Exploring strategies that foster a growth mindset rather than a fixed mindset in previously high attaining secondary school mathematics students

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Abstract

The aim of this study is to explore strategies that might foster a 'growth' rather than a fixed mindset in previously high attaining mathematics students. Literature suggests that previously high attaining students may be subject to maladaptive responses to both success and failure depending on their mindsets, goal orientation and attributions. Students can exhibit learned helplessness or self-protection when faced with increased levels of challenge.

The desirability of a growth mindset was introduced to staff and students throughout the whole school. Strategies intended to encourage a growth mindset were discussed by me and a colleague and with 59 top set year 9 students over a 5 month period. Questionnaires and interviews of students and teachers provided qualitative and quantitative data that illuminated interpretations of growth mindsets and perceptions of strategies intended to promote them. The results showed that the introduction of entirely formative assessment was a useful cue for clarifying implicit theories of intelligence. Teachers were prompted to deliver relevant attribution retraining through process specific, non-ego involving, strategy feedback based on individual student perspectives. The students often described "intelligence" as an inherent aptitude that could be enhanced by their efforts to improve. Their personal observations conflicted with their interpretation of the growth mindset questionnaire items. This conflict was often explained by their goal orientation and their definition of what intelligence actually *is*. The main findings of this study are that as well as overt strategies that teach the malleability of intelligence to change teacher and student mindsets continued subtle exposure to experiences which demonstrate that intelligence is unstable and controllable is possible. To prevent alienation of students, this should include acknowledgement that although normative comparisons will reveal different starting points for individuals, attention to honest strategy feedback will lead to improved attainment. Practices such as grading and ego-involving praise can to be avoided if replaced with specific feedback and this promotes learning goals. Essentially teachers and students need to understand that improved attainment is not just achievable through increasing knowledge but through improving processing as well.

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Chapter 1: Introduction

When infants begin to learn their motivation is very rarely lacking, moreover it tends to be universal, not subject specific. Parents might comment on how early their child first walked or spoke but this is not seen to have any long term consequence for their physical or linguistic attainment. You will not hear a mother describing her toddler by saying "Elisabeth is doing well at walking, but talking is something she struggles with. She is just not a talker, which is to be expected really because I was always hopeless at talking when I was young, still am!" Substitute 'literacy' for 'walking', 'maths' for 'talking' and 'mathematician' for 'talker' and this becomes a quote I heard from a teacher colleague describing her 5 year old daughter. Surely this shouldn't be decided by age 5? Yet, Jo Boaler (2009:116) found 'that 88 per cent of children placed in [maths] ability groups at age 4 remain in the same groupings until they leave school'.

I have heard similarly immutable comments about older, secondary school students' lack of mathematical ability. Even when the students in question are in top sets, when grouped on prior attainment, they often describe themselves as being 'no good at maths'. It is quite common for students, despite performing well at school, to believe that in some domains their ability is genetically fixed. How does this belief about mathematical ability persist even when a student has performed relatively well in previous standardised tests? Does it matter? What leads to the development of these views? Are there things teachers could avoid doing so that they don't inadvertently reinforce fixed, negative views of mathematical ability? What can they do to promote a more incremental view of mathematical ability?

The rest of this introductory chapter first gives a background to this study and choice of title. The issue to be addressed is then discussed in the national context, the local context of my

school and of two year 9 top sets. A possible solution to the issue is proposed which, with an explanation of my personal context, provides a rationale for my research questions.

The second chapter of this study is a literature review which is aimed at the first of my research questions.

RQ1: Does research literature suggest strategies to adopt for promoting 'growth' mindsets and strategies to avoid which embed 'fixed' mindsets?

The first section of the chapter describes Carol Dweck's implicit theories of intelligence. The second section looks at the literature on strategies used to foster a growth mindset and practices that inadvertently foster a fixed mindset. This section includes a consideration of the challenges associated with scaling interventions beyond one classroom. This is followed by a brief section looking at conceptions of intelligence, a fundamental aspect of Dweck's theory, and a key issue that arose from the first cycle of data collection in this action research project.

Chapter 3 describes the methodology used in this study. An action research framework uses the 'knowledge and insight' (Altrichter, et al., 1993: 153) gained from the literature review to explore the scaling of mindset strategies in the context of a UK secondary school. Using an interpretive paradigm (revised from an initial plan), quantitative and qualitative data is gathered and analysed to interpret the mindsets of 59 year 9 students, in the top two sets, and the reactions of associated staff to attempt to scale mindset strategies beyond my own classroom. A mixed methods approach uses questionnaires, teacher internet interviews and informal interviews of four case study students to triangulate findings and contribute to discussions relating to my remaining research questions.

RQ2: How do the mindsets of previously high attaining students' in a UK secondary school situate with research literature?

RQ3: How is teaching practice affected by scaling strategies to promote “growth” mindsets?

RQ4: Are student perspectives on mindsets affected by scaling strategies to promote “growth” mindsets?

In Chapter 4, I present and discuss the findings from each stage of the data collection process. The concluding chapter identifies the limitations of the study, summarising the findings and considering the implications for future practice.

1.1 Background to this project and choice of title

I have taught mathematics in secondary schools for 22 years. Ten years ago a colleague sparked my interest in motivation theory and introduced me to the theory of mindsets. Over the last two years, as part of a part-time master’s degree, my research was focussed on ways to improve aspects of motivation in my own classroom and to disseminate the findings to my colleagues. This has involved literature reviews on the use of praise and its effects on intrinsic motivation (Dasgupta, 2013) and the effects of grading on goal orientation (Dasgupta, 2014). Motivational states connect to academic outcomes via different degrees of engagement (Reeve, 2013). As a classroom teacher it is the different ways in which students engage with their education that is immediately apparent. Clearly certain types of engagement lead to better academic outcomes than others. By understanding the motivational factors behind the adoption of particular types of engagement we will be better able to foster the adaptive patterns of engagement and to avoid encouraging the maladaptive patterns. Psychology literature describes several theories of motivation that can be considered applicable in different situations, one of which is Carol Dweck’s (1999) theory of motivation that describes two distinct, implicit self-theories (mindsets) that students have about their intelligence. A large body of research on implicit mindsets details the characteristics of each mindset and the effects it has on motivation, engagement and academic outcomes. The focus of this study is an exploration of strategies that affect the mindsets of previously high attaining students in mathematics in a UK secondary school.

1.2 Issue to be addressed

My opening anecdote about Elisabeth exemplifies the opening point that Susan Hart (2004) makes in her book 'Learning without limits'. She refers to the very early experiences children have of school which lead them to develop ideas about their ability compared to that of their peers in particular domains. This early establishment of a lack of ability in maths often persists despite relatively high performance in standardised tests. Brown et al. (2008) consulted over 1500 16 year olds in the UK to uncover their reasons for choosing whether to continue studying maths. Despite GCSE predicted grades of C or above only 34% intended to continue, with the most common reason being that post-16 maths would be 'too difficult'. Many students predicted A or A* for their GCSE echoed that reason.

Inevitably not all 5 year olds will go on to be professional mathematicians or even to study mathematics post 16, but the proportion that do so in the UK is relatively low. A Nuffield Foundation study investigated numbers of students participating in post-16 mathematics in 24 countries and found England, Wales and Northern Ireland to have the lowest (Hodgen et al., 2010). We are losing a huge resource of potential STEM (science, technology, engineering and mathematics) professionals if students continue to write off mathematics before they even finish primary school. Hodgen's (2010) report has been used as evidence for the need to reform post-16 mathematics provision. These reforms include an amendment to the annual school performance tables so that they include data relating to participation in mathematical and scientific subjects at A level and the introduction of new, more challenging A levels in mathematics. Neither of these reforms addresses the issue of a perceived limit to achievement in mathematics held by some students.

This issue is replicated in my school, including the gender differences seen nationally. Over the last three years despite the fact that around 50% of students achieved a B or higher in maths, only about 25% chose to continue studying maths. Of those only one third were girls.

Between one quarter and one third of all students dropped maths after the AS level each year.

Brown et al. (2008) found that a key factor influencing students' perception of post -16 maths was the impression gained from older siblings or teachers of an increase in difficulty from that previously experienced at GCSE. Current year 9 students in the UK will be the first cohort to take a new GCSE in mathematics. They have no experience of the New National Curriculum which has just been introduced in Key Stages 1, 2 and 3 and is designed to lead up to this high stakes qualification. The expectation of increased difficulty that A level students previously reported back to students who were deciding whether or not to choose maths is already being experienced by these year 9 students. The Department for Education (2015: 3) state in their 'Reformed GCSE and A level subject content consultation' that 'The proposed GCSE subject content aims to provide students with more fulfilling and demanding courses of study'.

As previously high attainers in maths, the students in the top two sets are likely to continue studying maths post-16 should they choose to. Hogden (2013) refers to a 2011 DfE report that found that achievement at or above the expected level in mathematics led to a higher likelihood of participation in A level mathematics. At that point these students would face another increase in challenge as they experience a brand new A level specification. Understanding how to support those with negative perceptions of potential mathematical ability is particularly important for this year group and the previously high attaining students we might lose as potential STEM professionals.

The warnings about the 'step up' in difficulty from GCSE to A level maths are not intended to put people off choosing maths. For many students the prospect of increased challenge is what attracts them. Carol Dweck's implicit theories of intelligence and associated achievement goal orientations offer an explanation for the difference between those

choosing and those rejecting further mathematical study. Students with incremental (growth) views of intelligence are likely to adapt well to increased challenge (completing the two year A level course) and those with an entity (fixed) view of intelligence are likely to resist the challenge (failing to choose a potentially 'difficult' subject) or adapt badly to it (dropping out after the first year). In their conclusion Brown et al. (2008: 16) propose strategies to solve the problem of low post-16 maths participation which include 'dissolving the personal barriers to mathematics, confronting the tendency we found in this study to feel that there are innate boundaries to their progress'. Dweck (2012) says that mindsets are malleable. Is it feasible that we could change the fixed theories of intelligence held by previously high attaining students within our school maths department so that they adapt well to the increased challenge of the new GCSE and look forward to choosing the challenging new A levels?

1.3 Personal context and possible solution

As a participant researcher consideration of my own perspective cannot be ignored. In September I began teaching in a new school as Head of the Mathematics Department. Various external factors added to the context in which this study had been initially planned.

As a classroom teacher, my practice has been influenced my previous work surrounding Dweck's implicit theories of intelligence. My awareness of the characteristics of students with incremental or entity mindsets and associated goal orientations guides my verbal feedback. This is specific, non-ego involving and about the mathematical process not the students or their ability. I never give verbal praise to students (in the sense that 'praise' is most usually interpreted) and I give no tangible rewards to students. I challenge normative comparisons if students make them and never include National Curriculum levels or GCSE grades in written feedback from assessments. This entrenched routine practice is 'value laden' and this has 'implications for issues of justification and validation of research findings' (McNiff et al, 2003: 16). It would not be possible to measure the impact of my own use of

mindset strategies experimentally without withholding them until the initial questionnaires were collected which I feel would be unethical.

As Head of Department I implemented the introduction of formative feedback as a departmental improvement target. My literature review points at the use of whole cohort assessments as a suitable vehicle for communicating the growth mindset message to my staff. This represents a 'stealthy' approach to scaling the mindset strategies (Yeager and Walton, 2011).

The school context also needs to be considered. The Deputy Head teacher responsible for Teaching and Learning had researched growth mindsets herself and had planned whole school INSET for teaching staff in October (when all staff were to be given a copy of Dweck's (2012) 'Mindset' book). She had also prepared whole school (20 minute) growth mindset tutorial sessions and assemblies for students, using Dweck's materials to support the promotion of growth mindsets in schools (http://www.mindsetworks.com/). I supported this by sharing my previous work on the effects of ego-involving praise on goal orientation and mindsets with the whole staff.

Thus my colleagues and students have been exposed to a variety of strategies intended to promote growth mindsets. One purpose of this study is to explore these strategies, the theory behind them and their applicability to the previously high attaining year 9 students whose post-16 participation in maths we hope to increase. A second purpose is to understand the effects of scaling these strategies on teachers' and students' theories of intelligence (mindsets). This understanding could significantly influence future practice not just in our school but wherever teachers are trying to promote growth mindsets.

So my research questions are:

RQ1: Does research literature suggest strategies to adopt for promoting 'growth' mindsets and strategies to avoid which embed 'fixed' mindsets?

RQ2: How do previously high attaining students' mindsets in a UK secondary school situate with research literature?

RQ3: How is teaching practice affected by scaling strategies to promote "growth" mindsets?

RQ4: Are student perspectives on mindsets affected by scaling strategies to promote "growth" mindsets?

Chapter 2: Literature review

2.1 Dweck's 'Implicit theories of intelligence'

Carol Dweck's 'Implicit theory of intelligence' is rooted in 30 years of psychological research. As well as a large number of peer reviewed articles she has published two books. Her first book 'Self-theories: their role in motivation, personality, and development' Dweck (1999) details her theory and her findings from various laboratory, school and college trials. The second book 'Mindset' is more populist, designed to share the theory and 'show people how to make use of it in their lives' Dweck (2012: ix). These books have led to widespread discussion of the theory both in the US and more recently in the UK. Throughout this study I may refer to Dweck's 'Implicit theories of intelligence' more simply as 'mindsets' but note that Dweck's theory is sometimes referred to as achievement goal theory (Dweck & Leggett, 1988; Ames, 1987) when included amongst other theories of motivation. The dichotomy of mindsets that form the basis of the theory are referred to as 'incremental' or 'entity' theories (of intelligence) but more colloquially as 'growth' or 'fixed' mindsets. I use the language of both, depending on the context. Although the theory extends to include implicit theories of morality and of 'kind of person' (Dweck et al., 1995), in this study I will focus on describing the key points that relate to theories of intelligence only.

2.1.1 Summary of Dweck's theory

Achievement goal theory contends that the reasons individuals behave differently when involved in academic tasks depends on their purpose or goal, suggesting that this goal is strongly correlated to the individuals' theory about the malleability of their own intelligence. The success or failure in reaching that goal following their engagement with a task then predicts their behaviour when presented with future tasks (Ames, 1987; Dweck and Leggett, 1988; Dweck and Elliott, 1983). When encountering failure they could either adopt a helpless or mastery-oriented approach to subsequent tasks (Dweck, 1999). If they are successful they may choose easy tasks to ensure future success (a maladaptive response) or look for more challenging tasks to further their learning even though this risks future success (an adaptive response).

By temporarily inducing students' goal orientations or theories of intelligence and then measuring the subsequent mindsets or goal orientations respectively, Dweck and her colleagues have shown a correlation between goal orientation and implicit theories of intelligence (Dweck, 1999; Dweck and Leggett, 1988; Elliot & Harackiewicz 1996; Elliot and Dweck, 1988; Hong et al., 1999; Robins and Pals, 1998).

Students with mastery (or learning or task) goal orientation, who are focused on gaining proficiency in a skill for its own sake, tend to have an incremental view of intelligence. Mastery oriented students are more likely to take risks by choosing challenging tasks that they can learn from, even at the expense of not appearing clever, asking for help if needed, and unconcerned about external perceptions of their performance. They will view difficulty as a cue to search for more effective strategies, not as a judgement on their lack of ability. These students have growth mindsets, believing that their ability is malleable and that through effort they can overcome difficulties.

Students with performance goals are concerned with demonstrating their abilities, tending to believe they have a fixed intelligence, either high or low in comparison to others'

intelligence. They will choose tasks where they can outperform others, hide mistakes or give up entirely when they realise they might not be successful. If they develop 'learned helplessness' they may not attempt tasks at all because they are convinced they will not succeed. It is beyond their control. They may misbehave so they can blame underperformance on their behaviour rather than a lack of ability.

In brief then, Dweck's theory divides people into two types; entity theorists with performance goals and incremental theorists with learning goals. Early articles suggest that 15% of people are undecided and the rest divided equally between the two types, regardless of prior attainment.

One study appears to contradict Dweck's assertions. In a study where students' self-theories were manipulated by Niiya et al. (2010:293), they found that 'when failure is likely, incremental theorists whose self-esteem is contingent on their performance self-handicap to protect their self- esteem from the potential failure.' However, the manipulation of self-theories in this study involved students reading entity or incremental theory 'priming texts' and the manipulation check involved the students indicating what the text implied, not what they themselves believed. This evidence suggests that the students could identify the theory in the text but did not necessarily hold those self-theories themselves. A student whose self-esteem is contingent on performance does not seem to believe their intelligence is malleable so I am not convinced that this study really does contradict Dweck's theory. It suggests that students can hold both learning and performance goals.

The second section of this literature review looks at the results of two approaches to mindset intervention and the possibilities for scaling these interventions beyond a single classroom.

2.2 Changing mindsets and scaling interventions

Research on the theory of mindsets was initially concerned with ascertaining the key features and mediating factors for each type of mindset (fixed or growth) and establishing associated goal orientations (performance or learning). These studies developed to often include manipulation of implicit theories of intelligence or goal orientation so that factors such as prior attainment or self-efficacy could be controlled for. Additionally the effects of different strategies were measured to explore how certain mindsets may have evolved and how mindsets are themselves malleable.

Yeager and Walton (2011:268) summarised several projects that had successfully sought to alter students' thoughts and beliefs in and about school and state that 'seemingly "small" social-psychological interventions—typically brief exercises that do not teach academic content but instead target students' beliefs, thoughts and feelings—have had striking effects on educational achievement even over months and years' (Dweck, 1999; Dweck, 2012; Farrington et al. 2012; Paunesku et al., 2015; Blackwell et al., 2007; Good et al., 2003). These interventions fall into two types. In some, students are directly taught about the malleability of intelligence, in others they are indirectly introduced to ideas that allow them to arrive at the idea of intelligence as a malleable trait without explicitly mentioning it. Conversely, certain classroom practices, in particular person praise, praise for intelligence or grading during feedback following assessments can lead to the reinforcement of performance goals and a fixed mindset (Butler, 1987; Mueller and Dweck, 1998; Black and Wiliam, 1998; Henderlong Corpus and Lepper, 2007; Rattan et al. 2012).

I will consider the two types of growth mindset promoting interventions and then discuss the evidence surrounding fixed mindset promoting practices.

2.2.1 Promoting a growth mindset

Studies which have overtly taught the malleability of intelligence have become more prevalent in recent years. These interventions have included asking students to read

scientific articles (Hong et al., 1999; Blackwell et al., 2007; Nussbaum and Dweck, 2008; Dweck et al. 1995), to watch films (Aronson et al. 2002) or computer animations (Donohoe et al., 2012) each describing the malleability of intelligence. Others have involved trained mentors teaching an incremental theory of intelligence through neuroscience workshops to students (Blackwell et al., 2007).

An alternative or additional approach to changing mindsets is to adopt what Yeager and Walton (2011) describe as 'stealthy' methods. Good et al. (2003) used undergraduate students as mentors to seventh grade students. The mentors described the difficulties they had with the transition to seventh grade but that they had eventually overcome these difficulties. They encouraged the younger students to 'shift their attributions for difficulties … from their own shortcomings to the novelty of the situation.' (Good et al., 2003: 654). In the study by Aronson et al. (2002: 117) participants were engaged as 'pen pals' responding to letters from struggling middle school students and 'were asked to write a reply that would encourage their pen pals to work hard in spite of their difficulties'.

The most recent study of this type sought to use the content and procedures of these previous projects to 'scale' up the intervention, creating two 45 minute online sessions to be delivered to around 1600 students from the 9^{th} to 12^{th} grade (Paunesku et al., 2015). The sessions included a combination of overt and stealthy methods providing articles to read about brain plasticity and requiring writing tasks to cement the ideas through the 'saying is believing effect' (Aronson et al., 2003: 116). Students were asked to write a summary of what they had learnt and to write some advice to a hypothetical student who was displaying helpless, performance avoidance behaviour.

A similar combination of overt and stealthy approaches was used in the 'Changing Mindsets Project', a very recent study of year 5 students in the U.K. published by the Education Endowment Foundation (Rienzo et al., 2015). This project consisted of a pupil intervention

and a teacher intervention. The former used the overt approach, using undergraduates and other project partners to teach year 5 students a course of mindset workshops over 10 weeks. I consider the teacher intervention a stealthier approach where teachers, in addition to being encouraged to teach about the malleability of intelligence, were also taught how to 'reinforce this in lessons through the way they communicate with pupils…The changes to classroom culture related to teacher expectation, use of language, reward systems and allowing pupils to value learning from mistakes.' (Rienzo et al., 2015: 10).

In most of the studies mentioned above, significantly higher academic attainment was measured in standardised tests for those in the intervention groups when compared to those in the control groups. This was not the case in the two UK trials, the Donohoe et al. (2012) study and 'Changing Mindsets project' (Rienzo et al., 2015). This suggests a more complicated solution to the problem of increasing proportions of students with an incremental view of intelligence in the UK is required. The Donohoe et al. study found that the students' initial moves towards a growth mindset, noted a week after the intervention, were not sustained. Students had returned to their original mindset at follow-up three months later. The failure to replicate the results of the US studies might be a result of the small sample size (n=33) but I propose that there may be other factors to consider particularly since sample size was not an issue in the 'Changing Mindsets Project'. This project involved 286 students in the pupil intervention and reached 1505 students through the teacher intervention. The different outcomes of these UK studies might be due to misunderstandings about the classroom culture best suited to encouraging a growth mindset. This problem will be exaggerated if teacher theories of intelligence are not truly incremental. Teachers may unintentionally be reinforcing a fixed mindset message and students, rather than believing what they are told about the malleability of intelligence, believe what they experience.

2.2.2 Inadvertently fostering a fixed mindset

As discussed earlier there is a body of evidence to support the idea that entity theorists are likely to hold performance goals and that performance goals are likely to reinforce a fixed view of intelligence (Elliott & Dweck, 1988; Dweck, 1999). Performance goals have been linked to ego-involving feedback practices such as grading students work (rather than providing specific comments), rewarding attainment and praise (Butler and Nisan, 1986; Butler, 1987; Butler, 1993; Kluger and DeNisi, 1996; Black and Wiliam, 1998; Mueller and Dweck, 1998; Kamins and Dweck, 1999; Hattie and Timperley, 2007). Only praise is really discussed in the mindset literature and then it is only praise for ability that is discouraged. Praise for effort is suggested as the alternative that will promote a growth mindset. The evidence was initially provided from a study with young children by Mueller and Dweck (1998). They designed experiments to assess the impact of different types of feedback or praise. They found that,

> praise for intelligence had more negative consequences for students' achievement motivation than praise for effort. Fifth graders praised for intelligence were found to care more about performance goals relative to learning goals than children praised for effort. After failure, they also displayed less task persistence, less task enjoyment, more low-ability attributions, and worse task performance than children praised for effort. Finally, children praised for intelligence described it as a fixed trait more than children praised for hard work, who believed it to be subject to improvement.' (33)

Praise for intelligence can be inadvertently conveyed even when teachers are trying to adopt strategies that will encourage growth mindsets. The labelling of students as 'gifted and talented'; reward systems such as merits or commendations; ability grouping and early study leave for GCSE students deemed 'on track' to meet their targets are all examples of school practices that inevitably benefit those who attain above their peers. Indirectly these students are being praised for their intelligence and the others cannot fail to notice. It is likely that it is experiences such as these that give rise to performance goals and perpetuate these goals even when teachers are deliberately trying to encourage learning goals. The lack

of significant effect on the academic achievement of the participants in the 'Changing Mindsets Project' might be due to teacher practices that countered the growth mindset messages. Although the teachers were trained 'How teachers put this learning into practice was at their discretion.' (Rienzo et al., 2015: 11). Feedback from the teacher intervention describes how the growth mindset promotion was implemented and included use of whole school 'pupil reward systems' and 'gifted and talented programmes' (Rienzo et al., 2015: 32). The authors consider these adaptations to the mindset approach to have 'reinforced classroom approaches and strengthened its impact rather than compromised fidelity'. I disagree. It seems more likely that these practices would encourage normative comparisons and lead to ego-involvement, each of which would promote performance goals and therefore a fixed view of intelligence. Students might receive rewards for effort but if they don't attain relatively highly they will not be included in gifted and talented programmes. Any reward system is extrinsically judged and so the locus of control is removed from the student. Offering rewards is a typically controlling teacher behaviour that reduces student autonomy (Reeve, 2009). Additionally by setting targets, grading students work and reporting NC levels teachers will be reinforcing performance goals which will reinforce fixed mindsets. As soon as they report externally judged attainment that is less than hoped for, they risk turning performance approach goals to performance avoidance goals. Using comment only feedback would avoid that risk (Butler, 1987).

The advocacy of effort praise as an alternative does not appear to consider the potential negative effects on students with entity views of intelligence. These students are likely to consider effort as an indicator of low intelligence (Dweck, 1999) and so will see praise for effort as an indication that the teacher feels they have low (fixed) intelligence. Rattan et al. (2012: 731) found that teachers who held entity views of intelligence tended to 'both comfort students for low math ability and use "kind" strategies unlikely to promote engagement with the field (e.g., assigning less homework)'. The college students receiving

'comfort-oriented' feedback (rather than strategy-oriented or control feedback) identified their teacher's entity view of mathematical ability and perceived their teacher as having low expectations of them. Their expectancy was lowered and so was their motivation. This well intentioned focus on 'accepting weaknesses (as long as one focuses on strengths) is not quite as positive as intended' (Rattan et al., 2012: 736) and might well be a significant factor in the low participation rates we experience in post 16 maths study in the UK.

It is clear that promoting growth mindsets is not as simple as just telling students that intelligence is malleable and that learning itself is a worthwhile goal. We need to convince teachers and students by our actions and to take into consideration the views they already hold if we are to scale interventions beyond an individual classroom.

2.2.3 Challenges associated with scaling interventions

Yeager and Walton (2011) recognise that the effects of social psychological interventions may be different when they are scaled up to school level and delivered by a practising teacher rather than a researcher. A teacher's precise understanding of the theory to be delivered, their own belief in the intervention and the behaviour management in the class where the intervention is delivered are all factors in the success of the intervention.

Yeager and Walton (2011: 293) suggest that the success of the interventions is partly due to the 'recursive processes present in local contexts' and 'because they use persuasive yet stealthy methods for conveying psychological ideas'. These 'stealthy' approaches leave the locus of control with the students and so leave their autonomy and therefore their intrinsic motivation intact.

Haimovitz et al. (2011) studied 978 third to eighth graders. They found that students who lost motivation over the school year were more likely (than those who maintained or gained motivation) to have a fixed mindset and that this was explained by their adoption of 'ability-validation' goals. They suggest 'A focus on decreasing endorsement of ability-validation goals' (751). In this case the intervention would involve changing existing practices rather

than introducing new ones. This sort of intervention relies heavily on accurate communication of the theory to the teachers involved in the intervention as well as their own belief in the theory. Yeager and Walton (2011: 289) point out that 'The history of school reform reminds us that teachers can vary in whether they deliver an intervention in the way intended or in name only, changing the meaning and effect of the intervention'. In the context of strategies to promote Assessment for Learning, Smith and Gorard (2005: 36) highlight this important lesson 'for schools and researchers about how research-based designs fare in the 'real world''. They contrast the findings from their school based research project where 'control is passed from the designers to the practitioners alone' (36) with the supportive collaborative research between Black and Wiliam (1998) and the schools they worked with. This highlights the importance of considering teacher's own conceptions of intelligence when exploring strategies that might effect mindset change. Teachers can directly teach a conception of intelligence that tells students that their intelligence is malleable, but if their ongoing actions suggest otherwise then students are unlikely to be convinced by the overt growth mindset message.

In the 'Changing Mindsets' project, the need to train teachers to reconsider a classroom culture that would encourage a growth mindset, as well as overtly teaching students that intelligence is malleable was recognised. Although there was no significant additional progress for those students in either the pupil or teacher intervention groups, the findings were close to significant for English attainment in the pupil intervention. There is a suggestion that the pre-existing use of a growth mindset approach might have weakened the impact of the interventions and that a longer trial that combines the two types of intervention might be a useful future trial. I propose that another factor was the disregard for the implicit theories of intelligence held by the teachers themselves.

We need to employ 'stealthy' methods that reinforce the malleability of intelligence without building resistance to the message by appearing controlling. The method should reveal

conceptions of intelligence that are clearly established in the teacher, and move clearly from teacher to student. A focus on promoting learning goals by giving formative feedback and no grades should promote growth mindsets. Using assessment follow up to promote student autonomy and controllability of outcomes via self-regulation should promote a malleable view of intelligence. In both cases illumination of students' conceptions of intelligence and the traits to which they attribute success or failure can then offer opportunities for attribution retraining.

We should aim to retrain attributions for failure by directing students away from blaming a lack of innate intelligence and towards factors such as lack of effort; poor learning strategy; increased challenge. At the same time success needs to be attributed to deliberate practice; agentic engagement; honest self- assessment and persistence by giving process and strategy feedback that is not ego-involving but is autonomy supportive.

I believe that a key feature of effective mindset strategies is an ongoing teacher reaction to students' expressions of fixed intelligence beliefs. The usefulness of these reactions will inevitably be affected by the beliefs of the teacher themselves. The final section of this literature review reflects on different views of intelligence that teachers might hold.

2.3 Conceptions of intelligence

This section of the literature review was added after the first questionnaire data was collected. It became apparent that fundamental to a person's implicit theory of intelligence is their conception of what intelligence actually is and the potential barrier particular conceptions might have to belief in the malleability of intelligence. In this section I will first clarify the language around 'intelligence' commonly used. Aspects of the debate surrounding what intelligence might actually be are then discussed. I conclude with my view of the most helpful conception.

2.3.1 'Intelligence' Language

The language used around intelligence can be confusing (Hart, 2004). From an early age children are discussed as more or less able as a result of comparison with their peers. This may simply refer to their ability to do certain things at that point in time. Alternatively, it could mean something about their genetically inherited, innate, fixed cognitive ability and capacity to learn. Gordan Stobart (2014:10) suggests that teachers often replace the word 'intelligence' with 'ability' as this is just a more socially acceptable way to describe an innate capacity given the 'doubtful past of IQ testing'.

2.3.2 What might intelligence be?

Dweck (1999) describes an unpublished study where she and Claudia Mueller asked college students to define intelligence. She summarises the results by comparing the responses of entity or incremental theorists. Entity theorists (who believe intelligence cannot be changed) tended to view intelligence as an innate set of processing skills that can't be learnt and are not influenced by effort. Incremental theorists (who believe intelligence can be changed) included non-cognitive skills such as effort, willingness to learn and self-monitoring. These 'growth' mindset students put greater emphasis on knowledge which can be acquired. Dweck (1999:60) acknowledges that the question of 'what intelligence *really* is' [original emphasis] has 'no agreed-upon answer'.

The history of intelligence testing in the UK as summarised by Gordon Stobart (2014: 21) explains the prevalence of the view that some are 'born with it' and there are others who 'just don't have it'. Around the beginning of the twentieth century, in the UK, Francis Galton was introducing 'eugenics', the idea that since those in the lower social classes were genetically prone to lower intelligence, they should breed less! In 1944 the 11+ exam was introduced in England to determine whether children should attend a grammar school, technical college or secondary modern school. The 11+ exam still exists in many counties today as a way of selecting students for grammar schools. The tests are similar to the classic IQ tests or CATs (cognitive ability tests) taken by students and use as predictors of potential

attainment. This was not however the intention of Alfred Binet who invented the IQ test. The purpose of this test was to identify children who were not achieving well in the Paris school system. Binet's intention was to focus intervention programmes on these currently underperforming children to help them get back on track (Dweck, 1999; Stobart, 2014; Sternberg, 2014) and improve on their scores in the tests. Hart (2004) suggests that it is this predictive value of these sorts of cognitive ability tests that reinforce the view that intelligence is fixed.

Debatable questions surrounding definitions of intelligence include

- Is intelligence genetically programmed, environmentally determined or do both genes and environment together construct intelligence?
- Can intelligence measures predict achievement outcomes or only predict performance in repeated intelligence tests?
- Is intelligence independent of prior knowledge and about processing skills or does it depend on quantity of knowledge.
- Do intelligence measures predict rates of learning, do they predict limits to learning or do they just measure the current state of learning?

There is plenty of evidence that measures of IQ correlate to academic outcomes but as Sternberg (2012: 15) points out 'The problem regarding the traditional model is not in its statement of a correlation between ability tests and other forms of achievement but in its proposal of a causal relation whereby the tests reflect a construct that is somehow causal of, rather than merely temporally antecedent to, later success.' Sternberg has debated for decades with psychologists such as Jensen the idea that a single 'g factor' can measure intelligence and that this is an indicator of innate ability (Dweck, 1999). Influential evidence to support the idea that intelligence is not fixed, even as measured by IQ-like tests, is referred to as the 'Flynn effect' (Stobart, 2014; Sternberg, 2014). Flynn found that average

scores in IQ tests have risen over time far more quickly than could have been caused by natural selection of genes. As Flynn himself puts it 'Everyone concedes that people altered when the Enlightenment banished a mindset that tried animals in court and believed in witches. Did the alteration of our minds stop dead in 1900?' (Flynn, 2014: 857).

The current conclusion to the debate in the academic literature seems to be that whilst some of the variance in IQ scores can be attributed to inherited genes, genetic and environmental factors work together to create 'developing expertise' (Sternberg, 1998: 13). Those who do well on IQ tests do so as a result of their genes and their environment, they have developed the expertise required to do well on such tests. This is not to say that they have taken their innate genetic processing ability and simply added some knowledge, they have developed their processing ability. This explains the large number of parents who pay for private tutors to 'coach' their children for the 11+ exams. The circumstances that led to success in IQ like tests may continue and therefore correlate with academic outcomes but not necessarily. Intelligence tests measure current states of learning not potential or limits to learning.

A key factor in the use of strategies to affect mindsets must be the consideration of the conceptions of intelligence held by students and teachers involved in the interventions. Without addressing misconceptions about the nature of intelligence mindset messages risk being superficially received or dismissed (Yeager and Walton, 2011). These misconceptions will not necessarily reveal themselves naturally. The introduction of comment only feedback and promotion of agentic engagement through self-assessment might be a useful tool to cue discussions about such misconceptions. It has the additional benefit of reducing opportunities for normative comparison; ego involving feedback and comfort-oriented feedback. It allows teachers to promote learning goals and emphasise the locus of control for improvement as internal to the student.

2.3.3 Research questions

The first research question can now be considered.

RQ1: Does research literature suggest strategies to adopt for promoting 'growth' mindsets and strategies to avoid which embed 'fixed' mindsets?

The literature does seem to suggest that, through a variety of small and large scale, laboratory and classroom based trials, strategies do exist that can promote growth mindsets. Classroom practices also exist that create or embed fixed mindsets but these can be avoided.

Growth mindsets can be promoted directly, although perhaps not sustained, through the overt teaching of brain plasticity. Successful interventions of this nature are likely to have been supported through the less obviously 'growth mindset promoting' use of specific, strategy information that retrains attributions and promotes agentic engagement. This information demonstrates the unstable, controllable and internal nature of intelligence.

Strategies to avoid include grading students' work and person or intelligence praise. These practices encourage normative comparisons, ego-involvement and performance goals. Control appears to be located externally to the student and so their autonomy is reduced. There is a suggestion that intelligence is a stable trait and that previous outcomes will be repeated regardless of effort to change them. Students embed fixed mindsets. If outcomes have previously been relatively high this need not be a negative perspective but when future challenging tasks are encountered, performance avoidance goals may lead to maladaptive responses such as helplessness, work avoidance and anxiety. These strategies can be replaced by the use of specific formative feedback in place of grades and non-ego-involving positive feedback that focusses on the processes that led to success rather than an innate trait of the person who was successful.

It was noted earlier that very little of the research in this area has been conducted in the UK and very little has explored how these strategies are viewed by the subjects whose mindsets

are being challenged. The next chapter described the methodology of this study which seeks to answer the remaining research questions.

RQ2: How do previously high attaining students' mindsets in a UK secondary school situate with research literature?

RQ3: How is teaching practice affected by scaling strategies to promote "growth" mindsets?

RQ4: Are student perspectives on mindsets affected by scaling strategies to promote "growth" mindsets?

Chapter 3: Methodology

In this chapter I describe my choice of design frame and include a rationale for my change of approach, consideration of the contextual circumstances in which the study was undertaken and my own positionality. The following sections detail participant selection, instrument design and ethical considerations. A section on data collection relates to two rounds of student questionnaires, my own reflections on the scalability of growth mindset strategies resulting from colleague interactions and external influences and interviews of selected students. The final section in this chapter details my final research questions.

3.1 Context and rationale for design frame choice

My choice of focus for this project was influenced by my dual roles as a classroom teacher (seeking to improve my own classroom practice) and as a manager (keen to promote collaborative improved practice). Specifically, I hope first to develop my own knowledge and understanding of the phenomenon of growth mindsets and how they might be changed. Secondly, through discussion with colleagues, implement a departmental approach to assessment feedback, suggesting strategies that might be scaled up beyond my classroom. Thirdly, I wished to better understand the mindsets of my students and their perceptions of growth mindset promoting strategies. These various explorations of mindset strategies in schools suited the approach of practitioner action research.

Cohen et al. (2007) give various definitions of action research but common features include: problematic issues identified by practitioners; an intention to improve practice; reflections on actions that are shared with the wider profession and practitioner participation. These features are present in my project. I have identified the issues faced by the transition from GCSE to A level for some previously high attaining mathematics students both nationally and in my school, in the first section of the literature review. I certainly hope to develop my own practice and that of my colleagues and I am committed to sharing my reflections on actions taken.

The spiral nature of action research that typifies the approach founded by Kurt Lewin (Thomas, 2009) is a good fit for my project. Each cycle of data collection will prompt actions determined by reflections on the issues that arise from the previous collection. Elliot's (1991: 71) 'revised version of Lewin's model of action research' fits my project most closely. It includes a review of the implementation and effects of the first action steps which lead to a revised general idea. In fact the initial round of data collection reflected the influence of changes to the context in which the research was conducted that were beyond my control. This made it more appropriate for me to revise my initial research design and to adopt a more interpretivist approach for the subsequent data collection.

My interpretations of the data collected are not obviously generalisable because the experimental validity was compromised by the introduction of whole school 'growth mindset' intervention and experimenter effects. However, the introduction of whole school mindset interventions is increasingly prevalent and the descriptions accompanying my interpretations of events could allow judgment of how applicable my findings might be in the reader's context. I introduced a case study approach since an experimental design was no longer suitable. Comparisons of the initial quantitative data from the questionnaires remain valid, no longer as measures of the effectiveness of the interventions, but instead, as a snapshot of opinions as they were at that time. Together with the qualitative data from

the questionnaires and the teacher and student interviews these mixed methods of data gathering created a source of 'insights to be gained from looking at the individual case that can have wider implications' (Denscombe, 2007: 36).

3.2.1 My own positionality

In explaining their definition of action research McNiff et al (2003: 12) note that 'the researcher is inside the situation, and will inevitably influence what is happening'. My role as Head of Department adds to my responsibility to check that this influence is justifiable and to ensure that I do not abuse my position. By adopting an interpretivist approach as a participant researcher I will be seeking to discover the situated knowledge (about mindsets) of the student and colleague participants and I need to bear my own position in mind when interpreting the data I gather (Thomas, 2009).

3.2 Participants

3.2.1 Students

The 59 students participating in the study were in year 9 in a mixed comprehensive school. Prior attainment assessments at the end of year 8 placed them in the top two of ten maths groups. In years 7 and 8 these students had been mixed in two parallel 'top' groups but for year 9 the then departmental policy was to set 'top to bottom' and so 30 students were placed in set 1 (taught by me) and 29 in set 2 (taught by a newly qualified teacher). These groups were chosen for this project for a number of reasons.

Firstly, in addition to choosing to focus on previously high attaining students in Mathematics I needed to choose a year group to focus on. The literature suggests that those retaining fixed ability mindsets are at risk of adapting poorly to increased challenge at any age but particularly in early adolescence (Blackwell et al, 2007). Secondly, I was interested to see to

see if these students matched the picture in the general population where 40% have a fixed mindset, 40% a growth mindset and 20 % do not fit either category (Dweck, 2000). Did those who had been placed in the 'top' set tend to have more of a growth mindset than those in the second set?

Thirdly, there were practical reasons. I am the class teacher for one group and Head of the Department. As such I could, without disruption to the students' usual experience or expectation, administer questionnaires to both classes and interview selected students. My involvement in the lessons would be typical and thus non-interfering. Additional ethical considerations are explained later.

3.2.2 Colleagues

To preserve the anonymity of the teachers involved I will refer to the two collaborating teachers as NQT (newly qualified teacher) and ET (experienced part time teacher).

In the first month of teaching my class it was apparent to me (as someone familiar with Dweck's research) that some students in my maths set (9M1) exhibited typically 'fixed mindset' behaviours and that this was leading to maladaptive responses. I was already reacting to this in ways that I believed would promote more of a growth mindset but this was difficult to explain succinctly to colleagues. Through my conversations with NQT it was clear that she was making similar observations, not just with this group, but with a top set Year 10 she also taught. Including NQT and my class in this project enabled me to work with NQT sharing our thoughts on how we might promote the growth mindset. However as a newly qualified teacher, NQT's experience was not typical of the rest of the maths department. I was interested in how the mindset strategies would be interpreted by more experienced teachers.

ET has taught for over 15 years and now has two young children so works part time. She teaches a top set in year 8 who are not part of this study but were the group she related to

when discussing mindset strategies. Her experiences as a mother also contributed to her perspective.

Not only would my own practice improve through reflection on my actions and attempts to explain and justify them but I might also usefully contribute to 'the collective development of the profession by means of opening up individual practice to scrutiny and discussion', a key factor in action research (Altrichter etal., 1993: 207).

3.3 Instrument design

Instruments used in this study include a mixture of qualitative and quantitative methods and reflect the inductive process of this action research. Student questionnaires collected both qualitative and quantitative data. Semi-structured internet teacher interviews gave insight into their perspective and challenged my own conception of intelligence. Finally, unstructured case study interviews of selected students who had conflicting questionnaire responses completed the exploration of growth mindset strategies by clarifying their views.

The original design frame used questionnaires to gather quantitative data to measure mindsets of previously high attaining students. This data would establish the relevance of the literature on mindsets. Qualitative data would also be collected to triangulate the findings with that in the literature and illuminate the implicit theories held by the students.

3.3.1 Questionnaire design

The questionnaire (Appendix 3) was designed to collect quantitative and qualitative data that would illuminate students' implicit theories of intelligence and goal orientation and to assess whether the responses from UK previously high attaining students would replicate the findings from Dweck's research. The wording of the questions was kept close to that used by Dweck unless the language used would have appeared alien to UK students and teachers (Krueger and Casey, 2000). The adjustments to the original wording were chosen using my own 'practical wisdom' (Aubsson et al., 2009). Before issuing the questionnaire, it

was completed by two students with similar reading ages to the participants and no problems with comprehension were found.

The first question is a direct copy of the three entity theory items used in Dweck et al. (1995). Using only the three entity items reduced the likelihood that students would tend towards an incremental response as was observed over time by Dweck when three incremental items were added. The incremental items were seen as 'too appealing and drew too high rates of agreement' (Dweck, 1999: 176). The students indicate their agreement on a 6 point Likert scale to three statements about the malleability of intelligence. Higher scores indicate a more incremental view of intelligence. The three entity items have been shown to have high internal validity and test-retest reliability. When first used, responses on the Likert scales were triangulated with quantitative explanations and Dweck et al. (1995: 270) found that 'those who disagreed with the entity statements gave clear incremental theory justifications for their responses.' These scales have been widely used to determine whether students have entity (fixed) or incremental (growth) theories of intelligence. Mueller and Dweck (1997) found that students' definition of intelligence also differed according to mindset. Of course the conception of intelligence a participant holds will mediate their response to the entity theory items in the questionnaire. Questions 7 and 8 invite students to describe intelligence and subdivide intelligence into percentages contributed by effort and ability respectively.

One of the key features of the mindset theory is that the proportions of students with a fixed or growth mindset is similar regardless of prior attainment (Dweck and Leggett, 1988). What can differ is the students' self-conception regarding their intelligence. Questions 2 to 4 address this by asking students to choose between statements about their own intelligence; their confidence about learning new work and their intellectual ability.

Motivational patterns determined by mindsets are enacted via goal orientation when students are faced with challenge. Questions 5 and 6 are drawn from Dweck's 'Task-choice goal measure' (Dweck, 2000: 185). Question 5 was adapted 'to describe a hypothetical case where students might choose tasks' (Dasgupta, 2014: 18) for my 'Part 2' assignment which looked at the effects of grading on goal orientation. Four options are offered to students during an experiment.

> Choices 1 and 3 offer a task that will allow them to avoid looking dumb (a performance goal with no challenge; or a "performance-avoidance" goal); choice 4 represents a task that will allow them to look smart (a performance goal with challenge); and choice 2 is a task that will allow them to learn something new and important, but holds the risk of looking dumb (a learning goal). (Dweck, 1999: 184)

Question 6 asks students to choose whether performance or learning is a more important goal for them. Several studies have used these scales and found that when measures are used that 'pit learning goals against performance goals…a clear relation with students' theories of intelligence' is found (Dweck and Leggett, 1998; Mueller and Dweck, 1998). In contrast when asked separately, both entity and incremental theorists favour both learning and performance goals (Elliott and Dweck, 1988). Inclusion of questions 5 and 6 will give evidence of the relevance of dividing performance goals (determined in question 6) into performance approach and performance avoidance goals (differentiated in question 5).

The combination of quantitative and qualitative data from these questionnaires will on first collection allow me to understand the mindsets of the two year 9 classes participating and to compare them to the results in the literature. The second collection will provide further insights into the students' initial responses and any reactions to the mindset strategies they have experienced from January to May.

3.3.2 'Stealthy' assessment feedback procedure

Running concurrent with overt discussion with students are 'stealthy' methods.

> These indirect approaches may be more effective than overt strategies. They do not feel controlling and so they minimize resistence (sic) and reactance to the message. They also allow students to take credit for their success rather than risking the possibility that students attribute outcomes to a heavy-handed intervention. (Yeager and Walton, 2011:284)

This approach has the added advantage of 'targeting students' experience in school from the students' perspective' (Yeager and Walton, 2011:285) so that they are actively not passively involved in the intervention and are therefore more likely to be persuaded by the message.

Persuading teachers of the benefits of growth mindsets is essential if they are to deliver the growth mindset message (Yeager and Walton, 2011). The benefits of a 'stealthy' approach are equally applicable when seeking to persuade teachers to consider the benefits of mindset change as when persuading students. To serve both purposes I decided to introduce a departmental assessment feedback and follow up strategy that would require teachers to promote learning goals and the idea that academic improvement is internally controllable by the students themselves. At the same time, by not reporting marks or levels at assessment points, performance goals could be suppressed and extrinsic, ego-involving judgements reduced. The interpretive, practitioner research approach to this study provides an opportunity to 'reveal settings in which mind-set interventions are redundant with messages already present' (Paunesku et al., 2015: 8). As discussed earlier, too many external factors were in place and were ongoing to effectively measure any causal impact of the assessment strategy. The intention is to assess the introduction of the strategy as a vehicle to reveal perceptions of mindsets and the thoughts of those who resist mindset change.

The steps in the assessment strategy and intended effect on mindsets and goal orientations of teachers and students are detailed in Table 3.1. An example of a 'self-assessment sheet' and a 'feedback sheet' are given in Appendix 4.

The assessment strategy was introduced in department meetings with a rationale for not reporting levels and not writing on scripts.

Table 3.1: Assessment strategy

Step in procedure	Teacher	Student
The learning goal associated with each question part in the assessment is summarised by the teacher.	Focus on learning goal of each question and therefore on possible specific strategy feedback.	Not yet involved.
Students' scripts are marked but nothing is written on the scripts. The marks awarded in each part of the question are recorded in a database.	Teachers are required to communicate success criteria and specific feedback – focusses on learning goals.	Students cannot compare to peers before considering outcomes on each question. Performance goals supressed. No extrinsic judgement.
Scripts are returned to students and collaboratively assessed in groups; with mark schemes or with teacher guidance.	Provides an opportunity to promote learning goals. Promotes giving of specific strategy feedback which encourages learner autonomy.	Focus on mastery of topics, not performance. Reinforces internal locus of control. Required to engage in strategy feedback to understand how they did.
Students complete a self-assessment sheet which lists the learning goals for each question part. They record whether they made a 'silly mistake'; can 'revise themselves' or 'need help' for each deficient area.	Provides opportunity to re-train attributions to internal, unstable traits. Places control over improvement in hands of students. Allows teacher to reassure students that mistakes are seen as opportunities for learning not negative judgements on the student.	Attribution of deficiency in respect to learning goal directed inwards and in their control but attributed to a malleable trait.
In the next lesson, students receive a feedback sheet with red, amber, green indicators next to each learning goal covered in the assessment. This is kept and used for focussing revision and informing teacher planning.	Generates authentic discussion of why normative comparisons are unhelpful and how better strategies can lead to improvement – indirectly promotes growth mindset.	No grades or levels for normative comparison – supressing performance goals.

3.4 Ethical consideration

The CUREC 1A ethical approval checklist was used to identify potential ethical issues and to detail the steps taken to address them, and was subsequently approved by the university ethics committee. Issues were the introduction of atypical practice on a group of students; participant students and teachers unaware of the nature of the research and therefore unable to make an informed decision about withdrawing; data collected being used in a judgemental way. These issues were addressed as follows.

I acquired head teacher consent (Appendix 1). Pupils were not subject to any research processes that went beyond usual practice, for instance, out of curriculum time, (Appendix 3), and students orally consented, given guarantees of opt out opportunities, anonymity,

coded naming of responses and no effect on grouping (Appendix 3). Arrangements were made for hard copy security. Issues and methods implemented as part of my research would be in line with my job description, requiring innovation and student voice consultation.

The teacher colleagues involved are an experienced (20+ years) part time teacher and a newly qualified teacher. They each volunteered their participation and were free to use as many of the strategies discussed as they wished. It is common for us to discuss teaching and learning strategies. Observations noted by me for this project were not recorded on the school database so formed no part of those teachers' professional development record. Teachers were shown the questionnaire (Appendix 3) before it was issued to their students. None of the questions on the questionnaire invite comment on the teacher themselves or their practice. In the second round of student data collection the students were asked to write on the back of their questionnaires, anything they thought their teacher had done to promote a growth mindset. They were informed that their teacher would be able to read what they had written and that it was acceptable to leave this blank if they couldn't think of anything. The teachers were given access to the results of their students' questionnaires.

Teachers involved were shown any written analysis of my interviews with them (questions in Appendix 4) and were free to withdraw their input if they chose to. The right to teacher approval of all forms of response was given. All hard copies of responses were secured and would be destroyed at the end of the research period.

All data will be processed on a password protected, school owned laptop. The final project will be saved as a pdf file for submission on the secure University website. The same pdf format will be available to the Headteacher and Deputy Headteacher of the school. The two teachers involved are anonymous, as are the students, in the final written project.

3.5 Data collection

3.5.1 Student interpretation 1: Questionnaire

Paper copies of the questionnaires (Appendix 3) were given to the students in both classes by me within the same lesson. The oral consent script (Appendix 2) was read to the students and they were invited to ask questions. No one asked a question from either class and they completed the questionnaires without discussion with their peers. No students were absent from 9M1 (n=30). One student was absent from 9M2 and they were not included in the study (n=29).

The results were collated and responses coded. These codes were written on the hard copies of the questionnaires so that they second responses could be related to the first.

The numerical values from the Likert scales in questions 1 and 6 were recorded for each part. The positions indicated on the confidence measure scales beneath questions 2, 3 and 4 were translated into numbers 1 to 6 from 1 being ' "very true for me" on the low confidence option' to 6 being '"very true for me" on the high confidence option' (Dweck, 1999: 182).

The data validation facility in Excel was used to make sure the choices from option lists in questions 2, 3, 4, 5 and 6d were recorded accurately. The descriptions of intelligence were typed in verbatim and the percentage shares between effort and ability were recorded as numbers.

Additional columns were then added for analysis. These included columns headed Entity/Incremental average where the mean value from question 1a, b and c was calculated and Entity/Incremental from scores. The latter was populated with the word 'entity' if the average score was less than or equal to 3; 'incremental' if the score was greater than or equal to 4 and 'not sure' if the score was between 3 and 4. This follows the description of how Dweck et al. (1995) measured implicit theories of intelligence.

A similar process was used to determine confidence and goal orientation. Average scores from the 1-6 ratings on questions 2, 3 and 4 were used to define confidence. Scores of 3 and below were then categorised as 'not confident'; 4 and above as 'confident' and those in between as 'not sure'.

The responses to question 6a, b, c and d equated to a performance goal (if average was less than or equal to 3) or a learning goal (greater than or equal to 4). In this case the response to part c had to be reversed. If the response to part d was 'good mark' then a score of 5 was allocated and a response of 'being challenged' was allocated a score of 2. Four students indicated a response between the two options and these were allocated a score of 3.5.

Responses to question 5 were related to goal orientation as described earlier with options 1 and 3 revealing performance avoidance goals; option 4 showing performance approach goals and option 2 reflecting learning goals.

The correlation between responses to each pairing of the three entity items in question 1 were calculated using the Pearson function in Excel. Similarly correlation coefficients between the goal orientation items were calculated. The qualitative data was collated using pivot tables and chi-squared tests were used to look for associations between combinations of implicit theories of intelligence; confidence; goal orientation (dichotomy); goal orientation (trichotomy) and proportions of intelligence attributed to effort versus ability.

The quantitative data was coded as described in chapter 4.

3.5.2 Student interpretation 2: Revisiting the questionnaires

In light of the revision to my design frame, the second issue of the questionnaires was conducted in a different way. Rather than give out fresh questionnaires to be used as a second measure of mindset and goal orientation, students in both classes were asked to review and then expand on their initial responses. As before the questionnaires were returned to each class within one of their timetabled lessons by me. Revisions were made in

purple pen. They were asked to annotate any alterations with reasons for the change and to give some explanation to back up their original answers if they had not changed their minds. I reminded them of the features of the student consent form. They were briefly reminded that the year group had had an assembly and 'tutor time' on the topic. They were then invited to freely write on the back blank page any thoughts they had about growth mindsets and anything they thought their maths teacher had done to promote a growth mindset. NQT was not present when I reissued the questionnaires to her class but I explained to the students that she might see anything they wrote. Several of the students in 9M2 scribbled out their names so that their scripts were unidentifiable. Two students from each class were absent when the questionnaires were returned and they were invited to annotate their questionnaires in their next lessons. Their responses were included in the data.

The adjusted questionnaire responses were recorded in Excel exactly as the initial responses had been. The same statistics were calculated. However, it is not possible to attribute any differences in the quantitative data to the feedback intervention, due to uncertainty regarding exposure to growth mindset messages elsewhere in the school. Consequently, only the qualitative annotations to the questionnaires are analysed and discussed this time.

3.5.3 Colleague interpretation: Informal discussions and internet interviews

Discussions with colleagues clarified my own thoughts on intelligence and highlighted issues they might have in using mindset strategies.

Teacher interviews were conducted through email exchanges because of the pressure on free time in school for teachers. This pressure is amplified for ET, a part time teacher with a young family. Gathering responses through email has the benefit of allowing teachers time for reflection and so 'the quality of their answers might be improved as a result of them having time to think through the issues.' Denscombe (2007: 188). It also saves the time that transcribing verbal responses would have taken and ensures that the teachers' views are

exactly as they chose to represent them. The original interview prompts were expanded upon in an email (Appendix 5) to the teachers as a result of reflections on the informal discussions we had regarding growth mindsets. The teachers' full email responses are included in Appendix 6.

3.5.4 Student interpretation 3: Interviews of four case study students

As is consistent with Cohen et al.'s (2007) description of how to choose a case study the students to be interviewed were selected because of the significance of their questionnaire responses and classroom interactions. The evidence that led to my choice of the four students interviewed is given in Chapter 4. They represented particular cases of students whose questionnaire responses conflicted with the literature on mindsets and goal orientation.

The strengths listed by Cohen et al. (2007: 256), sourced from Nisbet and Watt (1984) of case study suit my exploration of how the growth mindset strategies have been interpreted. These include: ease of understanding; capture of unique features key to understanding the situation; ability to be undertaken by me alone; accommodation of the 'unanticipated events and uncontrolled variables' the whole school intervention introduced and the provision of 'insights into other, similar situations'. Although the weaknesses listed also apply, chances of bias are minimised by the purpose of the interviews. I am not seeking to find evidence to make any particular point; I want to explore their understanding of the situation. The potential for experimenter effects 'leading' participants to say what they think I want to hear exists, but I was careful to appear unsure of my own opinion and to query all their comments until their position was clear. The question of generalisability is a common criticism of case study but Bassey (1981:85) concludes that if the details of the case study are communicated well enough for readers in similar situations to relate to, then the 'relatability of a case study is more important than its generalisability'. The details of the

interviews with these particular students should help with the interpretation of similar cases.

The interviews were unstructured (two person), mini- focus groups. One to one interviews or larger group interviews would have been intimidating and restrictive of follow up questioning. Interviews started with students re-reading responses as a stimulus. In my role as what Denscombe (2007) describes as a 'moderator' I then asked them to explain more about specific comments they had made on the questionnaires. I invited them to agree or disagree with each other's remarks, and to give examples to clarify the points they made.

My own familiarity with the participants served to put them at their ease and since they were used to my giving credence to their views in lessons, they were happy to participate in the interviews. The four selected students were interviewed during lesson times in a quiet classroom, in pairs to stimulate discussion, and given the option to decline the interview. Interview lasted 15 minutes. They agreed to be recorded and it was made clear to them that no-one but me would listen to the recordings and that the recordings were only made to prompt my memory of what they had said. Relevant extracts from the recordings are discussed in Chapter 4 and are reported with names coded. Details of the participant's questionnaire responses are given. Of course this creates a risk of experimenter-expectation bias in the selection and transcription of quotes but as mentioned earlier, the data is being used to lend understanding to a perspective, not to prove a point.

Chapter 4: Findings, analysis and discussion

The findings from each delivery of the questionnaires; the teacher discussions and interviews and the student interviews are discussed in chronological order. Analysis and discussion relate to the remaining three research questions.

RQ2: How do previously high attaining students' mindsets in a UK secondary school situate with research literature?

RQ3: How is teaching practice affected by scaling strategies to promote "growth" mindsets?

RQ4: Are student perspectives on mindsets affected by scaling strategies to promote "growth" mindsets?

4.1 Student interpretation 1: Questionnaire

This first round of data collection addresses the second research question RQ2: How do previously high attaining students' mindsets in a UK secondary school situate with research literature?

The data is considered in light of three key themes in the theory of mindsets. Firstly, are the proportions of students with a particular mindset the same in these previously high attaining groups? Secondly, are there associations between mindsets and goal orientation; between mindsets and confidence in one's intelligence and between mindsets and the ratio of effort to ability as factors of intelligence? Finally, how do different mindsets affect the traits attributed to intelligence? These comparisons will highlight any differences in the sampled students and those involved in previous research studies. This will inform the applicability of mindset changing strategies.

4.1.1 Proportions of students with growth mindsets

There was a strong correlation between items measuring implicit theories of intelligence (Parts a and b: r=0.85; a and c: r= 0.73 and b and c: r=0.76) suggesting that it is valid to average the three results to indicate the theory held by each student. Dweck (1999) suggests that 15%-20% of students do not identify as having either entity or incremental theories of intelligence. The rest are divided equally between the two mindsets. These proportions are independent of prior attainment. The questionnaires showed that of the 59 students involved, 53% of had an incremental view of intelligence; 30% had an entity view of intelligence and 17% were not sure. The 15-20% unsure overall fits the theory well. The slightly higher proportion with incremental mindsets could be an indication of the benefits of a growth mindset – students with fixed mindsets are likely to have coped less well with

the increase in challenge of secondary school maths and so not 'made it' into the top two sets. There is not sufficient evidence to claim that this is the case, however an interesting future project could gather evidence from top sets in other year groups and would have implications for the way we nurture top set students at transition from primary to secondary school.

Of the 30 students in the top set the proportions were 50% incremental; 40% entity and 10% not sure. In the second set the proportions were 55% incremental; 21% entity and 24% not sure. The way in which the groups were made offers an explanation for the higher number of incremental theorists in the second set. The groups were taken from two parallel top sets in year 8. Teachers of those groups decided (based on end of year assessments but not entirely) which students went into the top set and which into the second. The teachers' conceptions of intelligence as a measure of potential inevitably affected their decisions. It seems likely that students who were perceived to have put a lot of effort into their attainment would be placed in the second set whereas those who had apparently effortlessly attained the same level of attainment would be put into the top set. Those students who continue with effortless success at the ones at risk of adapting poorly to the more demanding situation they will be placed in. This could explain the higher proportions of fixed mindset students in the top set compared to the second set. It also supports the idea that teacher perceptions of intelligence need to be explored.

4.1.2 Factors associated with mindsets

Goal orientations

Dweck's research suggests that there is a strong association between implicit theories of intelligence and goal orientations. Those with fixed mindsets are likely to have performance goals and those with growth mindsets are likely to have learning goals. The goal orientation dichotomy is enlarged to a trichotomy by Elliot (1999) through the differentiation of performance goals into performance approach or avoidance goals. Chi squared statistics

were calculated to test for association from contingency tables comparing mindset (incremental, entity or not sure) with goal orientation. When the dichotomy of goals (performance versus learning) was used (from the responses to question 6) the results showed that the probability that the observed data was down to chance was only 1%. This confirms the strong association between mindsets and goal orientations found in the literature (Dweck and Leggett, 1998; Dweck, 1999). More students with incremental theories of intelligence had learning goals and more entity theorists had performance goals than would be expected if there was no association. However when the trichotomy (learning versus performance avoidance or performance avoidance) was used to categorise the goal orientations (using their responses to question 5) the chi squared test suggested that there was a 45% chance that the distributions were down to chance. In fact the results from question 5 showed a higher proportion of students with learning goals (63%) than question 6 suggested (56%). When the numbers attributed performance approach and avoidance goals in question 5 were combined a chi squared test gave a 91% chance of the results being due to chance. Questions 5 and 6 have given very different indications of the association between mindsets and goal orientations. This is something can hopefully be illuminated in the next round of data collection.

Confidence measures

Unsurprisingly 71% of the sample (n=59) rate as 'confident' when their answers to questions 2, 3 and 4 were coded as described in chapter 3. In the top set this figure was 83% and in the second set 59% which is also unsurprising. A chi-squared test for association between mindset and confidence gave the chance of the observed outcomes being purely down to chance a probability of 19%. There is no significant evidence that confidence and mindset are associated. This confirms the findings in the literature and suggests that the higher than commonly found proportion of incremental theorists in the sample is not a result of higher confidence levels. The difference in confidence levels between the sets is likely to be the result of the setting itself. The majority of the sampled students have high expectancy of

success but the proportion indicating performance avoidance goals is not significantly associated with their confidence (chi squared statistic between confidence and two types of performance goal suggests 41% of variance due to chance). This anomaly with Elliot's (1999) research needs further clarification and is likely to be related to the students' interpretation of the statements in question 5. The student interviews may clarify these results.

Contribution of 'effort' as a factor of intelligence

The measurement of implicit theories requires students to respond to statements about intelligence. Of course what students mean by intelligence significantly affects their responses and Dweck (1999) found that entity and incremental theorists disagree about what intelligence is. Mueller and Dweck (1997) found that when they asked college students to define intelligence entity theorists 'ruled out effort…as part of intelligence or as something that enhances intelligence' Dweck (1999: 61). As well as the analysis of the open response to the invitation to define intelligence my questionnaire replicated the equation Mueller and Dweck (1997) asked students to complete:

Intelligence = _____% effort + _____% ability

In their study Mueller and Dweck (1997) found that incremental theorists put more weight on effort (65%) than ability (35%) and the reverse was true for entity theorists. The results from the first data collection of my questionnaire show that the mean weights entity theorists allocated were 36% on effort and 64% on ability. The incremental theorists shared intelligence as mean weights of 61% on effort and 39% on ability. These results almost exactly match those in Mueller and Dweck's study. If students who attribute 50% or more of intelligence to effort are labelled as incremental theorists and those who attribute more than 50% to ability are labelled as entity theorists, a very strong association is found between this measure of implicit theories and that measures from the items in question 1 (0.1% of the association is likely to be the result of chance). These results provide quite strong evidence that strategies to alter mindsets will need to address conceptions of what

intelligence actually *is* as well as how malleable it is. As is consistent with the interpretivist approach of this study, I returned to the literature.

Dweck (1999: 3) defines people who hold an incremental theory of intelligence and states:

> It's not that people holding this theory deny that there are differences among people in how much they know or in how quickly they master things at present. It's just that they focus on the idea that everyone, with effort and guidance can increase their intellectual abilities.

Blackwell et al. (2007: 247) points out that:

> It is important to recognize that believing intelligence to be malleable does not imply that everyone has exactly the same potential in every domain, or will learn everything with equal ease. Rather, it means that for any given individual, intellectual ability can always be further developed.

This challenge to my own conceptions of intelligence led me to the literature review that was included as section 2.4 in Chapter 2. As a result of this review, the quantitative responses in the questionnaires that define intelligence were coded according to factors that intelligence might include. The variance between factors mentioned by students holding different theories of the malleability of intelligence was analysed.

4.1.3 Factors involved in intelligence

As well as the weight attributed to effort as a factor of intelligence there is a significant difference between incremental and entity theorist's definitions of what intelligence actually is. When Mueller and Dweck (1997: 61) asked college students and 'fifth graders' to define intelligence entity theorists told them 'that intelligence is simply about smartness or IQ' but incremental theorists 'put the emphasis on knowledge and effort'. The codes relate to factors of intelligence identified by considering the qualitative responses to question 7 and spotting recursive patterns (Denscombe, 2007). The criteria for deciding on the allocation of codes are given in Table 4.1. This is followed by Table 4.2. which gives a selection of responses that exemplify the coding process.

Table 4.1: Criteria for coding responses to question 7

Processing	Some reference to doing something with one's knowledge; rate of acquiring skills; understanding; application of one's knowledge.
Knowledge	Some reference to quantity or breadth of knowledge or memory.
Practical	Some reference to practical, 'non-academic' skills
Innate	Some reference to innate, genetically endowed ability
Effort	Some reference to effort
Engagement	Some reference to the nature of engagement – agentic engagement (self-regulation); persistence (grit); attention; good behaviour; learning strategies; self-awareness (Reeve, 2014)

Table 4.2: Examples of coded responses to question 7

Response	Codes allocated
I would say intelligence is the way people or a person grasps different concepts and how easily they find it to understand separate topics. It is mainly inherited but can be enhanced through hard work and the right backing.	Processing; Innate; Effort
Intelligence is like making something like a chair. You put in a lot of effort and soon you learn and have the general ability. Therefore I believe intelligence is about 80% effort, 15% patients (sic) and 5% ability.	Practical; Effort; Engagement
Intelligence is the stuff you have learnt in life. Intelligence is the human's capability to learn	Knowledge; Processing
Intelligence is not only being naturally smart but also being open to the idea of learning. However, I also think it is having a good mindset and being committed to wanting to learn	Innate; Engagement
I would describe intelligence as not only something you are born with but I think you can work really hard to almost "gain" intelligence. So in a way everyone has a fair chance because "she" might naturally be intelligent but can't be bothered to work hard so loses it whereas "he" might be born not very intelligent but works really hard and always concentrates so is passed as intelligent.	Innate; Effort
Intelligence is when you use resources to work your brain to gather information. So eventually you can get better at it.	Knowledge
Intelligence is how much you know. This could be maths or art. Being intelligent would take more effort than ability I think and so that is why students in higher classes seem to pay more attention.	Knowledge; Effort; Engagement
Intelligence is quite a lot of things such as how much you know, how quickly you learn and how logical you are. If you get good grades and you don't also have to try too hard. Some people don't need to try to be intelligent and others have to try really hard to be intelligent.	Processing ; Knowledge; Innate; Effort

It was possible to code all the responses using the factors identified. The proportions of students with a particular mindset who mentioned a particular factor are given in Table 4.3.

Table 4.3 Factors of intelligence referred to by different theorists of intelligence

	Entity theorists	Incremental theorists	Not sure	Whole sample
Processing	89%	48%	80%	66%
Knowledge	22%	39%	50%	36%
Practical	6%	10%	10%	8%
Innate	11%	29%	30%	24%
Effort	17%	52%	30%	37%
Engagement	11%	35%	30%	27%

The proportions of incremental theorists citing knowledge, effort and engagement are all higher than the proportions of entity theorists as expected from the Mueller and Dweck (1997) research. As expected a relatively high proportion of entity theorists commented on the processing aspects of intelligence and yet a fairly low proportion mentioned the fact that intelligence was an innate trait (only 2 out of 18). The high number of incremental theorists describing innate features of intelligence and the low number commenting on knowledge does not fit with the findings of Mueller and Dweck. This is another area to clarify through revisiting the questionnaires and student interviews.

4.2 Student interpretation 2: Revisiting the questionnaires

The comments students added to their questionnaires explain the previous findings that conflicted with the literature on growth mindsets and goal orientations. They also illuminate the students' feelings about perceived growth mindset interventions.

Several students, whose question 5 response suggested performance avoidance goals, explained that they would choose easier questions when practising or revising but harder questions to challenge themselves.

> I would choose a mix, challenging like when we did 3D trigonometry to push myself but more simple for revision.
>
> It depends if I am revising or going over things so that I can practise however sometimes I am confident with what I know then I will challenge myself to learn something new.

> I want to challenge myself but sometimes I don't know enough about the topic yet so I have to practice the easy ones but if they are too easy I'll go onto harder ones.

These students (and 8 others with similar comments) have an awareness of how to develop their understanding and all scored as incremental theorists on question 1. This explains the lack of association between incremental theories and goal orientation.

Many of the students whose responses to the goal orientation items in question 6 suggested performance goals explained that 'the best grades' would help them get a job or get into university.

> When you are at a job interview they look at grades.
>
> I want a good mark, that's what gets you the job.
>
> Although I need to learn things I like to get good grades as this proves my level of intelligence.
>
> The mark is the only thing you need to use in day to day life.

These comments reflect Dweck's (1999) theory that students can sometimes hold both performance and learning goals. The utility value of the grades as passports to future learning opportunities could actually comprise a learning goal but will have been scored as a performance goal. This adds further evidence to suggest that the lack of association between incremental theories and goal orientation was not a generalisable result.

31 of the 59 of students added comments to their questionnaires that recognised our efforts to promote learning goals and the malleability of intelligence and to reduce normative comparisons. This suggests that our 'stealthy' approach was successful. A few typical examples are given below.

> She uses the egg diagram to try and get us to challenge ourselves and not give up.
>
> Miss NQT does often say that she believes that we can do the hard stuff if we try. If someone says to her that they can't do it, she says that she can help them and that they can't do it yet!

> You tell us what we need to improve on after tests rather than telling us our percentage so that we know what we need to work on.
>
> Instead of just marking a test she gives it back and makes you mark it to learn from it…she gives you a choice of what to work on so you can stretch yourself which is different from other teachers who just tell you what they want you to do and you do it.
>
> You allow us to do harder work. Also you do not constantly give praise for small things. This is good!!! Other teachers give rewards and praise for things we just know. This is bad!!!
>
> You do not tell us our mark after a test which I guess is so that we don't compare ourselves to others and so we focus on how to improve.

8 of the 59 students were quite negative about 'growth' mindset. The negative comments of four of these students come from perceived threats to their autonomy. Each comment is accompanied by the average score on the entity questionnaire items and resulting mindset.

> I don't really see the point in having different mindsets because I haven't changed my opinion. I think the school should try and teach rather than yelling 'GROWTH MINDSET' all the time. I don't think it's important. (5 = incremental)
>
> The school hasn't changed my mind about this topic in any way and my answers work for me personally so no one could change that. (2.7 = entity)
>
> School needs to stop forcing the growth mindset thing on us, it's so depressing to be repeatedly told how you think is wrong, stop with the growth mindset buzzwords. (2.3 = entity)
>
> I think having a growth mindset is important but constantly going on about it and making the focus of everything about growth mindset is stupid. Not giving us the marks to a test does not stop us wanting the marks. (3 = entity)

The proportion of students who felt so negative about the growth mindset message suggests that stealthy methods are important, particularly when it requires a change of mind. A whole school approach may come across as heavy handed, provoking these negative reactions (Yeager and Walton, 2011).

The other four students were chosen for interview because, alongside their resistance to the growth mindset message, their responses suggested potential illumination of the questions arising from the analysis.

4.3 Colleague interpretation: informal discussions and internet interviews

This ongoing data collection addresses the third research question RQ3: How is teaching practice affected by scaling strategies to promote "growth" mindsets?

It was hoped that the introduction of formative, comment only assessment would combine three 'stealthy' strategies for promoting growth mindsets and avoiding promoting fixed mindsets. Firstly, it would encourage explicit teaching of agentic engagement that promotes a growth mindset and supports autonomy. Secondly, it would provide a barrier to the entrenching of fixed mindsets or performance goals. Thirdly, it would reveal teacher conceptions of intelligence which I believe are key to the effective delivery of mindset interventions.

I will refer to the email responses from NQT and ET (Appendix 6) as evidence to support the claim that the use of comment only feedback could be a successful strategy for promoting growth mindsets. The two teachers involved represent extremes of the continuum of experience of growth mindset promotion that exists in my school.

In her email response NQT refers to traits in the students she teaches which she views as negative and which are typical of entity theorists. She indirectly mentions performance approach goals; normative comparisons; complacency; performance avoidance goals; helplessness; risk aversion and the fixed nature of intelligence. She evidently thinks it more positive that these traits are changing to those typical of incremental theorists: learning goals; internal, controllable attributions for success; attitude to challenge; resilience following failure and a malleable view of intelligence.

ET relates growth mindset to 'advice about good ways to study'. Her 'tacit knowledge' developed over years of teaching emphasises the need for specific strategic feedback without considering the beliefs of those who respond to this feedback and those who do not.

It is clear from the responses of the two teachers that NQT has more of an understanding of

the theory of implicit views of intelligence. This is by no means a criticism of ET. As a form tutor, NQT delivered the twenty minute mindset intervention that explicitly taught the malleability of intelligence, whereas ET did not. NQT was in meetings where the rationale for not giving grades on assessments was given and we have had several conversations about the behaviour of students in her year 9 class in which I have referred to the theory. My point is that even with the difference in knowledge of the theory of implicit theories of intelligence, this 'expert' teacher uses many of the strategies that promote learning goals and address performance avoidance goals.

4.2.1 Promoting a growth mindset

Both NQT and ET described practice that has arisen from the use of comment only feedback. ET refers to encouraging agentic engagement (student initiated activity during the learning process that can include asking questions, expressing preferences, letting the teacher know what they need (Reeve, 2013)). For example, ET describes a conversation with a girl who revised without focussing on topics she found difficult. ET used the feedback sheets to prompt the girl to focus future revision on topics that she wasn't happy with. ET also mentions that the feedback sheets give students 'information they need to be able to identify which topics need to be revisited'.

NQT explains how she has retrained attributions for success or failure to internal, controllable traits or external circumstances respectively. For example, NQT attributes struggle to the difficulty of new topics through conversations 'about how trigonometry and quadratics are challenging, but they are just beginning to work on them and so everything feels a lot more like a work in progress.' She explains how she has encouraged students not to compare with others but to their previous selves, highlighting the malleability of intelligence.

Both teachers have used the comment only feedback as a tool to promote growth mindsets via learning goals.

4.2.2 Avoiding promoting fixed mindsets

The introduction of comment only feedback was designed to offer opportunities for teachers to promote learning goals and to retrain attributions for success or failure. Similarly the use of non-ego-involving praise gives opportunities to attribute success to better strategy.

NQT refers to the self-improvement students notice by 'seeing a lot more "greens"' compared to the normative comparisons they had made when she had reported levels. She noted that the students 'seem to be more interested in their improvement vs. where they were in the class.' When considering the effect on her year 10 class, NQT points out that 'there was definitely a sense of complacency' when the class were given a grade and that once this was removed they look 'at the maths they don't yet fully understand, instead of relaxing because they got over 90%.' This suggests that the performance approach goals previously held by these students are being turned to learning goals.

When considering her use of praise NQT recognises the difficulty she had not using ego-involving language but acknowledges the fact that avoiding traditional forms of praise provides an opportunity to give more specific verbal feedback. It has meant that she can reassure students when 'the majority of the work is correct, they just made a small error so got the final answer incorrect.'

Reacting to students who struggle, NQT describes a temptation to offer 'comfort-oriented feedback' (Rattan et al., 2012) but describes that her verbal feedback 'is less about the answer they gave and more about the way they got there' which is actually strategy feedback. She goes on to explain that 'a correct and incorrect answer usually get a similar level of response.' This prevents normative comparisons and attributes success to good strategy rather than innate intelligence. Similarly, ET mentions that she has 'tried this year to praise effort… e.g. "you have shown your working out really clearly there"'. The example chosen actually gives specific process feedback so might not be considered 'praise' in the traditional sense. This suggests that as an 'expert' teacher ET uses 'praise' to mean positive

feedback and not necessarily to be ego-involving at all (Stobart, 2014). This is not typical of the way most teachers use praise (Brophy, 1981).

It appears that each teacher is using the comment only feedback in a way that will reinforce the overt growth mindset messages students have received from the whole school assemblies and tutor programme. Additionally, they are avoiding practice that might inadvertently foster fixed mindsets by giving strategy feedback and attributing success to good strategy, not intelligence.

Informal conversations I had with ET and NQT about the results of the first round of students questionnaires led me to believe the two teachers had different views about what intelligence is and my own views were also challenged. The next section is a discussion of these teachers' definitions of intelligence and my own conception of intelligence as developed through my conversations with my colleagues.

4.2.3 Teacher conceptions of intelligence and effort

NQT defines intelligence as

> the ability to apply yourself to different things, (as well as being strong academically) to be able to adapt a tool/skill you already know to do something different … not [to be] put off by the challenging questions which aren't just more examples of the work I have already shown ... being aware of what you don't already know.

I think this definition fits that typical of an incremental theorist which explains the thorough understanding of the features of a growth mindset demonstrated in the rest of NQT's response.

ET defines intelligence as 'the ability to absorb ideas and link them at speed to prior knowledge'. She implies the innate nature of this speed by saying that 'a baby or young child could be very "bright", referring to the impression that they give of being alert, absorbing what is happening around them and the speed of their responses'. The implication that prior knowledge is a feature of intelligence suggests an element of growth is possible. This would increase the pool of knowledge available to draw from but not necessarily the speed at

which the ideas can be linked. As were several student definitions of intelligence, this definition would be coded as 'Processing and knowledge'. In light of definitions such as these, Dweck's distinction between the beliefs entity and incremental theorists hold about what intelligence *is*, appears to be overly simplistic. She suggests the entity theorists believe intelligence is an innate capacity whereas incremental theorists 'define it more in terms of what you know, what you can do, and how hard you try' (Dweck, 1999: 62). The suggestion here is that there is an innate component to intelligence (that relates to processing skills) and also one that is the result of effort (what you know). Remembering that what matters is the consequent belief in the malleability of intelligence, these beliefs could suggest a limit to learning (Hart,2004) unless we believe (and convey to students) that the processing skills can be developed.

It is clear from the student questionnaires that a belief in innate intelligence is common. Prompted by the assertion from the 'youcubed' team that 'there is no such thing as a math brain' (www.youcubed.org) I began to question my own view of intelligence. Perhaps I am misunderstanding them but it seems clear to me that some students' *do* progress in maths 'more easily' than others and *do* have a maths brain. That does not mean that I don't believe others can acquire the same processing skills and knowledge, just that it will be more difficult for some. Dweck (1999:154) acknowledges that genes may 'make it easier for some to learn adaptive skills' but that everyone can learn these skills. High prior attainment is inevitably a result of previous experiences from genetic contributions onwards. Whilst genetic and environmental factors may have led to prior attainment, continuing with or developing successful learning strategies is necessary for future attainment. Essentially this is about improving processing ability not just adding knowledge. The understanding that processing ability can be improved is important for teachers to believe and to convey to students so that there is no perceived limit to their learning.

It is unhelpful and inaccurate for students or teachers to attribute prior attainment solely to

innate traits. Unfortunately, many previously high attaining students maintain success in school without too much effort, reinforcing the view that innate traits will be enough. When they do then meet with challenge they have not developed adaptive responses and respond negatively.

Following the first data analysis I realised that pupil conceptions of what effort actually is affects their beliefs about intelligence. Several students implied that intelligent people do not have to make effort. Mueller and Dweck (1997) also found that college students rated an effortless, previously high attainer as more intelligent that a diligent one, even though the diligent student was now performing better. I discussed these students' responses with NQT who said that she had "not really had to try in school". I asked if she had behaved well, engaged in the lessons, persevered with challenging problems, done homework. She had and she recognised that this was effort but would not appear so to others. Further investigation was needed into what students actually consider to be effort. This led to my choice of F13 and F21 as case study students to be interviewed.

4.4 Student interpretation 3: Interviews of four case study students

The four students chosen for interview each added some comments to their questionnaires that indicate a resistance to the growth mindset message. Their responses also suggested that further discussion would illuminate some of the issues found in the questionnaire analysis. Tables 4.4.1 and 4.4.2 summarise their initial questionnaire responses.

Table 4.4.1 Summary of questionnaire responses for F20 and F21

Initial Questionnaire	F20	F21
Qu1 Average& mindset	4 = incremental	2.3 = entity
Confidence average	4 = confident	4.3 = confident
Qu5 Goal orientation	Performance avoidance	Performance approach
Qu6 Goal orientation	2.75 = Performance	3 = Performance
Definition of intelligence	Intelligence is your level of cleverness and how able you are at certain things. I feel it is hard to change your basic intelligence but it is possible to learn more things.	Intelligence is a measurement of your brain power combined with your effort.
Coding	Processing; innate; knowledge	Processing; effort
Effort: ability weighting	60:40	10:90

For each student pair in turn I will quote the comments they added to their questionnaires when they were returned in May. I will then explain what I learnt from discussing their questionnaires with them.

F20 and F21

> Growth mindset sounds like a good thing but what we have been taught doesn't seem like what should be going on. Rather than focus on the good things you've done people need to focus on the bad. (F20)
>
> I've not been doing well lately. (F20)
>
> My friends in set 4/5 are dumb and always have been even though they try hard. (F21)
>
> I revised well for my test but didn't do well. I could read a maths encyclopaedia and not be as clever as M. I revised more and still M beat me. M admitted not revising. (F21)
>
> My life motto is "enjoy life" a growth mindset means you can't do this. A growth mindset means you have a negative look on what you did for example in a test you focus on the red subjects. (F21)

F20 felt that the mindset message was really just an encouraging pep talk and what he meant by 'focus on the bad' was that teachers should find out what students can't do and work with them on that. F21 disagreed and said that the 'reds' on the feedback sheet made him feel bad. They debated this and in the end F21 agreed that he did need to know about the topics he couldn't do but maybe only a manageable few at a time. His description suggests a performance avoidance goal but his questionnaire response, a performance approach goal. I believe the difference comes from the wording of the questions. The questions contributing to the 'confidence' measure refer to intelligence and these students believe this to be an innate trait which they possess. Both boys are confident in their ability, they consider themselves 'clever' but both feel that they are not doing well at the moment in tests. F21 judges this by comparing to M (the highest attaining student in the class) whereas F20 judges this by his own lack of confidence on the current work. The goal orientation measure refers to tasks they currently work on and F21 wants to protect his

intelligent image by showing he is clever. Since he is finding the work challenging, this means he would need easier tasks. He doesn't want to think about the 'reds'. This actually equates to a performance avoidance goal. F20 wants easy questions that he can get right but he knows this is not good for him, he knows he needs to 'focus on the bad'.

Interviewing these boys makes it clear that previously high attaining students need careful attention when they finally face challenging tasks but in subtly different ways. The questionnaire did not uncover this but talking to them about the colour coded feedback they received did. What they want and what they need is not necessarily the same thing. The balance between challenge and confidence is a fine line and depends on a strong relationship and dialogue. The comment only feedback procedure is good tool for prompting such dialogue.

Table 4.4.2 Summary of questionnaire responses for F13 and F16

Initial Questionnaire	F13	F16
Qu1 Average& mindset	5.7 = incremental	3.7 = not sure
Confidence average	3.3 = not sure	2.3 = not confident
Qu5 Goal orientation	Performance approach	Performance avoidance
Qu6 Goal orientation	3 = Performance	3.625 = Learning
Definition of intelligence	Being intelligent means you often get better grades than your peers and also showing good judgements yet also being correct for the majority of the time. I do not think it is about effort as someone may give 100% in their effort but not be very clever. As some people are naturally intelligent. Getting bad grades but putting lots of effort in doesn't make you clever or intelligent.	How smart you are, how much you can know and can do (not exactly physical), you should probably ask someone else.
Coding	Innate	Processing
Effort: ability weighting	0: 100	50:50

F13 and F16

> I think the growth mindset thing is stupid and annoying and we should just accept that there is always going to be someone better than you at something and someone worse than you, unless you get a gold medal in the Olympics or whatever. It is just one of those cheesy things schools say like 'it's the taking part that counts' which is just ridiculous. Plus in the future if my peers get higher levels in GCSEs or A levels they aren't going to be jealous that I 'learnt' more than them from that experience. (F13)

> I do not understand what a growth mindset is – 100% clueless. I'm bottom of 90% of set classes and because teachers push us a lot I don't feel very smart y'know. School isn't positive enough however. Its just GCSEs!!! GCSEs!!! IF YOU DON'T FOCUS YOU WILL NEVER GET ANYWHERE!!!!!! I do focus and stuff, but I'm 14 and there's so much homework and pressure and UGH school makes me feel like everything sucks. Sorry about that, this is a tangent, got in the zone. Positive mindset would be super cool. Thank you for all the stuff though. (F16)

F13 was clearly frustrated by the suggestion that everyone can achieve equally highly. She described students she views as 'cleverer' as not needing to make any effort and still understanding straight away. When I suggested that these students do make effort she agreed that they 'behave and everything' in lessons but that it was still unfair because her effort did not result in the same attainment. F13's questionnaire responses are self-contradictory and I believe it is her conception of what effort actually is that can explain this. She disagreed with all three entity items but proportioned intelligence as 0% effort + 100% ability. She explained that she had disagreed with the entity items because 'you can get better than other people'. For F13, intelligence is very much about normative comparisons. F13 equates time spent and feeling 'stuck' with effort. Learning requires time and overcoming challenge but the quiet students persevering with their work are not visibly striving so effort does not appear to be a factor in their success. I realised that I need to make more reference to the successful strategies that have led to high attainment whilst acknowledging that given their age 'catching up' to the highest attainers might not happen for a while. Steering F13 away from normative comparisons and giving her honest strategic feedback should reconcile her frustration.

F16 agreed with F13 about the 'clever' students in the class and introduced the idea of belonging. Her additional comments point to the stress she is feeling because of the high expectations on her. All her comments suggest that her autonomy is threatened but she still maintains learning goals. Her confidence is affected by normative comparisons but her actions are not. Of all the students in the class F16 is the most self- regulatory. She always

comes to catch-up from missed lessons or to ask about HW. The strategy of providing honest, strategic feedback that recognises her effort should not only boost her confidence but will also clarify for others (such as F13) what useful effort actually looks like.

These interviews have further illuminated the benefits of the 'stealthy' approach to promoting growth mindsets and highlighted the need for dialogue with individuals who need to be turned away from normative comparisons and to focus on useful learning strategies. Honest discussion that attributes success and failure to learning habits should improve confidence and resilience in the face of challenge.

Chapter 5: Conclusion

5.1 Summary of findings

In this project I have explored Carol Dweck's implicit theories of intelligence, relating them to other theories of motivation and to previously high attaining students in my school. Strategies for fostering growth mindsets and avoiding the promotion of fixed mindsets have been explored. My understanding of the theory and these strategies has been deepened by examining the reactions of students and two collaborating teachers to a 'stealthy' approach to mindset change.

The issue of growth or fixed mindsets is of central importance to our understanding of the low participation rates in the study of post 16 mathematics in the UK. This national issue is replicated in my school. This has been shown to be a result of fixed views of mathematical intelligence which become established in young children and continue throughout school despite success on standardised tests. Although mindset interventions have been successful elsewhere, as yet in the only large scale UK study (the 'Changing Mindsets Project') similar strategies have had no lasting changes to mindsets.

In my research, I set out to relate Dweck's theory to other theories of motivation and to explore strategies for changing mindsets. An original experimental design was changed to an

interpretive one for two reasons. Firstly, it became apparent that whole school mindset interventions would make any generalisations about the impact of my intervention impossible. Secondly, initial questionnaire responses showed that the results did not entirely match those expected from the literature and this needed further investigation.

I went on to explore how the introduction of comment only feedback and non-ego involving verbal feedback could act as a 'stealthy' approach to mindset change. Alongside a whole school overt approach to promoting growth mindset, the feedback strategy was intended to foster growth mindsets by providing opportunities for promoting learning goals and strategic feedback whilst at the same time avoiding promoting fixed mindsets by removing normative comparisons and attributing failure to poor learning strategy not lack of intelligence.

The findings of this project show that Dweck's theory of mindsets may explain the continued prevalence of fixed mindsets in education where, through the introduction of accountability measures, school performance has become such an overwhelming goal. The literature on mindset interventions revealed two types, the overt teaching of the malleability of intelligence and the 'stealthier' social-psychological interventions that retrain attributions for success or failure. I suggest a third type of indirect intervention which involves avoiding practices that inadvertently promote fixed mindsets and propose that it is this third aspect that may have contributed to the failure of the UK 'Changing Mindsets project' to replicate US studies.

Interpretive analysis of quantitative and qualitative data from questionnaires and interviews confirms that the use of comment only feedback from assessments provides opportunities to promote learning goals; to attribute success to effort; to challenge normative comparisons and to provide specific, strategy feedback. In some cases students need careful nurturing to balance levels of challenge and confidence. They might mask their struggle

through rejection of the mindset message. As with any intervention, too heavy-handed an approach can also trigger rejection of the message as it is seen as a threat to autonomy.

Scaling the intervention beyond my own classroom involved collaborating with colleagues. The introduction of the feedback strategy proved a useful cue to clarify the mindset message with teachers. Triangulation between teacher and student reactions suggests that this was successful. As a result of this teacher collaboration, conceptions of intelligence were challenged and crucial points for further discussion were raised.

5.2 Limitations of study

Further triangulation through lesson observations would have provided more evidence but was not possible due to timetabling.

As a practitioner researcher central to the delivery of the intervention strategies my analysis of the data and selection of exemplar qualitative comments to support discussion points must be viewed as subjective. However the aim of the study was to explore mindset strategies in order to illuminate my understanding of the student and teacher perspectives of those strategies, not to assert generalisable effects of mindset strategies. The relevance of the findings is left to the reader to position in their own context and to consider for themselves whether the views of our students and teachers might shed light on their own situation.

It has not been possible to accurately measure the exposure any particular student has had regarding growth mindset. They may have been absent for the assembly or tutor time when the whole school intervention was delivered. Their other subject teachers may have been promoting growth mindsets in some way following the whole staff INSET. This may explain the ‘overload’ of growth mindset messages some students described.

My relationship with the students I taught may have had an effect on their responses but none opted out of the study and they appeared more appreciative of the interest in their

views than concerned about how I might respond to their views. In fact the 'Hawthorne' experimenter effect (Thomas, 2009: 141) may explain all of the quantitative evidence for mindset change and is another reason for the interpretive response to the data. I was not an impartial observer, it was in the design of the study that I should 'lead' the participants and in fact what was interesting was what lay behind some students' resistance to changing their mindset.

The backgrounds of the teacher colleagues involved will inevitably have had a bearing on their perspectives but have not been discussed here as this would overstep the agreed level of their participation and so be unethical. It is an interesting area for future research since if whole school mindset change is desired, teachers will be directly involved in the overt delivery (as they already have been in my school). They will also be indirectly influencing mindsets through their practice. Care must be taken to avoid the heavy handed approach that might lead to rejection of the entire message.

5.3 Implications for future research and practice

The literature suggests that those retaining fixed mindsets are at risk of adapting poorly to increased challenge at any age. It seems likely that it is the first learning challenges in school that set a child's mindset in a particular domain. It would be interesting to see if young children in the UK show different proportions of entity or incremental mindsets and different goal orientations to older children. An adaptation of this study that explores mindset changing strategies in an early-years setting, a more controllable environment, might reveal the influence of pre-school experiences; teacher perceptions of intelligence and the inadvertent practices that begin to reinforce performance goals and fixed mindsets.

Another area for future research would be to compare responses of boys and girls. The low participation of girls is certainly an issue and much of the literature suggests that mindset strategies work well at addressing stereotype threat.

There are currently no plans to overtly 'teach' growth mindsets to our whole school next year. However, NQT and I are timetabled to teach the same two groups next year so we will continue our stealthy approach and monitor the self-theories of these students as they face increasingly challenging mathematics. In light of this study we have agreed to return the groups to two parallel top sets. We will continue to use comment only feedback and to focus on strategy feedback and will use the opportunities this provides to highlight successful learning strategies and to attribute poor performance to poor strategy. In fact broader 'setting' has been introduced across the maths department. This has already prompted several conversations regarding teacher conceptions of intelligence and this is another area for further investigation.

As secondary school teachers, we meet children at age 11 with a Key Stage 2 prior attainment level in mathematics. This may be the result of a fortuitous genetic and environmental start to life and effortless engagement or it may be the result of a less fortunate start to life but continuous engagement and attention to strategy feedback. Both are likely to continue to progress in the right circumstances. However if the former are led to believe their success is all due to innate traits, when their effortless engagement ceases to result in the desired performance, they are at risk of maladaptive responses. Even if their lucky circumstances result in high performance at GCSE these students are unlikely to choose to study mathematics post 16, having already met their goal. This significantly reduces the numbers of STEM qualified adults we have in this country. This is obviously of concern but even more saddening is that these students are denied the enjoyment and satisfaction that studying maths could give them.

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Appendices

Appendix 1: Letter to Head teacher and reply slip

23 November 2014

Wendy Hemmingsley

The Henry Box School

Church Green

Witney

OX28 4AX

Dear [redacted],

I am writing to enquire about conducting research in school this academic year. As you know, I am studying for the Master's in Learning and teaching at Oxford University, supervised by [redacted]. In my final research project, *Exploring strategies that foster a growth mind-set rather than a fixed mind-set in previously high attaining secondary school Mathematics students*, I will explore classroom strategies that can promote a growth mind-set.

The research will take place with two Year 9 mathematics sets (set 1 and set 2). I am developing strategies such as formative written feedback following assessments (rather than grades) and the use of non-ego-involving verbal feedback both in my lessons and with colleagues. My research focus is on students' mind-set in relation to their mathematical ability, and how teachers can develop this. [redacted] and [redacted] have agreed to collaborate with me on this.

By participating in the research, the school would be contributing to a project that will deepen the department's understanding of mathematics learning for students with high prior attainment, and so contribute towards developing ways of improving attainment for similar students in the school in the future. It will also contribute to Mathematics education more widely.

I hope to conduct this research between January and September 2015. I would issue a questionnaire to students before and after the strategies are implemented assessing whether they have an incremental or fixed view of their mathematical ability and how they felt about

the strategies used. I would also observe and interview the teachers, and take notes on the phrases I use in verbal feedback.

Oxford University has strict ethical procedures on conducting ethical research with teachers and young people, consistent with current British Educational Research Association guidelines. As practitioner research however, the University recognises that schools have the highest ethical standards in any event. Therefore only your consent is necessary, and not that of parents. Throughout the research, students and other teachers will be able to refuse to participate in any research activities at any time.

All participants, including students, teacher and the school, would be made anonymous in all research reports. The data collected would be kept strictly confidential, available only to my supervisor and myself, and not used other than specified without further consent. All questionnaires would be destroyed at the end of the research period, and kept in locked conditions until then.

If you feel you would like to take part in the study, or need more information about what is involved, please contact me.

I look forward to hearing from you.

Yours sincerely,





Exploring strategies that foster a growth mind-set rather than a fixed mind-set in previously high attaining secondary school Mathematics students

[redacted]

University of Oxford, Department of Education

[redacted]

[redacted] *(Electronic signature)*

☐ We do not wish to participate in this project.

☐ We would like to find out more about this project.

☒ **We would like to take part in this project.**

If you would like further information, please contact me, or my supervisor. If you require clarification of the ethical approval, process please contact Chair of Department of Education Research Ethics Committee, [redacted]

Supervisor emails: [redacted]

Chair of Department of Education Research Ethics Committee, [redacted]

Please return this form to me.

Thank you for your help.

Appendix 2: Oral Consent Script

Script to be read to students before participation in the mind-set questionnaire.

I am doing a project with the University of Oxford and I want to talk to you about the project I told you about before.

I just want to go over again some of details of the project to make sure you understand what's involved for you. These were that:

- It's a project about mind-sets and it's being used for a postgraduate project I'm writing.
- If you take part, you will need you to do this 10 minute questionnaire now and again around May in class time.
- The questionnaire is about your views on your ability and how different things your teacher does might affect those views.
- You don't have to say yes to the project; you can ask me any questions you want before or throughout; you can also withdraw at any stage.
- Whether you take part or not has no effect on your work here as a student, or your maths set nor do the answers you write.
- Oxford University's Ethics committee has approved this work
- I won't keep any of your details for longer than necessary and won't use your name next to answers you provide.
- The final written work be published online but no one will be able to connect you to the work.

Are you still willing to take part? …So if you're happy with all of that, and have no more questions, let's start.

Appendix 3: Student Questionnaire

Student Questionnaire

We are interested in what you think about your intelligence.
The last question allows you to write your own answer. Be as detailed as you can and use examples to explain your answer.

1. Read each sentence below and then circle the one number that shows how much you agree with it. There are no right or wrong answers.

a) You have a certain amount of intelligence, and you really can't do much to change it.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly agree	Mostly Disagree	Disagree	Strongly Disagree

b) Your intelligence is something about you that you can't change very much.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly agree	Mostly Disagree	Disagree	Strongly Disagree

c) You can learn new things, but you can't really change your basic intelligence.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly agree	Mostly Disagree	Disagree	Strongly Disagree

2. Tick the sentence that is most true for you.

☐ I usually think I am intelligent.

☐ I wonder if I'm intelligent.

Now, show how true the statement you chose is for you.

Very true for me	True for me	Sort of true for me

3. Tick the sentence that is most true for you.

☐ When I get new work in school, I'm usually sure I will be able to learn it.

☐ When I get new work in school, I often think I may not be able to learn it.

Now, show how true the statement you chose is for you.

Very true for me	True for me	Sort of true for me

4. Tick the sentence that is most true for you.

   ☐ I am not very confident about my intellectual ability

   ☐ I feel pretty confident about my intellectual ability

Now, show how true the statement you chose is for you.

Very true for me	True for me	Sort of true for me

5. Not everyone one in a class does the same work. Different students would choose different kinds of work – there is no right answer. Tick next to the type of work you would choose:

   ☐ Questions that aren't too hard, so I don't get many wrong.

   ☐ Questions that I'll learn a lot from, even if I won't look so clever.

   ☐ Questions that are pretty easy, so I'll do well.

   ☐ Questions that I'm pretty good at, so I can show that I'm clever.

6. Read each sentence below and then circle the one number that shows how much you agree with it. There are no right or wrong answers.

a) If I knew I wasn't going to do well at a task, I probably wouldn't do it even if I might learn a lot from it

1	2	3	4	5	6
Strongly Agree	Agree	Mostly agree	Mostly Disagree	Disagree	Strongly Disagree

b) Although I hate to admit it, I sometimes would rather do well in class than learn a lot.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly agree	Mostly Disagree	Disagree	Strongly Disagree

c) It is much more important for me to learn things in my classes than it is to get the best grades.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly agree	Mostly Disagree	Disagree	Strongly Disagree

d) If I *had* to choose between getting a good mark and being challenged in class I would choose…(circle one)

"good mark" "being challenged"

This next question allows you to write your own answer. Remember, be as detailed as you can and use examples to explain your answer.

7. If you were asked to tell someone what intelligence is, how would you describe it? Be as specific as you can and use examples.

8. Complete the statement below with the amounts you think fit.

Intelligence = _____% effort + _____% ability.

Thank you.

Appendix 4: Self-assessment sheet and Feedback sheet

Class: 9-1 [redacted]

[redacted]

Assessment Summary

Year 9 Geometry test Tier 3

Tier 3 20-Mar-15

Q	Topic	Score	Out of	Silly Mistake	Learn myself	Please help
01	Area of compound shapes		2			
02	Constructing triangles		2			
03a	Area of parallelogram - calculation		1			
03b	Area of parallelogram - units		1			
04	Angles with reasons		2			
05	Angles in polygons		4			
06	Constructions		2			
07a	Problem solving with circles		3			
07b	Construction and loci		3			

Class: 9-1 [redacted]

[redacted]

Assessment Summary

Year 9 Geometry test Tier 3

Tier 3 20-Mar-15

Q	Topic	
01	Area of compound shapes	
02	Constructing triangles	
03a	Area of parallelogram - calculation	
03b	Area of parallelogram - units	
04	Angles with reasons	
05	Angles in polygons	
06	Constructions	
07a	Problem solving with circles	
07b	Construction and loci	

Appendix 5 Teacher informal interview email prompt

From: [redacted]
Sent: 15 May 2015 13:49
To: [redacted]
Subject: Encouraging a Growth mindset

Dear Both

I am interested in how the promotion of a "growth mind set" influences the way you teach (if at all), your perception of what promoting this mind set might mean (are you doing anything differently?) and also what you think your students' perception of having a growth mind set means. I am also interested in how easy you find it to convey a growth mindset and any barriers to this.

With my year 9 set 1 (and my other classes) I have tried to promote a growth mind set in various ways, based on my interpretation of what this means. I gave them the attached questionnaire at the start of the term and again recently asking them if they had changed their minds about any of the questions. I also asked them if they thought I had been doing anything in particular to promote a growth mindset and how they felt about that. The first three questions below refer to the three ways I have tried to promote the growth mindset.

1. *How do you feel about giving formative written feedback without grades?*
2. *How do you feel about giving non-ego-involving verbal feedback?*
3. *How do you feel about everyday conversations that promote a growth mind-set? Do you have any examples?*
4. *Do you have any other comments about the project?*
5. *Please could you describe what you think "having a Growth mind set" would mean? How important do you think it is to have this sort of mind-set?*

Please could you respond with as much specific detail as possible, detailing examples of student interactions, particularly with the more able students you teach ([redacted] your year 8, [redacted] your year 9 or 10)? Could you please also refer to any sources that have built your understanding of what a "growth mind set" is or how it might be promoted?

Thank you so much for taking to the time to help me with this project.

[redacted]

Appendix 6: Teacher email responses

Appendix 6.1 From NQT

Hello,

I hope this is ok... since I've only been teaching with this "growth mindset" always being talked about, its less about how I have adapted my teaching, because there wasn't much to change, more about me just attempting to get the students to have it.

How do you feel about giving formative written feedback without grades?

At first I didn't like it because of the fuss the students caused and the fact that there were some parental complaints, However, now that my 9s and 10s are used to this, they focus more on the questions they got incorrect and are less bothered with grades.

I also like that the classes no longer compare and rank themselves against each other, if they see a lot more "greens" they know they have done better than last time, and seem to be more interested in their improvement vs. where they were in the class.

(After parents evenings and conversations with parents, it seems that it is usually them that are the most worried about levels, position in class etc...)

After the 10s had all performed well in the first test where I gave them a mark/grade, there was definitely a sense of complacency and this was reflected with a dip in their achievement at Christmas. Not giving them a grade, and instead just seeing there were quite a lot of topics they didn't get correct seemed to enthuse them a bit more and so all did put in an extra effort. Now when they do just as well as before but only get coloured feedback, they are still looking at the maths they don't yet fully understand, instead of relaxing because they got over 90%.

How do you feel about giving non-ego-involving verbal feedback?

I find this difficult because I started off saying lots of "excellents" and "well dones", and so now when I try and be more neutral, students take that to mean they gave an incorrect response. With my year 9 class I particularly find myself giving lots of "ego involved" feedback, because some do struggle with the difficult topics and I want to praise the fact that the majority of the work is correct, they just made a small error so got the final answer incorrect.

I still like to praise them if they make a good contribution- but do always try and make it effort related, so that it is less about the answer they gave and more about the way they got there, and so a correct and incorrect answer usually get a similar level of response. This has seemed to encourage a lot more of the quieter students to have a go and they don't give up because one lesson they got a few answers wrong.

With the 10s, they have a lot less of a growth mindset and they rely too much on the brightest students to answer/ get the top marks and appear to have accepted the position

of "cleverness" they have in the class, so I try to give as little praise as possible, so that the "clever" ones still get to contribute, but aren't seen to get more praise than the others.

How do you feel about everyday conversations that promote a growth mind-set? Do you have any examples?

Again this is easier with my year 9s, because a lot of our conversations are about how trigonometry and quadratics are challenging, but they are just beginning to work on them and so everything feels a lot more like a work in progress. They might not get something instantly, but can see that in comparison to last term they have really improved, and there is a strong feeling that if they put the work in during lessons/homework and revision there is no reason why they won't get it.

In the majority of lessons I try to give the students a choice about what work to start on and there is never an attitude that because you did the easier ones yesterday you have to do the easier ones today... The years 9s used to either go for the hardest all the time because they wanted to show off or some like to only stick on the ones they knew they could do.

After a few conversations with a few key individuals, I explained that getting a few correct on the more challenging ones was more beneficial than 10/10 on some easier ones. I also reflect this in my marking and I have seen the majority being less afraid to try something harder.

Unfortunately, there are still some year 10s who seem to have labelled themselves as the stupid ones, and always go for the easy option and are surprised when I talk to them about moving onto the trickier work. I think if they went back to year 7 now and had the "egg" and the questionnaires from the start they would be a lot more open to the concept of intelligence being something they can improve on.

I also think that next year, changing the setting a little bit will also really help, since there will be less opportunity for them to rank themselves, and there will no longer be a top set assuming they are "clever" and so become complacent.

Please could you describe what you think "having a Growth mind set" would mean? How important do you think it is to have this sort of mind-set?

I think this sums it up "if you always do what you've always done, you're always going to get what you always got". I have said this a lot to my year 11s about their effort in class and revision techniques, they don't like being asked to change and usually just shrug their shoulders and carry on doing the same thing!

I think having a growth mindset is about valuing the progress you are making, and not the levels/grades you receive. It's about realising that 100% on some questions you can already do is a lot less beneficial than getting a lot wrong on something more challenging. I think it is important, and is why in the long run the majority of students in my year 9 class will be more successful than those "clever" ones in year 10, who do not like to try the work they can't already do.

I think intelligence is the ability to apply yourself to different things, (as well as being strong academically) to be able to adapt a tool/skill you already know to do something different. The most intelligent students I see are the ones not put off by the challenging questions which aren't just more examples of the work I have already shown, e.g being able to use angle and perpendicular bisectors to construct angles other than a right angle. I also think being intelligent is about being aware of what you don't already know, which is usually why the ones who finish an exam worried because they couldn't do a few questions perform lots better than the ones who say it was really easy.



Appendix 6.2 From ET

Hope this is OK.



I think that having a growth mind set is about believing that you can do things and pushing yourself to do them. In order to be successful, starting with wanting to do something, we need to be able to have the right tools.

I have not spoken to any of my classes about growth mindset but have been expecting them to take on board advice about good ways to study. I have been pleased when they have done so, and even more disappointed when particular students have not done so, as they stand out even more now.

With set 1 in Year 8 they have embraced the idea of red/amber/green sheets in order to go back over topics. At parents' evening in Feb I gave each of them an A4 sheet with all of the qns to all of their module tests colour coded with qn titles. Many of the parents said that that was really helpful in them being able to help their child. Several asked if it was possible to have a textbook to refer to and said that they would value this week by week.

I have been particularly pleased with the way my Y10 middle ability group has got stuck in to the idea if going through a test that has no markings on it, now I have worked out the best way to do it with them (them talking about maybe three qns and then me leading from the front. Repeat). I have been frustrated that when doing this with top set year 8 there are still 2 or 3 students who are not correcting their own tests in purple even though I have asked them to. Through using the self-marked tests as part of revision I have tried to show them why having the correct answer next to a question is valuable.

I have tried harder this year to hide my instinctive emotional response when a student does something that I find frustrating (because I think I have given them a particular tool and they have not used it) e.g. on the morning of Dom's GCSE maths exam when he was trying a quadratic formula question and I asked him whether he had got the calculation correct, he didn't know. I asked him if he had checked the answers in the back of his revision guide, and it was clear that he didn't know that there were answers there.

I have tried to make a learning point for the whole class when someone gets something wrong, and making that a positive thing, but I think I have always tried to do that. Sally-Ann in Year 11 thinks out loud a lot and there is often something there to pick up on that we can all learn from – when we were doing standard form and I was showing students how to enter a number in SIF using the exp button, she said 'no you've got the number of zeros wrong Miss', when in fact she had pressed x10 exp instead of just exp. We were able to all try it out and see the difference.

I have tried this year to praise effort, particularly when a student has done something well that will be of benefit to their learning, e.g. 'you have shown your working out really clearly there'.

I have felt more confident this year in expecting students in all my classes to explain things to each other and have used that a lot more.

There is one particular girl in year 8 set 1 who I think has a fixed mind set, a few times bringing a note from home saying she couldn't complete the hwk. She got a low test score (May 2015) and was disappointed. She said she had revised hard. When I asked her how, she said she had been through her exercise books and looked at topics on mymaths. I asked her if she had used the red, amber, green sheets to identify which topics to look at and she said that she had lost the sheet, but now found it. When she had been on mymaths, which topics had she done? She said firstly decimals. I said that I thought she was good at decimals and she agreed that she was happier looking at topics she was comfortable with. I told her about the idea that if you do what you've always done, you'll get what you've always got and challenged her that next time she was going to spend her time working at revising maths she use the r a g sheets and try a topic on mymaths that she wasn't happy about.

A piece of advice I was given on day one of university, by my tutor was 'learn the Greek alphabet, never divide by zero and only do the questions you can't do.' And I have always tried to pass this on, particularly to top sets. What I realize more and more is that just because I have said something, doesn't mean the student is ready to hear that thing and judging when the time is right is crucial, as with [redacted] in the previous paragraph.

I feel positive about giving feedback without grades, and I think that the students now have the information they need to be able to identify which topics need to be revisited. I don't think I have yet closed the loop effectively for all of them about how to go about being able to do something that they have not been able to do before, without input from me or another adult.

So, having thought lots about this over the last week or so, my personal definition of intelligence is 'the ability to absorb ideas and link them at speed to prior knowledge'. I would therefore say a baby or young child could be very 'bright', referring to the impression that they give of being alert, absorbing what is happening around them and the speed of their responses, but I wouldn't describe a young child as being very 'intelligent'.

Always open to suggestions though.

[redacted]

Appendix 7: Statistics

7.1 Statistics from Student questionnaires 1

Entity/ Incremental proportions from Qu1

	Entity	Incremental	not sure	Grand Total
9M1	40%	50%	10%	100%
9M2	21%	55%	24%	100%
Grand Total	**31%**	**53%**	**17%**	**100%**

Confidence proportions from Qu 2 - 4

	Confident	Not confident	Not sure	Grand Total
9M1	83%	10%	7%	100%
9M2	59%	28%	14%	100%
Grand Total	**71%**	**19%**	**10%**	**100%**

Goal orientation proportions from Qu 5

	Learning	Performance approach	Performance avoidance	Grand Total
9M1	60%	10%	30%	100%
9M2	66%	17%	17%	100%
Grand Total	**63%**	**14%**	**24%**	**100%**

Goal orientation proportions from Qu 6

	Learning	Performance	Not sure	Grand Total
9M1	57%	33%	10%	100%
9M2	55%	14%	31%	100%
Grand Total	**56%**	**24%**	**20%**	**100%**

Effort 50% or more? proportions from Qu 8

	Effort 50% or more	Effort less than 50%	N/A	Grand Total
9M1	47%	43%	10%	100%
9M2	90%	7%	3%	100%
Grand Total	**68%**	**25%**	**7%**	**100%**

7.2 Contingency tables

Mindset vs Goal orientations from Qu 6

Observed	Learning	Performance	Not sure	Grand Total
Entity	9	8	1	18
Incremental	21	4	6	31
not sure	3	2	5	10
Grand Total	**33**	**14**	**12**	**59**
	Chi test probability		1%	

Mindset vs goal orientation from Qu 5

Observed	Learning	Performance approach	Performance avoidance	Grand Total
Entity	12	2	4	18
Incremental	19	3	9	31
not sure	6	3	1	10
Grand Total	**37**	**8**	**14**	**59**
	Chi test probability		45%	

Mindset vs combined goal orientation from Qu 5

Observed	Learning	Performance	Grand Total
Entity	12	6	18
Incremental	19	12	31
not sure	6	4	10
Grand Total	**37**	**22**	**59**
	Chi test probability		91%

Mindset vs confidence

Observed	Confident	Not confident	Not sure	Grand Total
Entity	13.0	3.0	2.0	18
Incremental	25.0	4.0	2.0	31
not sure	4.0	4.0	2.0	10
Grand Total	**42**	**11**	**6**	**59**
	Chi test probability		19%	

Mindset vs Effort 50% or more?

Row Labels	Effort 50% or more	Effort less than 50%	Grand Total
Entity	7	10	**15**
Incremental	26	4	30
not sure	9	1	10
Grand Total	**42**	**15**	**57**
	Chi test probability		0.1%