one of the following: adoption; a special guardianship order; a child arrangements order."(Macleod, Sharp, Bernardinelli, Skipp, & Higgins, 2015). This category also includes students in receipt of free school meals.

Twenty-three Year 9 participants were initially allocated to the experimental group for the *Brainology* intervention through random allocation; however, two of these students requested to return to their timetabled class with the control group at the start of the intervention, so were replaced by two other students who had been originally allocated to the control group. The allotment of the two students who moved from the control to experimental group was decided by taking names from a hat and, as it took place at the start of the study, meant that they did not miss out on any of the *Brainology*-based intervention. Two students from the experimental group and one from the control group left the school to move to another school out of the catchment area during the study, and they were not replaced as the intervention was already underway. The adjusted figure meant that for the *Brainology* intervention, the case group had *n*= 22 students and the control group *n* = 20 for the remainder of the research project and that the total sample size was *n*=42.

Table 1

Descriptive statistics showing the results of random allocation of students to experimental and control groups in the *Brainology* intervention.

	Male	Female	Set 1	Set 4	Disadvantaged
Experimental group (*n* =22) *	14	8	13	9	8
Controls (*n* = 20) *	10	10	10	10	5
Total	24	18	23	19	13

*Note: these figures have been adjusted to exclude the 3 students who were removed from the school roll during the study.

3.2 Measures

Mindset

Mindset was measured using Dweck's 8-item mindset questionnaire taken directly from the *Brainology's* Mindset Assessment Tool (MAT) targeted at children aged 12 and above (https://blog.mindsetworks.com/my-mindset?force=1&Itemid=908). This was based on Dweck's Implicit Theories of Intelligence Scale for children (Dweck, 2000). The measure included items such as, "You can learn new things, but you cannot really change your basic amount of intelligence" and was scored using a 6-point Likert scale which ranged from "disagree a lot" to "agree a lot". Of the eight items, four were positively-keyed and four negatively-keyed. Students were then given a mark, or "profile number", for each question, which students in the experimental group added up to calculate their Mindset Assessment Profile (MAP) based on the criteria included in the *Brainology* programme. All negatively-keyed items were reverse scored to ensure accurate calculation. Additionally, all participants' scored were added up and verified by the researcher to ensure accurate data entry for statistical analysis.

MAP groups were divided into 10 categories ranging from F5 (8-12 marks), "You strongly believe that your intelligence is fixed" to G5 (45-48 marks), "You really feel sure you can increase your intelligence by learning and you like a challenge." Mindset data was gathered at four time points across the school year, as described in the Procedure section of this report. Students were then placed into one of three categories depending on their mindset scores. Those who scored 0-24 on the questionnaire were placed in the "Fixed Mindset" category, with MAP descriptors that indicated these students believed intelligence could not be changed much or at all. Any student scoring between 25 – 32 was placed in an "Undecided" category, which correlated to MAP descriptors indicating that they were not sure if intelligence could be changed. Students scoring within a range of 33-48 were categorised as “Growth Mindset” and described by the MAP as believing that intelligence is something that can be increased.

Effort

All students in the school have their effort measured half-termly as part the school’s existing reporting system, known as Praising Stars. Effort measures in school range from E1 (outstanding) to E4 (unsatisfactory); there is a clear list of criteria for each effort level to ensure a consistent approach and two hours timetabled department training time is allocated every half-term specifically to moderate Praising Stars effort levels. Effort descriptors for E1 include criteria such as, “I always settle to work quickly at the start of the lesson” and, “I am aware of areas of development in my learning and always take steps to improve these.” Comparable descriptors for E4 effort includes measures such as, “I often do not settle to work quickly at the start of a lesson.” And, “I am not aware enough of area of development in my learning and do little to address them.” The school also requires students to reflect on effort levels and how to improve them in their planners, during mentor time, in each Praising Stars report cycle. Students that regularly receive E3s and E4s are monitored closely and placed on Head of Year intervention programmes.

The effort data for cases and controls (*n*=42) in this study was taken from English Language and Mathematics lessons in all six Praising Stars cycles across the academic year, and four of these matched the time when the four mindset questionnaires were completed. As students in Year 9 had begun their GCSE courses, it was not possible to take an average effort score from all subjects, as all students study different subjects depending on their GCSE choices. Although some teachers in the school were aware that some students were participating in a growth mindset intervention, they did not what the intervention consisted of, or which students had been randomly allocated to the intervention. All Mathematics and English teachers inputting

Praising Stars information for Year 9 participants were blind to which students had been allocated to cases and controls in order to eliminate unconscious bias.

***Brainology* Questionnaires**

At the end of the intervention, students in the experimental group completed an evaluation questionnaire about their experiences of the intervention (*n*=21), designed to help students articulate their responses to the intervention. One student from the group (*n*=1) was absent and did not complete the questionnaire. Questions included, “Has the *Brainology* invention changed what you think about intelligence? Please explain your answer.” and, “Has the *Brainology* intervention changed how much effort you are putting into your other lessons? Please explain your answer.” Students were also asked to evaluate the *Brainology* content through two questions, “What do was the best thing about the *Brainology* intervention? Please explain your answer.” and “What would you change / improve about the *Brainology* intervention? Please explain your answer.” Respondents were instructed to answer the questions fully and given 30 minutes to explain their answer to each question and give examples to support their ideas.

Study Design and Procedure

All students invited to take part in the study had information about the *Brainology* programme, consent letters and forms sent home for parents to sign. In order to ensure that parents were fully informed, an opt-in consent form was chosen, and any unreturned forms were followed up by the school’s administration team until all forms were returned. All students chose to participate in both the whole-school and the *Brainology* study; however two students subsequently asked to be placed in the control group for the *Brainology* intervention, but they consented for their data to be still used in the study. This occurred before the *Brainology* intervention began and they were replaced by two students randomly chosen from the control group using names in a hat.

The whole-school approach

This year marked a concerted shift in the participating school towards a whole school strategy for developing growth mindset, in all pupils and staff. Structurally this was supported by the appointment (in July 2016) of an Associate-Assistant Headteacher (AAHT) in Teaching and Learning. This was a temporary role for one year focused on developing and delivering whole school mindset training and the organisation of a TeachMeet style conference at school in February 2017, in collaboration with other local schools. TeachMeet is a forum for educators to get together and share good practice. Speakers give a short presentation in areas such as: teaching ideas and resources; feedback and assessment and research they are participating in. The focus of this TeachMeet was growth mindset and all presentations linked to their application of some element of this concept in their school or classroom. Growth mindset displays were created in the school's main corridor and both staff and students now have growth mindset quotations clearly visible on their desktops when they log on to the school's IT system; these are changed on a weekly basis.

Staff training

Initial growth mindset training was delivered to the whole staff in a 90-minute session on 7th September; it contained a précis of Dweck's mindset construct and how it can be applied in the classroom. Staff training was switched from the previous year's focus on closing the attainment gap between disadvantaged students and their peers to an emphasis on growth mindset and how it can be fostered in students and staff. In addition to whole school training sessions on growth mindset, staff were expected to participate in self-chosen courses, which were designed to give them the opportunity to learn new skills and develop their own teaching and learning by choosing (from a selection of 16) three optional courses which they felt challenged / benefited them the most. Courses included: Coaching for Growth; Brain Friendly Learning; Supporting Vulnerable Learners; NPQML and Using Google Aps. All staff were able to access additional courses, through the educare subscription provided by the school. An additional hour-long training session was delivered to staff, by the AAHT on 19th October, to give additional information on Dweck and growth mindset. This included Dweck's TED talk on the power of yet (https://www.youtube.com/watch?v=J-swZaKN2Ic), information sheets for teachers and a brief overview of how this approach could be used in lessons. More specific training on the use of growth mindset language and other pedagogical tools to help foster a growth mindset approach to teaching and learning in lessons were timetabled and took place throughout the academic year to support staff in developing a whole-school approach. This included a "growth mindset" inset day on 27th February, which comprised of a key-note speech from Andy Whittaker from *The Art of Brilliance* (www.artofbrilliance.co.uk), growth mindset workshops led by the Assistant Headteacher, and a final workshop led by Andy Whittaker. This was followed in the evening by a 3-hour TeachMeet, hosted at the school, opened with a keynote speech by Will Hussey from *The Art of Brilliance*, and followed by a series of three and six minute talks by teachers from different schools each with a growth mindset focus.

Students

An introduction to incremental learning was delivered to all students by the Assistant Headteacher in assemblies during the first week of the autumn term (assemblies are 15 minutes long). In the autumn term five out of seven assemblies had an explicit growth mindset message, focusing on the importance of effort and learning from mistakes, including one delivered by the Headteacher that linked directly to the school's motto, "Being the best we can be." Fostering a growth mindset message remained a key focus in assemblies in throughout the academic year, which provided a clear emphasis on the plasticity of intelligence; the importance of perseverance and applying effort in order to reach goals, and the value of making mistakes and failing as part of the process of achieving success. Students also had a new growth mindset section in their planners including Dweck's growth versus fixed mindset model (Dweck, 2006) and different terminology relating to both mindsets, which were introduced and explained to them during assemblies. In addition to these overt messages, students were expected to benefit from the impact of whole-staff training.

Intervention

Table 2

A table to show the timescale of the project over the academic year.

Timescale	Action
September 2016	Whole school approach to fostering growth mindsets in students and staff begins. Presentations given to both staff and students introducing the concepts of growth mindset.
October 2016	Mindset questionnaires completed by all participants. First Praising Stars data inputted by staff for the new academic year (including teacher rated effort grades).
December 2016	Praising Stars 2 data inputted. Participants randomly allocated to control / experimental groups for *Brainology* intervention.
January 2017	Pre –intervention mindset questionnaires completed by all participants.
January 2017	*Brainology* intervention begins
February 2017	Praising Stars 3 data inputted. Two teacher inset days and *Teachmee*t event focusing on growth mindset and how to foster a growth mindset ethos in students.
March 2017	Y9 pre-public examinations (PPEs).
April 2017	Praising Stars 4 data inputted.
May 2017	Praising Stars 5 data inputted. *Brainology* intervention ends. All participants complete mindset questionnaires. Experimental students complete evaluation questionnaires.
July 2017	Praising Stars 6 data inputted. All participants complete mindset questionnaires so follow up scores can be measured.

Life Lessons

All KS4 students attend a weekly one-hour class known as Life lessons, in attainment based sets. Content is based around developing awareness of a range of moral issues, attitudes to risk and managing personal safety. In Year 9, topics include human rights, crime and punishment, animal rights, substance misuse, prejudice and discrimination. As part of the course, students are also encouraged to explore their personal responses and Christian and Islamic beliefs about social justice. Certain elements of the course (such as the section on substance misuse) the school has a statutory duty to deliver; consequently, all students in the control / experiment group spent the autumn term on these compulsory elements. The control group for the *Brainology* intervention continued with non-statutory elements of the course for the duration of the 12-week study. The experimental group for this intervention were withdrawn from Life lessons for this same period.

***Brainology* intervention.**

MindsetWorks ™ was founded by Carol Dweck and Lisa Blackwell in 2007 and now includes their 2009 *Brainology* programme, which is based on their research into the malleability of intelligence. Students in the *Brainology* intervention experimental group completed the *Brainology* interactive programme through participation in 12 weekly sessions that each last one hour. The original intervention was planned to adhere strictly to the *Brainology* workbooks, lesson plans and software provided by MindsetWorks™; however, this needed to be adapted to meet the learning needs of the students, to fit within the 12 one-hour timetabled slots, and to meet the professional teaching standards required by the school. In order to help students access the learning, PowerPoint slides were created for each lesson that began with an Instant Challenge and ended with a Plenary reflecting on their learning. Each lesson also contained a Learning Objective, structured as a question that students would be able to answer at the end of the lesson, based on their learning, such as, "What strategies can I use to help me overcome different challenges?" and "What is my brain health and how can I improve it?"

Students still completed workbooks, but some of the lower attaining students struggled to access the large amount of information in them and needed the researcher to help them talk through some sections before they could write down their responses (one student had a reading age of seven compared to their chronological age of 14). Conversely many of the higher attaining students (with reading ages above their chronological age) found the workbooks uninspiring and repetitive in places. In order to address this the intervention was further adapted to make it more interactive by including video clips to help students access the concepts and more opportunities for group work, independent research and class discussions. All the video clips gave an explicit growth mindset message, and linked to different aspects of the *Brainology* programme. These included an animated video explaining neuroplasticity (https://www.youtube.com/watch?v=ELpfYCZa87g); a TED-ed video on the importance of sleep (https://www.youtube.com/watch?v=dqONk_48l5vY&t=191s), and in addition to playing students exerts from Dweck's TED speech on "The Power of Yet", they were also shown a similar message from Sesame Street clip also titled "The Power of Yet" (https://www.youtube.com/watch?v=XLeUvZvuvAs).

Furthermore, the structure of the course was altered so that students completed the sections on memory and learning in the weeks working up to their Year 9 Pre Public Examinations (PPEs-anecdotally known as mock exams). Comment from student questionnaires at the end of the programme revealed that the majority of students found this the most useful and relevant section of the intervention in relation to the rest of the adapted *Brainology* content. The 10th week of the course was used as a "catch-up" session for any students that had been absent during the intervention, so that they could complete the entire course. Students who had not missed any sessions used this time to further research the area of the course, which had interested them the most, and produce a poster demonstrating what they had learnt. Lessons were recorded using the school's secure IRIS software in order to help evaluate student's engagement and reactions to the intervention. Parents were informed of this in the consent letter.

Pre-test, post-test and end of year mindset data collection.

Pre-interventions all 42 students were tested using Dweck's mindset questionnaire to ascertain their individual mindset score immediately prior to the whole-school and then the *Brainology* intervention. This cohort was randomly allocated to either the experimental group or the control group for the *Brainology* intervention. students allocated to the control group were put together and taught their Life Lessons as a single class in order to fit in with school staffing and timetabling constraints. During mindset questionnaire data collections one and two, students were blind to which group they had been allocated to, in order to reduce intentional or unconscious bias in the way they answered the questionnaire Although in post and follow up mindset data collections all partcipants were back in their original attainment grouped Life lessons, it was not possible for them to do these questionnaires blind, as they were all aware of which group they had been allocated to for the *Brainology* intervention.

3.4 Analysis:

Initial allocation of the 42 students to the experimental / control group, for the *Brainology* intervention, was done using random allocation of names from a hat. This appeared to yield well-matched groups, so no adjustment was made apart from moving the two students who chose not to participate in the *Brainology* intervention into Life lessons and exchanging them with two randomly allocated students from the control group before intervention began. Cases and controls for this intervention completed the mindset questionnaire at the start of the academic year, pre-intervention, post-intervention and at the end of the academic year.

A paired-samples t-test was conducted to evaluate the impact of a whole-school mindset approach on mindset scores on all participants. This compared means between all participants at the start of the whole-school mindset approach (Time 1) and pre-intervention (Time 2).

One-way analysis of covariance (ANCOVA) was used to determine whether there were significant differences in mindset scores between cases and controls following the intensive mindset intervention. To control for variances between groups in pre-intervention scores, the ANCOVA was used to adjust for the pre-mindset score covariate on the dependent variable of post-mindset score.

An ANCOVA was also used to explore the effects of the intensive mindset intervention on teacher-rated effort score in English and Mathematics. Pre-intervention effort scores in both subjects were used as co-variants to adjust for differences in cases and controls; the dependant variable in both analyses were post-effort scores.

Brainology **Questionnaires**

The questionnaires were given out and administered by an independent member of the school staff, who was blind to the intervention aims and the research questions. This was to ensure that students answered independently and without any support or guidance from the researcher, in order to omit possible intentional or unconscious bias in the researcher's responses. Student responses to questionnaires were analysed using Braun and Clarke's thematic analysis in psychology model (Braun & Clarke, 2006), which entailed the six phases of analysis outlined in the table below (Braun & Clarke, 2006, p. 35). Responses to each question were coded into different categories and then collated into different themes.

Table 3: Braun and Clarke's Phases of Thematic Analysis (Braun & Clarke, 2006)

Phase	Description of the process
1. Familiarising yourself with your data:	Transcribing data (if necessary), reading and rereading the data, noting down initial ideas.
2. Generating initial codes:	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes:	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes:	Checking in the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic "map" of the analysis.
5. Defining and naming themes:	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells; generating clear definitions and names for each theme.
6. Producing the report:	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

Chapter Four

Results

4.1 Can a whole school mindset approach increase pupils' mindset scores?

Table 4

Comparison of differences in Mindset Score Means of all participants between the start of the academic year (Time 1) and pre-intervention testing (Time 2).

	All Participants *(n* = 42) *	
Mindset scores	Mean	SD
Time 1	29.88	6.46
Time 2	28.88	5.72

*Note: these figures have been adjusted to exclude the 3 students who were removed from the school roll during the study.

A paired-samples t-test was conducted to evaluate the impact of a whole school mindset approach on mindset scores on all participants.. There was no significant increase in mindset scores from Time 1 (M = 29.88, SD = 6.46) to Time 2 (M = 28.88, SD = 5.72), *t* (41) = .1.708, p = .0.95, with a 95% confidence interval ranging from -.182 to 2.182. In order to detect a 95% confidence level, with a margin of error of 5%, it would be necessary to have 130 participants in this group from the population size of 195 in the year group. This study was therefore underpowered to detect the expected effects.

4.2 Is *Brainology* effective over and above a whole-school mindset approach increasing mindset scores?

Table 5

Comparison of differences in Mindset Score Means of all participants, cases and controls for both the whole-school and *Brainology* interventions between the start of the academic year (Time 1) and follow up scores (Time 4).

Mindset scores	Mean All participants (*n*=42)*	Mean Experimental Group (*n*=22)	Mean Control Group (*n*=20)*
Time 1	29.88	28.82	31.05
Time 2	28.88	27.77	30.10
Time 3	30.14	29.91	30.40
Time 4	30.29	30.36	29.90

*Note: these figures have been adjusted to exclude the 3 students who were removed from the school roll during the study.

An ANCOVA was run to explore the effect of an intensive growth mindset intervention, *Brainology,* on student mindset scores compared to a control group.

At post-test there was no significant difference in mindset between the control and experimental groups while adjusting for differences in pre-intervention mindset score between groups ($F(1,39) = .472$, $p = .496$, partial $\eta^2 = .012$). At follow-up, a non-significant difference was observed between the control and experimental groups ($F(1,39) = 3.194$, $p = 0.082$, partial $\eta^2 = 0.76$).

4.3 Does *Brainology* and/or a whole school approach lead to an increase in teacher-rated effort in English and Mathematics?

Table 6

Comparison of teacher-rated effort between experimental and control groups before and after *Brainology* intervention**.** Cycle 2 represents pre-intervention data, Cycle 4, post-intervention data and Cycle 6 follow up score data.

Praising Star Cycle	Experimental Mean Effort Rating (*n* = 22)*		Control Mean Effort Rating (*n* = 20)*	
	English	Mathematics	English	Mathematics
1	2.77	2.32	2.45	2.10
2	2.41	2.45	2.15	2.25
3	2.45	2.32	2.25	2.25
4	2.45	2.55	2.35	2.30
5	2.27	2.32	2.10	2.25
6	2.27	2.18	2.20	2.25

*Note: these figures have been adjusted to exclude the three students who were removed from the school roll during the study.

Table 7

Frequency data showing a comparison of teacher-rated effort scores in English and Mathematics reported in the Praising Stars cycle between experimental and control groups before and after *Brainology* intervention.

	Experimental (*n*=22)				Control (*n*=20)			
	English		Mathematics		English		Mathematics	
Effort Grades	Before (PS2)	After (PS5)	Before (PS2)	After (PS5)	Before (PS2)	After (PS5)	Before (PS2)	After (PS5)
E1	3	5	0	1	7	6	2	2
E2	9	7	12	14	5	6	12	12
E3	8	8	10	7	7	8	5	5
E4	2	2	0	0	1	0	1	1
Total	22	22	22	22	20	20	20	20

*Note: these figures have been adjusted to exclude the three students who were removed from the school roll during the study.

An ANCOVA was conducted to explore the effects of the *Brainology* intervention on teacher-rated effort scores for English and Mathematics after controlling for pre-intervention effort scores in both the control and the experimental groups. After adjustment for pre-intervention effort scores, no significant difference was observed in post-intervention English teacher-rated effort scores (F (1,39) = .031, p = .861, partial η^2 = .001. There was also no statistically significant difference in Mathematics teacher-rated effort scores, after adjusting for pre-intervention effort scores, between the two groups (F (1,39) = .035, p = .852, partial η^2 = .001. The *Brainology* intervention did not have a statistically significant effect on teacher-rated effort.

4.4 Thematic Analysis of Students' qualitative evaluations of taking part in the experimental group.

Analysis of students' free response questionnaire data revealed three emerging themes which have been coded as: knowledge growth; behaviour change; and perceptions of the intervention.

Results

Table 8

Descriptive statistics showing the number of students in each mindset category pre- and post Brainology intervention.

	Brainology Control Group (*n*=20)			*Brainology Experimental* Group (*n*=22)		
	Fixed (F)	Undecided (U)	Growth (G)	Fixed (F)	Undecided (U)	Growth (G)
Pre-intervention	3	11	6	5	13	4
Post-intervention	3	13	4	3	14	5

*Note: these figures have been adjusted to exclude the three students who were removed from the school roll during the study.

Students' pre- *Brainology* intervention, post- *Brainology* intervention mindset scores category and gender are included in brackets after their comments. Those who scored 0-24 on the questionnaire were placed in the "Fixed Mindset" (F) category, with MAP descriptors that indicated these students believed intelligence could not be changed much or at all. Any student scoring between 25 – 32 was placed in an "Undecided" (U) category, which correlated to MAP descriptors indicating that they were not sure if intelligence could be changed. Students scoring within a range of 33-48 were categorised as "Growth Mindset" (G) and described by the MAP as believing that intelligence was something that can be increased. In the following section, the initials in brackets represent pre and post *Brainology* intervention mindset categories, respectively, followed by the gender of the participant.

Knowledge growth.

A notable theme, which emerged from student responses, was an increase in understanding of the malleability of intelligence, how the brain works and how increased effort links to increased attainment. The majority of students (*n*=19) wrote that they were now aware that intelligence could be grown. For students who indicated they were already aware of the malleability of intelligence (*n*=7), the intervention appeared to consolidate prior knowledge, "It just clarifies what I already knew." (U, U male). Over half of the students (*n=12*) wrote that the intervention had changed their understanding that, "intelligence can be grown", "Yes, I was not aware that you were able to grow your intelligence" (G, G, female); "I think this intervention has helped me change my mind about what intelligence is, I used to think that it couldn't be changed and you were born with intelligence, but now I understand that it can be changed and your brain can be grown." (F, U, male). Although the remaining two students wrote that the *Brainology* intervention had not taught them anything about intelligence, their responses were ambiguous as they did not clarify if this was because they were already aware that intelligence was malleable, "It's not changed because I don't feel anything that's changed" (U, U male); "I don't think it has helped me much because I haven't learnt anything new." (U, U, female).

A number of the responses (*n*=14) also demonstrated that students had an increased knowledge of the brain and, "how it works" as a result of the intervention. This was also reflected in the language used by some students to articulate their new knowledge, which referenced specific terminology, such as" hippocampus", "neurons" and "fight or flight reflex" in order to articulate their responses, "The more you try and learn, the more neurons will connect" (F, U, female). Moreover, growing knowledge about the brain and how it functioned was the outcome most often cited (*n*=10) by student responses to the question, “What was the best thing about the *Brainology* intervention?” Students wrote about enjoying, “learning about different parts of the brain and what they do” (U, U, female); “learning the way memory words and about channels in the brain” (U, U, female) and, “learning about why our brains do things” (G, U, male).

Another strand that appeared within this theme was an increase in understanding the connection between growth mindset concepts and effort. Ten students (47.6%) referenced this connection in their responses, “I challenge myself more when doing tasks because I know that by doing so I am helping my brain to grow connections. (U, U, female)”; “I use my brain a lot more to help me put more effort in my work. (U, U, female)”

Behaviour change

A second theme to emerge from the free-response questionnaire data was the extent to which the *Brainology* intervention impacted on student behaviours in terms of the amount of effort they said they put into their work. In response to the question, “Has the *Brainology* intervention changed how much effort you are putting into your other lessons?” three students (14.3 %) felt the intervention had not changed effort levels as they already believed they were putting in sufficient effort, “ No it hasn’t. Being a top set student I already had to put effort in.” (U, U, male) A further three considered that the intervention had has some impact on their effort, but their responses suggested that the intervention had not had a significant in changing their effort levels, “I kind of work harder in English” (U, U, male); “This intervention has made me put a little bit more effort into my work” (U, U, female). Fourteen students (66.7%) indicated that the intervention had increased the amount of effort they put into lessons. Although most of the answers to this question were general, “Yes, I challenge myself more when doing tasks” (U, U, female), one student gave a clear example of how they believed a change in effort had led to an increased test score, “I am now putting in good effort, and this can be seen in my improvement test in maths, where I got 86%.” (F, U, male).

Perceptions of the intervention

Student views of the *Brainology* intervention could be subdivided into three main strands: perceptions of the online computer-based aspect of the course; the content and structure of the intervention, and how useful students found the intervention overall.

Seven students wrote about the online aspect of the intervention, where students logged into MindsetWorks™ to develop and test their understanding of growth mindset and how the brain works. Of these, six found it the most enjoyable part of the course, “the computer programme was the best part about *Brainology* because it can really help you take in the information and it was really clear and detailed” (U, U, male). One student considered the website, “too long and boring” (F, F, female); however, most students wrote that it was the lack of interactivity in the rest of the programme and the amount of reading and writing in the workbook that the enjoyed the least. Ten students either criticised the intervention for being “boring” or suggested that it needed to be made, “more interactive”, “enjoyable” and “fun”. Student recommendations for how to change the intervention largely focussed on making it more interactive, with more group work and opportunities for “independent learning”. Three students also specifically referenced the workbook as the part of the intervention they would alter: “I would change the way the booklet is set out as it was very long and complicated, which to me may seem off putting.” (U, U, male).

The timing of this intervention coincided with the students’ Pre Public Examinations (PPEs), which are “mock” exams taken by all students each academic year during Key Stage 4. Students in this year group undertook PPEs in English, Science and Mathematics seven weeks into the intervention. One student specifically referenced how useful the intervention had been in helping them change the way they revised for these exams, “This showed me how to put the right effort in, like for revision, this helped with my PPEs.” (U, U, male). Altogether six students wrote about how the intervention had changed the way they studied; “Yes it has. I now think of diffrent (sic) ways to help me learn to put more effort in every lesson” (F, U, female), while four students cited it the best thing about the intervention “the best thing was learning how to study more effectively because I can apply this knowledge.” (U, U, female).

Chapter Five

Discussion

No significant effects were found in any outcome measures. Results for each research question are discussed below.

Can a whole school mindset approach increase pupils' mindset scores?

Results from the study sample indicated that the whole school mindset approach, taken by this school, caused no increase in student mindset scores. Instead the mean mindset score dropped very slightly (non-significantly) between the beginning of the academic year (M = 29.88, SD = 6.46) and pre-intervention testing just under one term later (M = 28.88, SD = 5.72). Although this was the first year of the whole-school approach to fostering a growth mindset in its students, it appears that delivering a growth mindset message collectively and repeatedly in assemblies, and through classroom and corridor displays has had no impact on students' understanding about the malleability of intelligence. A similar approach of using school assemblies as a way of communicating growth mindset concepts to students was adopted by the Headteacher at a Catholic secondary school in England and he concluded, anecdotally on the basis of his experience, that, "platitudes from an assembly…were not making a significant difference to students' test scores." (Lambert, 2013, p. 54). In spite of the large number of British school websites and teacher blogs, which have documented the use of assemblies as the main method of communicating growth mindset messages to students, there is no study to date that has evaluated the impact of this approach. Instead, there appears to be an increasing realisation that whole-school assemblies, isolated inset sessions and corridor displays do little to help schools foster a growth mindset culture and may even devalue the concept of incremental mindset as a positive trait. John Tomsett, Headteacher of Huntington Research School noted, "We've stopped using the phrases 'growth mindset', because the students have got sick of it…My son just gets fed up of self-righteous teachers giving assemblies about how great they were when they were up against it."(https://www.tes.com/news/school-news/breaking-news/weekend-read-growth-mindset-new-learning-styles).

Conversely, the slight drop in mindset scores over the course of the autumn term could be because there was a significant focus on the growth-mindset message during assemblies during the first academic half-term, which was not sustained over the second-half term. Pre-intervention mindset questionnaires were also completed by study students on the first day back of term, after the Christmas holidays, when they had not been exposed to the school's mindset message in the preceding two weeks. However, this small and non-significant difference should not be over-interpreted. Although seven students, who subsequently took part in the *Brainology* intervention reported post-intervention that they had been aware that intelligence could be grown, prior to the intervention, they did not state whether this was due to the whole school approach.

Is *Brainology* effective over and above a whole-school mindset approach?

The study's findings suggest that the *Brainology* intervention was not effective over and above a whole-school approach and that it had no statistically significant impact on students' mind set scores post-intervention compared to those of controls. Although there was a slight rise in the experimental group's scores seven weeks after the end of the intervention, this was not statistically significant either and cannot be over-interpreted. By contrast, thematic analysis of students' written responses to an open-ended questionnaire item suggests that the intervention was perceived as having had an impact on students' concepts of intelligence, with 19 of the 21 (90.5 %) students writing that they were aware that intelligence could be grown at the end of the intervention. Of these, 12 students (57.1%) stated that the *Brainology* intervention had resulted in new learning about the malleability of intelligence. Given the small sample size of the study ($n=42$), it may be that a larger study would yield more statistically significant results.

This pattern mirrors the disconnect between testimonials and empirical evidence observed elsewhere. Donohoe et al.'s quasi-experimental study on the impact of *Brainology* on mindset and resiliency (Donohoe et al., 2012) recorded a statistically significant increase in post-test intervention scores that subsequently disappeared. It may be that in Donohoe et al. (2012) the delivery of the intervention made a difference. In their case, the intervention was delivered primarily through the computer sessions, with students completing follow up worksheets for homework. It is possible that the short duration of the intervention, compared to that in the current study, gave less time for the students to embed and apply their knowledge of growth mindset concepts, or that the lack of a whole-school approach to fostering an incremental mindset among staff and students meant that the impact of the intervention was not sustained. However, this study's findings suggest that using longer period of intervention (12 weekly sessions of one hour) was not effective in increasing the experimental groups' mindset marks, as it did not result in a statistically significant increase in students' mindset scores even immediately post-intervention.

Does *Brainology* and/or a whole school approach lead to an increase in teacher-rated effort in English and Mathematics?

The *Brainology* intervention did not lead to a statistically significant increase in teacher-rated effort in either English or Mathematics in the experimental group in comparison to the control group. This may be due, in part, to some students achieving E1 effort scores in the pre-intervention Praising Stars scores. As E1 is the highest score students could achieve, it meant they were unable to increase their effort scores. Pre-intervention, two students began the intervention with E1 effort scores (they also achieved these scores at the end of the intervention) in Mathematics. In English, 10 students achieved pre-intervention E1 scores (five of those same students also achieved these scores at the end of the intervention and five actually achieved lower scores). In the school participating in the study, E2 effort is also considered to be a “good” effort level, so it may be that students (and parents / carers) perceive an E2 to be acceptable level of effort, which does not need to be improved. Of all the students in the study (*n* = 42), 24 students achieved either an E1 or an E2 in English and 26 achieved either an E1 or an E2 in mathematics pre-intervention.

In order to further assess the impact in a similar intervention, it may be beneficial to have a study group with only students achieving teacher-rated E3 and E4 effort levels in, as these are both grades which are construed as both inadequate and with the capacity for students achieve higher grades with increased effort. In this study, 18 students were teacher-rated with effort grades of E3 or E4 pre-intervention in English and 16 in Mathematics. Post-intervention the figure was the same for English, but had reduced slightly to 13 in Mathematics. During the course of the intervention, five E3/E4 students from the experimental group (*n*=22) remained at the same effort level in English, while four went up and one went down a mark. For E1/2 students in the same group, five remained the same, four went up and one went down. In comparison, five E3/E4 students from the control group (*n* = 20) remained at the same level in English and three increased their score. Two E1/E2 students in this group remained at the same effort level, while one student went up and a further four students went down.

Further consideration may also be needed of the impact of student perceptions of effort in the classroom. Although a thematic analysis of students’ free-response questionnaire data in this study suggested that some students believe that the *Brainology* intervention had increased their understanding about the malleability of intelligence, if effort is still seen sometimes as a negative trait in the classroom then this could affect the amount of effort students are putting into their work, despite their understanding of incremental mindset theories. This may be, as Covington and Omelich contend, because students do not want to appear to be trying too hard in front of their peers in case they subsequently “fail” in their work (Covington & Omelich, 1979). In this context, students may not consciously be putting effort into their work because they risk public shame in front of their peers if they are not successful, but have applied effort to their work. Far better for them to eschew effort, so that they can blame poor attainment on not studying. However, as this contrasts with the ethos of the mindset message, that failure and mistakes are a necessary part of learning and success and that effort in evaluating and applying different methods to learning are vital for success, it suggests that if students have not put in effort because of fear of failure they have either not fully understood, or have chosen not to apply growth mindset concepts to their learning. It may also be that some students do not apply effort because they are more concerned with how they are perceived by their peers within the school environment than by their own attainment. In the school participating in the research, students who work hard are considered to be "sweats", which is a pejorative term applied to students who work hard in lessons. Although this was not the focus of this study, and none of the data evidenced student perceptions of effort and the link between this and teacher-rated effort grades, this would be an interesting area for further study.

Limitations

As stated, the small sample size (n =42) and relatively short duration of the study (12 hours, over 12 weeks, compared to the recommended 15 – 20 hours over six weeks) were both limitations for investigating the effect of an intensive mindset intervention on student mindset and effort. Additionally, student responses to the *Brainology* programme materials may have restricted the impact of the intervention. Thematic analysis of student comments suggest that although most students enjoyed the on-line /computer-based aspects of the intervention, they found other parts "boring" and "cheesy". Students felt that, despite adaptations, the course was too workbook-based. The workbook is substantial at 98 pages, although this does include both of the differentiated worksheets (Option A and Option B) for some of the activities. It may be that taking out the appropriate set of differentiated materials would reduce the size of the workbook, but it would not reduce the amount of writing, or written information that students need to absorb in order to complete it. Students also felt that there needed to be more opportunities for independent learning, group activities and opportunities to link it to their own learning in different subject areas. A similar concern was also raised in teacher interviews following trials using *Brainology* in Choa et al.'s 2006 study (Chao et al., 2016), where teachers expressed concern that students found it difficult to engage with the programme or link it to learning in Mathematics.

Another barrier to student engagement may be the large age range targeted by the *Brainology* intervention. Mindsetworks™ recommends that *Brainology* is appropriate for students in grades 5-9 in the United States (years 6 – 10 in England). Academically and developmentally, there is a significant difference in the chronological target range of students between 10 and 15 years of age. Some of the content in the questionnaire is complex and may be inaccessible to 10-year old students without scaffolding or adaptations to support them in understanding some of the subject content and terminology used within the intervention, even with the use of the differentiated materials provided by the programme. Conversely, some 15-years olds may find the cartoon characters and language used by the animated characters juvenile. Schmidt et al.'s 2016 research into the effect of *Brainology* intervention sought to investigate if it was effective in meeting the needs of students across the 6th to 9th grade developmental range (Schmidt et al., 2016). They reported that the 9th grade experimental students in the study demonstrated and increased perception of control and interest over the academic year compared to the control group and both controls, and case students participating in the intervention in the 7th grade. The possibility that *Brainology* was not developmentally appropriate for all academic groups was one of the suggestions for the difference in impact between the two groups. While sections of the *Brainology* workbook are differentiated to try and meet the needs of a range of student attainment, and the programme was adapted for this intervention study, student feedback suggests that it would need significant further adaptations to meet the needs of a similar cohort participating in the intervention. Furthermore, although students in the study were all in year 9 (13-14 years old) there was a wide range of attainment and developmental differences within the group. For example, in the experimental group, one student had dyspraxia and dysgraphia and reading age of seven, compared to their chronological age of 14. Another student in this group was diagnosed with dyslexia, while a further student was diagnosed with Attention Deficit Hyperactivity Disorder (ADHD). The lowest reading age of students within the experimental group was seven and the highest 17 years, 6 months.

Another drawback was the large amount of literature which needed to be read and absorbed by the person delivering the intervention. The *Lessons and Materials Guides for Teachers* is very detailed; in total the reading material is over 200 pages long and may be unwieldy for someone unfamiliar with programme. Furthermore, though there is also a teacher edition of the workbook with the answers for the student worksheets, the limited explanation of incremental mindset concepts in the *Brainology* literature is not sufficient to provide a secure understanding of the research underpinning the intervention. While the Mindsetworks™ site does offer short video guides to support teachers, these mainly explain the administrative aspect of the programme, such as how to set up class lists and help students log on to the site. Although these issues may not be significant to an independent researcher delivering the programme, who has a secure understanding of mindset research and the time to absorb the *Brainology* guides, for a teacher working over 50 hours a week with another 20 lessons to plan during that week, they may not have the sufficient time to devote to doing the same.

Although *Brainology* is marketed and sold worldwide, as an American product, it may be that adaptations also need to be made to make it more accessible to British students participating in the programme. There is no explanation on the website of how American school grades equate to the British system, and case studies on the MindsetWorks™ website only include American schools. One student response to the evaluation questionnaire wrote, “A lot of the course was cringy and cheesy – they need to evaluate the target audience.”

The research was also limited by the inability of students achieving E1 effort grades to improve. This was further compounded by the school’s classification of an E2 effort-grade as good – although it does leave room for improvement it may be perceived by students as being an acceptably high level of effort that it does not require significant improvement.

Finally, the relatively short duration of time used to assess the effect of whole-school mindset and the small sample size (n = 42) limited the investigation. A more effective method would be to record the scores of all students in the school at the start and end of the academic year, and this might have yielded more statistically significant results. The initial research plan was for the whole year group (n = 195) to complete the mindset questionnaire at the same time as the those participating in the *Brainology* intervention study; however, inconstancies in staffing (due to staff absence, timetable changes and cover teachers taking some lessons) meant that not all students undertook the questionnaire, and that many students did not write their name on the questionnaire or complete it correctly. Therefore, it was not possible to use these in the study. This was not the case for those taking part in the *Brainology* intervention, as the questionnaire was administered by the researcher and one other teacher. A power analysis was not done before the intervention, as the study plan was for the whole population to be used in the study. In a future study, to ensure that the whole population complete the questionnaires and include the relevant information, students could complete the questionnaires together during a whole year group assembly led by the researcher. Alternatively, students could complete questionnaires in a specific timetabled mentor (form time) session, following training delivered by the research to staff on how students need to complete the mindset questionnaires. Although a short PowerPoint presentation was created and sent out by the researcher to explain to students how to complete the questionnaire correctly, for this study, this was not enough to ensure that the questionnaires were administered and completed correctly by all Year 9 students. A copy of this PowerPoint is included in the appendix.

The analysis for the effect of the whole-school mindset focus was also undertaken before the staff inset and TeachMeet conference in the spring term, so there is no measure of the impact of ongoing staff training. The Assistant Headteacher leading the whole-school growth mindset focus was also promoted and left to work in another school at the end of the spring term. Although an external candidate was appointed to the post, they did not take this up until September 2018. This resulted in a loss of direction in the way whole school mindset was implemented in the school during the summer term, when attention was prioritised on Year 11 GCSE revision and preparing Y10 students for their PPEs in June and July.

Directions for future research

One consideration for future research using *Brainology* in the English education system is how to adapt it so that it is an engaging programme, which meets the developmental and academic requirements of the students using it. Responses from student questionnaires suggested that students thought the “best” parts of the *Brainology* programme were: learning how the brain worked; learning strategies to help them learn and the computer-based section of the intervention. When combined with student suggestions for improvement, another approach may be to continue using the on-line part of the programme, while significantly reducing the amount of time students spent on the workbook. In addition to teacher-led activities; group work; short educational clips; independent research and group presentations could be used as alternative ways of encouraging students to explore and understand growth mindset concepts and link them to subject specific knowledge and skills. Although encouraging students to take ownership of their learning in this way may make the content more engaging, the intervention may also have more impact if it were more explicitly linked to students' experiences in their other classroom subjects. Questionnaire responses indicated that students found using the metacognitive practices from the programme useful in helping them prepare for examinations. Rather than deliver the *Brainology* programme as a short, single, intensive intervention, it may be more beneficial to students to introduce growth mindset concepts to them in a short course at the start of year 7. The computer-based section of the intervention could then be undertaken in year 8, linking it to how it can be applied in different subject areas and outside the classroom, using ideas from the workbook and study skills section of the programme. However, it is important that the intervention is seen as a tool to help students foster a growth mindset, rather than a "silver bullet" that will increase student effort and attainment. Although the whole-school assembly approach to delivering growth mindset messages appeared to have no impact on student perceptions about the malleability of intelligence for the *Brainology* intervention when reinforced either in yearly sessions, or through a more robust whole school approach could potentially have more impact on students' understanding of how intelligence can be "grown" and how to combine this understanding with metacognitive practises in order to improve their learning.

Further research into the impact of intensive mindset intervention, could also focus on possible links between teacher mindsets and how they affect students' mindsets in the classroom. Schmidt et al.'s 2015 study sought to investigate the effect teachers had on mindset interventions (including *Brainology*) in the classroom; however, the study only included two teachers, neither of whom delivered the intervention, and so was too small to draw any conclusive link between these factors (Schmidt et al., 2015). Schmidt et al. note that a result of the *Brainology* intervention being delivered by a research team, rather than classroom teachers, may have been the reduction in teachers' ability to apply and reinforce growth mindset messages in the classroom. They suggest, "It will be important in future students to examine whether and how teachers moderate the impact of mindset interventions on students' daily classroom experiences" (Schmidt et al., 2016, p. 18). As yet, there is no significant study in this area and a future study may benefit from seeking to investigate any links between teacher mindset scores and those of the students they teach.

There also exists no current research in whether students' mindset scores differ for each subject area, or if these differences are influenced by teacher mindset. Dweck proposed, "People can also have different mindsets in different areas…We've found that whatever mindset people have in a particular area will guide them in that area." (Dweck, 2006, p. 47). Thus, if a student perceives themselves to be unsuccessful in a subject area they may think they are inherently bad at it and not try as hard in a subject they believe themselves to be more successful in. Although Dweck does concede that different people have different natural abilities in some areas and that not, "anyone with proper motivation or education can become Einstein or Beethoven" (Dweck, 2006, p. 7), she argues that significant improvements can be made with the right education and growth mindset orientated teachers who teach students both that they can improve as well as how to improve. Although the whole-school approach of the school participating in the study demonstrated no statistically significant results in increasing students' growth mindset pre-intervention, they were only at the start of their mindset training and it may be that the current focus on developing growth mindsets in staff and how to use incremental mindset language in the classroom does yet begin to help students foster a growth mindset.

Given the limitations of some students' ability to improve their effort grades in this study, further research could be focused on using participants which are achieving lower effort grades as cases and controls. This could focus just on those achieving E3 and E4s grades pre-intervention, as the students who have most capacity to improve, or those with E2 – E4 grades as they are all capable of improving. Moreover, a future study may wish to consider student perceptions of effort and how they link to the effort grades students achieve. If there was a correlation between student negative perceptions of effort and low teacher-rated effort grades, it may be that a schools need to adopt a combined approach. This approach could begin with teaching students that intelligence can be grown, so they see that they can become better learners; changing their perceptions of effort, so they see why they should become better learners and teaching them metacognitive strategies so they learn how to become better learners.

Teaching students growth mindset strategies alone will not help them increase their achievement; they also need to have access to specific subject knowledge and a range of study skills to help them learn effectively. Recent criticisms of growth mindset have focused on how it is seen, by some schools and educators, as a panacea to increase students' success in the classroom when the focus should be on teaching subject knowledge and problem solving. Carl Hendrick, Head of Learning and Research at Wellington College, argues that teaching students about neuroplasticity will not help them solve subject specific problems, "I don't see how that's going to help little Johnny solve quadratic equations in period one. The thing that's going to help little Johnny solve quadratic equations is learning about quadratic equations." (https://www.tes.com/news/school-news/breaking-news/weekend-read-growth-mindset-new-learning-styles). Certainly, student-understanding of neuroplasticity in isolation is not enough to enable academic achievement; however, when combined with specialist subject knowledge and a range of skills about how to solve quadratic equations, it may be that an understanding that intelligence can be grown will help "little Johnny" and others understand that they have the capacity to solve quadratic equations and to persevere in the face of difficulty. Questionnaire responses from this study indicated that students felt that the *Brainology* intervention was most useful when they were able to apply the metacognitive study skills in the content to their own learning, particularly when it helped them prepare for high stakes testing in their PPEs.

Considering that recent changes to the GCSE system mean that a rising number of GCSE examinations are now 100% terminal, students have to memorise much more subject content than under the previous (A* - U grade) examinations. Further study into this area could investigate whether teaching a specific element of the curriculum had more effect if the content embeds teaching growth mindset concepts and metacognitive strategies alongside detailed subject knowledge on academic achievement in high-stakes examinations.

Course content from the six-week in school intervention used in the *Changing Mindsets* trial included one week on using specific spelling tasks and one week on maths games, both of which were designed to demonstrate to pupils how choosing the right strategy will help them master the appropriate skills. Although results from this intervention did not show statistically significant results, they did show promise that pupil workshop interventions may be able to help improve progress. The short duration and intensity of this intervention was identified as limitation in this trial, while teacher feedback suggested that it need to be linked with a whole school approach; however, it does suggest that when these limitations have been countered there may be the capacity for a combined knowledge and skill linked mindset intervention to create a positive impact on student attainment. Although teacher-inset did not yield statistically significant results for most pupils, it did for a subset of Free School Meal (FSM) students (now classified by the DfE as Disadvantaged students). Further investigation into whether growth mindset interventions and / or teacher interventions have a positive impact on mindset and academic would be an interesting field for further study, especially if linked explicitly to the teaching of specific knowledge-based skills.

Finally, consideration should be made for whether intensive mindset interventions should even be used in the classroom given that, to date, no study has been able to replicate Dweck's results in the classroom (Li & Bates, 2017). Carol Dweck contends that this failure is due to the complexity of mindset theory, which is difficult to apply in the classroom, “It’s not about educators giving a mindset lecture or putting up a poster – it’s about embodying it in all their practices.” However, the *Brainology* programme, is a short, targeted intervention that teaches students about mindsets, challenge, neuroplasticity and offers them some metacognitive strategies. Although there is educator guidance on how to deliver the materials on Mindsetworks™ and information for both educators and parents about the benefits of students developing a growth mindset on the site, its focus is not on showing teachers how to embody growth mindsets “in all their practices”. If mindset theory is too complex to apply effectively in the classroom, then this may be why this study and similar studies using *Brainology* as an isolated intervention tool (Donohoe et al., 2012) have no statistically significant impact on students’ mindsets.

If growth mindset concepts are so complex, it may also be that the focus needs to be not on fostering growth mindsets in students, but in teaching educators growth mindset theories more effectively. In the *THE* interview Dweck revealed that she intends to utilise the $4 000 000 funding she has recently received from winning the inaugural Yidan Prize for Education Research in developing new materials to educate both students and teachers in growth mindset, “We need to create workshops and interventions that are effective for a greater range of students and we need to create teacher training curricula so educators can create growth mindset cultures in schools.” Given the limited short-term success of Dweck’s intensive mindset (*Brainology*) intervention in this study, and the failure to replicated Dweck’s studies, it will be interesting to see what student interventions and teaching training curricula she develops to attempt to embed growth mindset strategies within schools and if these methods are effective in the context of the English educational system

Growth mindset still has value in an academic context if it can teach students how to respond to challenge. In circumstances where students are successful then growth mindset is not as valuable or even helpful. Where growth mindset most appears of benefit is when it comes to the point of challenge as it fosters an understanding that intelligence can be grown and, therefore, understanding can be developed. However, teaching growth mindset concepts on their own appear not to be enough. Nor, is telling a student that they need to apply more effort. Instead they need to be aligned to specific subject-based knowledge and skill to help them improve, learn from their mistakes and apply different strategies to their leaning until they find one that works for them. Over-simplification of the mindset concept through platitudes such as, "Don't give up!" and "Try harder!", while intended to be encouraging, offer no foundation for students to improve. Instead it needs to be embedded within the school ethos and curriculum. While short-term intensive interventions may still have a place in helping learners foster a growth mindset, it is unlikely to have any long-term impact unless combined with a whole-school approach and / or linked more specifically to the curriculum. Like "desirable difficulties", entrenching growth mindset concepts into a school ethos are effortful, but they are more likely to last if they are effectively researched and applied effectively to school structures.

Appendices

Consent letter sent to parents

Dear Parent / Carer,

I am currently carrying out a research project, at The University of York, to investigate the effect of a growth mindset intervention on student effort and attainment. I am writing to ask if you consent for ********* to take part in the study.

What would this mean for you and your child?

As part of a whole school initiative, all students are learning about growth mindset this year. This is the idea that intelligence is not fixed and can be altered by effort and learning positively from mistakes. As part of this, I would like to research whether a computer based program called *Brainology* can help students understand how to improve both their growth mindset and the effort they are placing into their school work more than the whole school approach.

We would like your child to be included in this research project. This would involve being one of a randomly allocated group of students either following the 15 week Brainology program in weekly one hour lessons instead of their current Life Lessons, or participating in their usual timetabled Life lessons. This will begin from the start of the spring term. A short description of the *Brainology* computer program is attached and further information can be found on their website: https://www.mindsetworks.com .A small, randomly selected group of students in the Brainology group will also be invited to take part in interviews about their experience of taking part in the project. These interviews will be recorded and the pupils involved will be given the opportunity to read and comment on a written account of their interview before the data is used.

Storing and using your data

Data will be stored on a password protected computer. Your child's personal information will be stored separately from the information they provide in their mindset questionnaire, interviews and workbooks. Only the researcher will have access to videos of the lesson using the school's secure IRIS system, which is also password protected. The research data will be kept until December 2021, after which time it will be destroyed. The data may be used in future analysis and shared for training or research purposes but students will not be identified individually. If you do not want your child's data to be included in any information shared as a result of this research, please do not sign the consent form.

Anonymity and confidentiality

The data that is collected (videos, questionnaire responses, workbooks and Praising Star effort grades) may be used in anonymous format in different ways, such as reports and presentations. Please indicate on the consent form attached if you are happy for this anonymized data to be used in the ways listed.

Please note: if I gather any information that raises concerns about your child's safety, or the safety of others, I may pass this information onto another person.

I hope that you will agree to ************ taking part. If you have any questions about the project that you would like to ask before giving consent or after the data collection, please feel free to contact me by email [redacted], or the Chair of Ethics Committee via email education-research-administrator@york.ac.uk .

If you are happy for ******** to participate please complete the form attached and hand it in to either myself in L5 or the school office by ********.

Please keep this information sheet for your own records.

Thank you for taking the time to read this information.

Yours sincerely,

Mrs S. Dowey

Brainology Intervention Consent Form

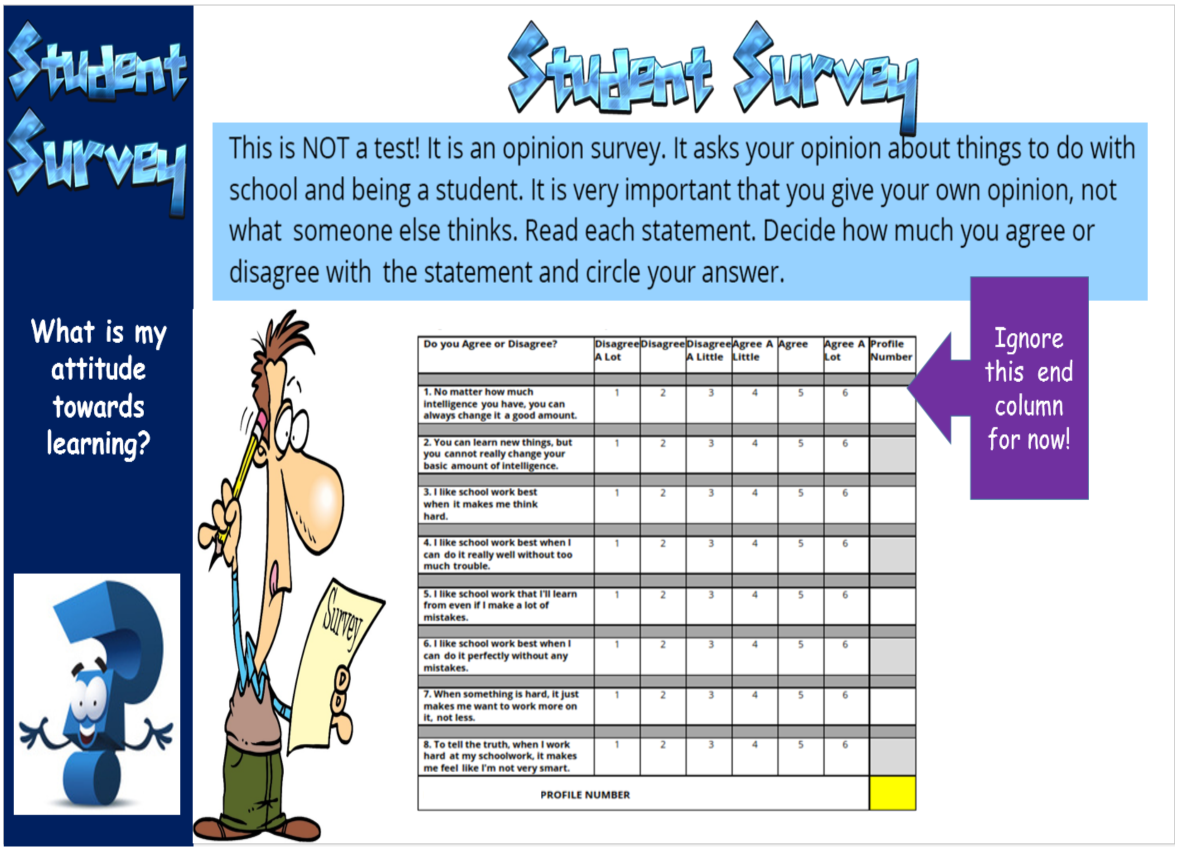
Please tick each box if you are happy for your child to take part in this research.

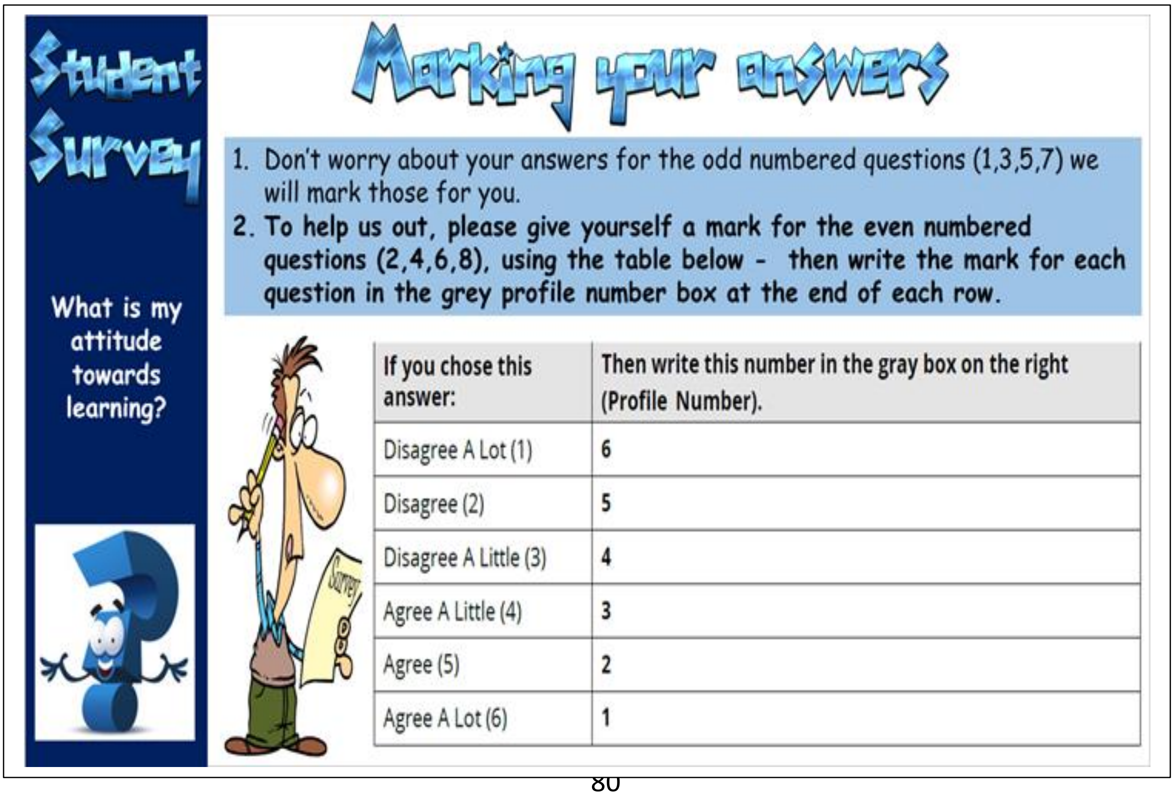
I confirm that I have read and understood the information given to me about the above named research project and I understand that this will involve my child taking part in either timetabled group as described in the information letter.	☐
I understand that the purpose of the research is to study the effect of the Brainology intervention on growth mindset and effort above a whole-school approach to growth mindset.	☐
I understand that data will be stored securely on a password protected computer and only Mrs S. Dowey and [redacted] will have access to any identifiable data. I understand that my child's identity will be protected by use of a code.	☐
I understand that my data will not be identifiable and the data may be used ….	
in publications that are mainly read by university academics	☐
in presentations that are mainly for university academics	☐
in publications that are mainly read by other educationalists	☐
in presentations that are mainly for other educationalists	☐
I understand that data will be kept until December 2021 after which it will be destroyed.	☐
I understand that data could be used for future analysis or other purposes.	☐
I understand that I can withdraw my child's data at any point during data collection or by June 2017	☐
I understand that my child will be given the opportunity to comment on a written record of their responses if they are interviewed by the researcher about the Brainology intervention.	☐

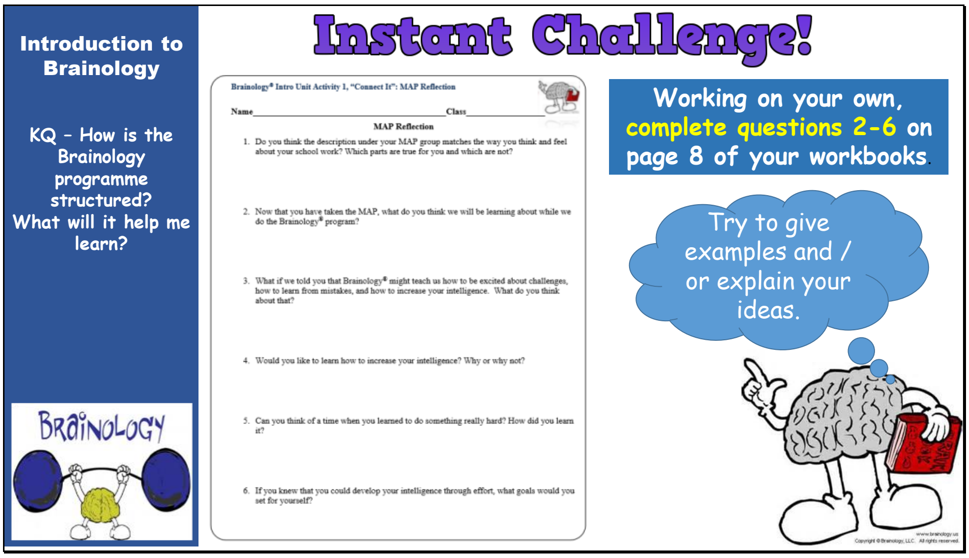
Name of student:________________ Date:

Signed by: ________________________ Name: ________________________

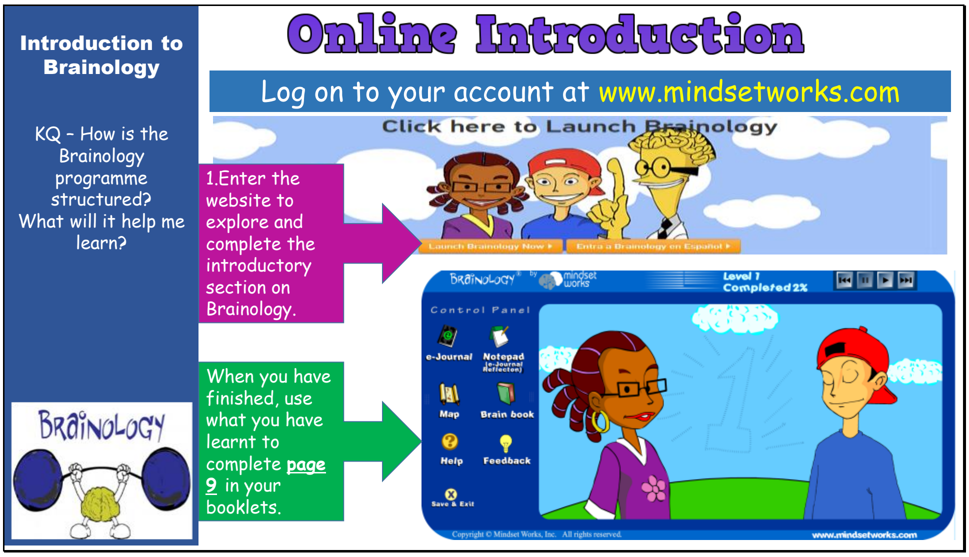
PowerPoint slides shown to students explaining how to complete mindset questionnaires



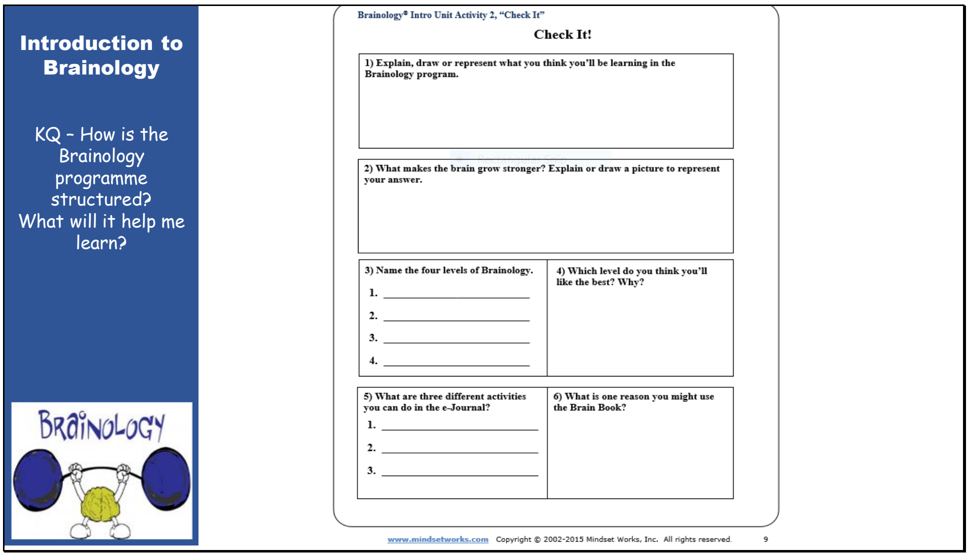



Introduction to Brainology
KQ – How is the Brainology programme structured? What will it help me learn?
Brainology
Instant Challenge!
Brainology® Intro Unit Activity 1, "Connect It": MAP Reflection
Name Class
MAP Reflection
1. Do you think the description under your MAP group matches the way you think and feel about your school work? Which parts are true for you and which are not?
2. Now that you have taken the MAP, what do you think we will be learning about while we do the Brainology® program?
3. What if we told you that Brainology® might teach us how to be excited about challenges, how to learn from mistakes, and how to increase your intelligence. What do you think about that?
4. Would you like to learn how to increase your intelligence? Why or why not?
5. Can you think of a time when you learned to do something really hard? How did you learn it?
6. If you knew that you could develop your intelligence through effort, what goals would you set for yourself?
Working on your own, complete questions 2-6 on page 8 of your workbooks.
Try to give examples and / or explain your ideas.

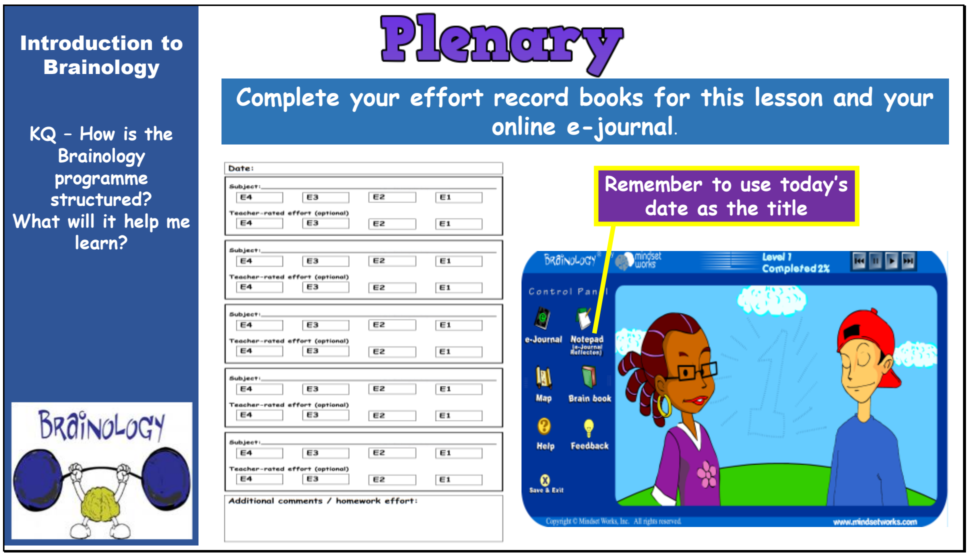
Slide 2


Introduction to Brainology
KQ – How is the Brainology programme structured? What will it help me learn?
Brainology
Online Introduction
Log on to your account at www.mindsetworks.com
Click here to Launch Brainology
1.Enter the website to explore and complete the introductory section on Brainology.
When you have finished, use what you have learnt to complete page 9 in your booklets.
Control Panel
e-Journal
Notepad
Map
Brain book
Help
Feedback
Save & Exit
Level 1 Completed 2%
www.mindsetworks.com

Slide 3

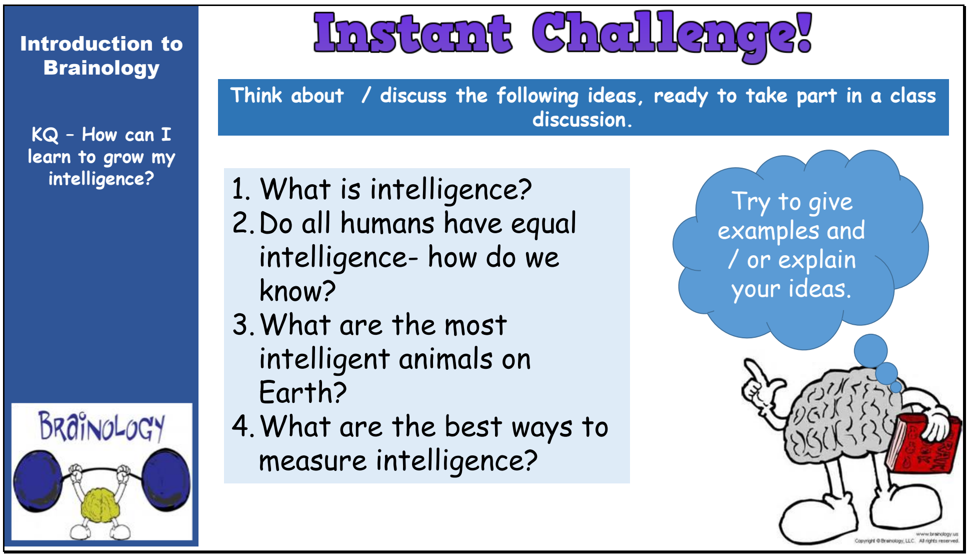


Slide 4



Brainology Intervention Lesson 2

Slide 1



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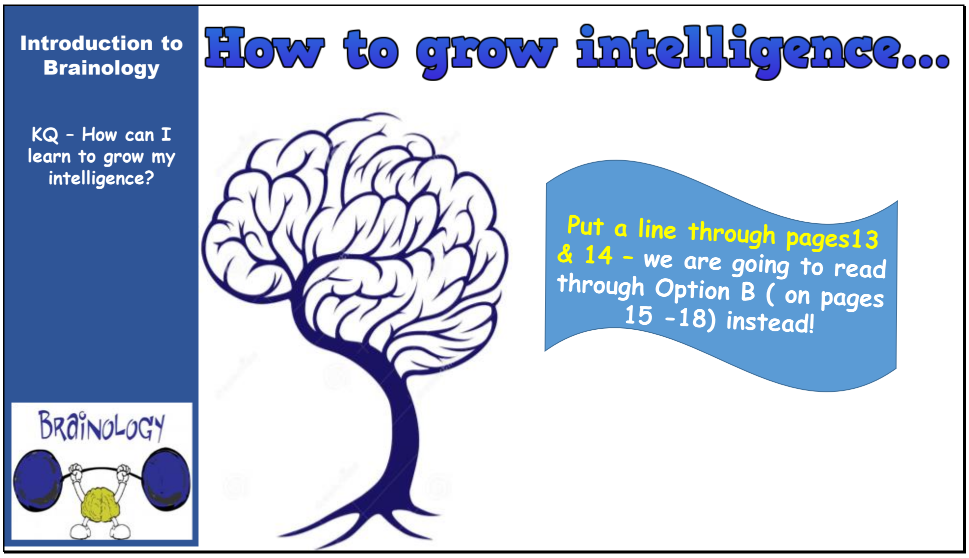
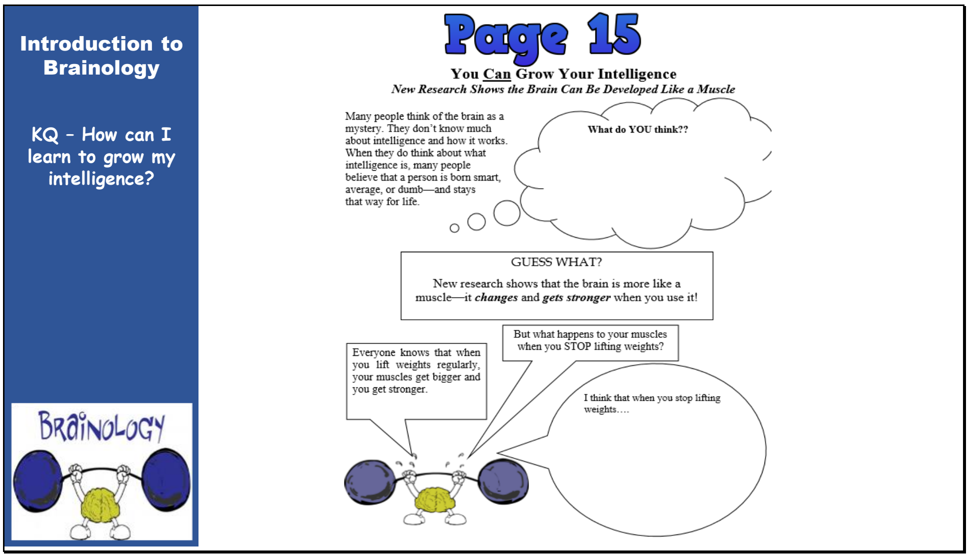


Slide 3



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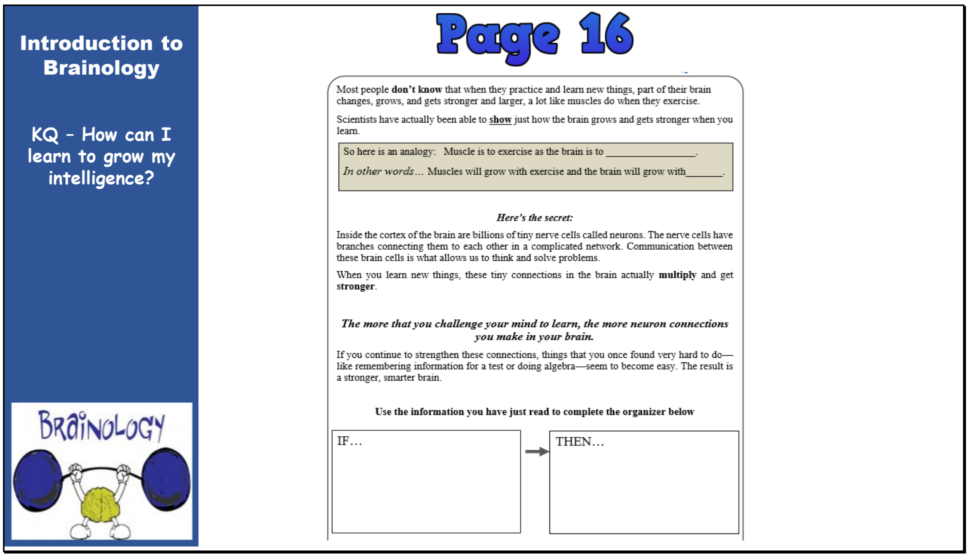

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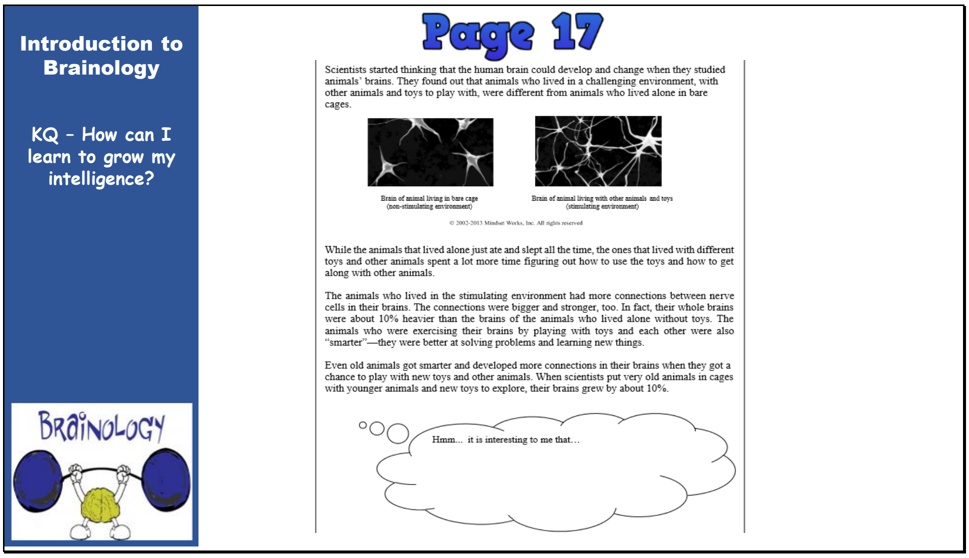

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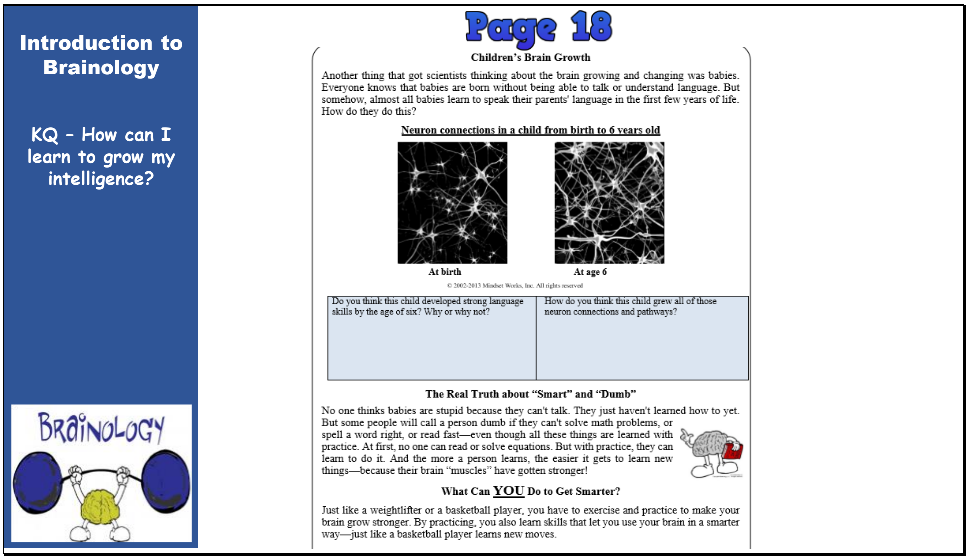
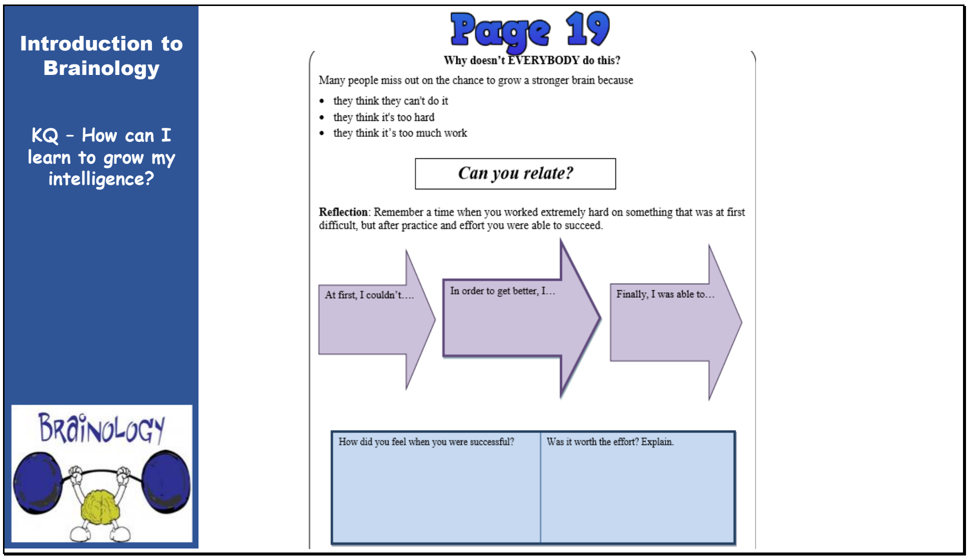
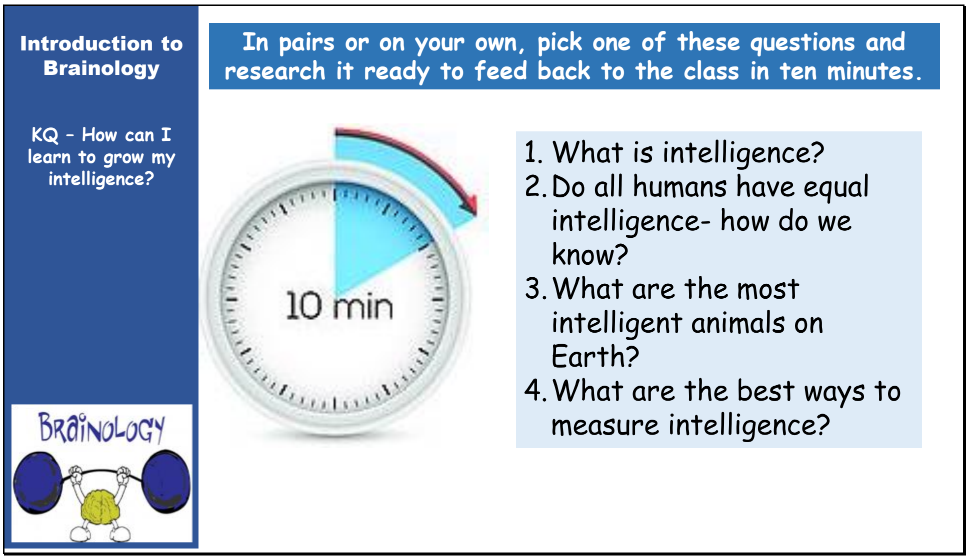


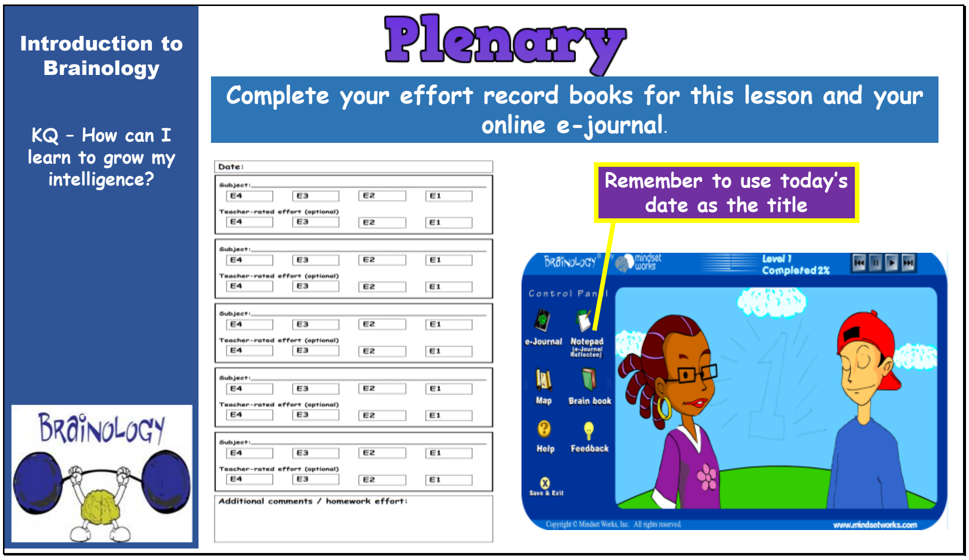
Slide 7



Slide 8



Slide 9



Introduction to Brainology
KQ – How can I learn to grow my intelligence?
Plenary
Complete your effort record books for this lesson and your online e-journal.
Remember to use today's date as the title

***Brainology* evaluation questionnaires**

BRAINOLOGY

Evaluation Questionnaire

Name:

Has the Brainology intervention changed what you think about **intelligence**? Please explain your answer:

Has the Brainology intervention changed how much **effort** you are putting into your other lessons? Please explain your answer:

What was the **best thing** about the Brainology intervention? Please explain your answer:

What would you **change / improve** about the Brainology intervention? Please explain your answer:

Any other comments:

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