The creation of an e-book designed to tackle the common misconceptions associated with the learning of analogue time telling using *'growth mindset'* strategies.

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ABSTRACT

This research study focuses on the creation of an e-storybook, designed not only to combat the common misconceptions associated with time telling on the analogue clock, but to do so in a way which cultivates a '*growth mindset*' attitude towards the learning of mathematics. The resource explicitly addresses telling time in five minute intervals past the hour, and thus is specifically tailored towards Key Stage 1 pupils. Needless to say however, the resource can be used for pupils in Key Stage 2, or indeed any pupil struggling with the addressed misconceptions. A literature review was conducted to not only examine the research that presently exists on the concepts of '*growth*' and '*fixed*' mindset, but to also investigate and apply these concepts to the learning of mathematics. It became apparent that classroom teachers do not feel confident, comfortable or knowledgeable enough to integrate '*growth mindset strategies'* in their classrooms. This is what ultimately led to the decision of creating a resource. The methodology briefly touches on the planning and creation of the e-storybook, and then goes on to explore and justify the research methods used to pilot and trial the resource. Findings suggest that the book is indeed a valuable resource, it can help pupils overcome the targeted misconceptions, and it does indeed help pupils adopt a different, more positive, growth minded attitude towards the learning of mathematics. This research however, does in no way suggest or imply that using the book will automatically shift pupils' mindset about mathematics from '*fixed'* to '*growth*'. Addressing and altering complex psychological matters such as *'mindsets'* will not be an instantaneous process and will require long term nurture. The teacher will be required to consistently integrate the strategies implicitly integrated in the book. The resource however does provide a baseline for teachers who struggle to assimilate such strategies, and also provides pupils with an alternative way of learning mathematics -through story.

1. INTRODUCTION

The belief that intelligence is malleable is not a relatively new concept. However, the idea that intelligence can be altered, advanced and grown has gathered much popularity in recent years. Research on brain plasticity has shown that with training and practice, neural networks can grow new connections, strengthen existing ones, and can construct insulation that speeds up the transmission of impulses. These neuroscientific discoveries prove that we can increase our neural growth through the actions we take, i.e. adopting good strategies, questioning, practicing, and following good nutrition and sleep habits, [Mindset Works, 2017].

At the same time that these neuroscientific discoveries were gaining attraction, Carol Dweck and her colleagues began to understand the link between mindsets and achievement. Dr. Dweck devised the terms '*fixed'* and '*growth*' mindset to describe the underlying beliefs that people have about learning and intelligence. Research concludes that students with a '*growth mindset'-* those who believe that intelligence can be developed, go on to attain higher levels of achievement, engagement and persistence, [Boaler, 2015].

This has huge implications for the way mathematics is taught and learned. Experts now believe that success in mathematics is not merely found in one's natural ability or talent, but rather the continuous development of those abilities, [National Numeracy, 2005]. Boaler (2015) claims that this new evidence gives a message that the *"UK has lacked for many years"* [pg1] – a message that mathematics can be learned to high levels by any child, and that there is no such thing as a *'maths gift'* or *a 'maths brain'*. Instead, with the right teaching and parenting, all students can inspire and aspire to great mathematical success.

1.1 The Rationale

Boaler (2010) claims that in the UK, mathematical achievement and interest is the lowest that it has ever been. A report conducted by the Department of Education in Northern Ireland, found that 57% of pupils, "*worry that mathematics is too difficult for them*" [pg43], 33% of pupils "*get very tense when doing mathematics*" [pg43], and 62% worry that they will "*get poor marks in mathematics*" [pg43]. Dweck (2010) claims that encouraging pupils to adopt a growth mindset attitude, may not only lead to higher achievement in mathematics, but also a greater enjoyment and a higher resilience towards the learning of mathematics.

Talking to previous school experience teachers and their colleagues, it would seem that there isn't a great awareness in Northern Ireland of Dweck's '*growth'* and '*fixed'* mindset concept. Regardless of this awareness, even teachers who are familiar with the concept, are not confident or comfortable in integrating such strategies into their own classroom, there is a desperate need for more training in this field, [Blad (2012)].

The Revised Curriculum for Northern Ireland (2007) however, subliminally encourages teachers to adopt a '*growth mindset'* approach. In the past, there was a focus on *"product-centred learning".* In attempt to demolish this *'traditional strategy'*, the revised curriculum has evolved to *"process-centred learning"*, meaning that the answer is no longer more important than the processes implemented during the finding of it.

1.2 Aims & Objectives

The purpose of this study is not only to raise awareness of the growth/fixed mindset concept, but primarily to plan, create and trial a mathematical '*growth*' mindset resource. A children's e-storybook will be created that addresses the complicated and abstract KS1 topic of time, whilst integrating various growth mindset strategies in attempt to cultivate a growth mindset attitude towards the learning of mathematics.

2. THE LITERATURE REVIEW

The following review will aim to outline and examine the growing body of literature surrounding the concept of '*growth*' and '*fixed*' mindset. After analysing the research upon which this concept is based, it will then explore the significant concern evident amongst teachers today, in that there is a clear gap between knowing about growth mindset, and having the resources and understanding to effectively incorporate it into the classroom. Whilst considering the KS1 topic of '*time*', the review will then assess and evaluate how to create a resource, in particular a children's e-storybook, which teaches this topic whilst nurturing a '*growth mindset'* attitude.

EDUCATIONAL THEORY

2.1 Growth & Fixed Mindset

Early in the 20th century, inventor of the IQ test Alfred Binet wrote:

> *A few modern philosophers assert that an individual's intelligence is a fixed quantity, a quantity which cannot be increased. We must protest and react against this brutal pessimism… With practise, training and above all, method, we can manage to increase our attention, our memory, our judgement and literally to become more intelligent than we were before.*

> [Translated by Heisler, 1984. pg106]

It has been known for over 100 years that intelligence is not a fixed trait. Yet, there remains a common stigma amongst schools that intelligence is a trait which cannot be increased.

Dweck (2006) defined mindsets as beliefs – beliefs about yourself and you're most basic qualities. According to Dweck (2006), there are two distinct types of mindsets that we human beings possess – *'fixed'* and *'growth'*. Individuals with a fixed mindset believe that their

intelligence is "*an inborn trait – they have a certain amount and that's that*" [Dweck, 2010.pg1]. Individuals with a growth mindset believe that they can develop their intelligence over time through hard work and dedication, (Blackwell, Trzesniewski & Dweck, 2007). As soon as children begin to compare themselves to others, which is usually as young as four years old, they are extremely liable and probable in developing a fixed mindset, Gross (2016).

2.2 Mindset Interventions

In 1998 Dweck and Mueller studied the implications of praising students' intelligence, as opposed to praising their effort. They gave over 400 fifth graders a relatively easy test. After the test, half of the students were praised on their intelligence, "*Well done, you must be very smart at this*" and the other half was praised for their effort, "*Well done, you must have worked really hard*". The students were then given the option to pick between two different subsequent tests. One test was difficult the other test was easy; they would "*surely do well in it*". Of the children praised for effort, 90% of them opted to do the more difficult test, while the majority of those praised with intelligence, chose to do the easier test.

Dweck & Mueller then tested the students '*fear of failure'*. They gave the students another test which was purposely designed way above their academic capabilities. Mueller & Dweck (1998) both agreed that those pupils who were praised for effort, worked harder to figure out the problems, whilst their counterparts quickly got discouraged and gave up a lot easier.

The students were then given the option to either look at the tests of students who performed better or worse than they did. The majority of students who received praise for their effort, opted to look at those who did better than they did, *"they wanted to see their mistakes and learn from their errors so that they may excel next time*" [Dweck, 2014]. Whilst the majority of those who were praised for their intelligence, wanted to look at those who did worse than they did, they wanted to "*feel better about themselves*" [Dweck, 2014].

Finally, Dweck & Mueller re-administered the initial test. Students who were praised for their effort exhibited a major improvement, raising their scores by 30%. On the other hand, students who were praised for their intelligence scored 20% lower, than they did on their first attempt.

Dweck (2014) sums up what most of these pupils with a *'fixed'* mindset do after acknowledging their *'failure'*. In one study, pupils admitted that they would cheat next time instead of study more, [Blackwell, Trzesniewski, & Dweck, 2007]. In another study, they said they would find someone who did worse than they did, so that they could feel better, [Nussbaum & Dweck, 2008; Cited in Dweck, 2014]. In many studies it was found that the children would simply avoid the difficulty next time, [Hong, Chiu, Dweck, Lin & Wan 1999; Moser et al.., 2011; Mueller & Dweck 1998; Nussbaum & Dweck, 2008; Cited in Dweck, 2014]

Dweck (2014) claims that praising pupils personally, not only develops within them a *'fixed'* mindset, but it also develops within them an obsession with getting A's. Pupils have begun to carry this need for constant validation with them into their future lives. Dweck (2014) jokingly admits that employers are complaining that teachers have *"raised a generation which can't get through the day without an award"*.

2.3 Implications at School

Dweck [cited in Sparks (2013)] claims that those growth minded individuals consistently "*seek challenges, learn from mistakes and keep faith in themselves in the face of failure*" [pg21]. These students are more likely to respond to initial obstacles or setbacks by remaining involved, adopting different strategies, and using all the resources at their disposal for learning, [Dweck (2010)].

In contrast to this, pupils with a fixed mindset believe intelligence is "*inherent and unchangeable*" [Blad, 2016.pg1]. This belief is detrimental at both ends of the continuum. For those students who struggle or do not perceive themselves as '*smart*' it becomes a self-

fulfilling prophecy. They don't believe that they can be successful and thus become *"reluctant to challenge themselves"* [Sparks, 2013.pg21]. For those successful students who are considered *'advanced learners'*, they become consumed with '*looking smart'*. They have coasted through school without putting in much effort, yet they are often praised for their good grades and strong skills, [Ricci, 2013]. Eventually, when these individuals come across something challenging, they are more than likely to avoid the situation, and sacrifice significant opportunities to learn, simply because it *"requires them to risk performing poorly, or admitting deficiencies"* [Dweck, 2010. pg16]. They tend not to handle setbacks too well as they doubt and question their own intelligence, [Dweck 2006].

2.4 Developing a Growth Mindset

The majority of human beings already naturally possess a fixed mindset [Ulrich, 2017]. Instead of trying to abolish this, Dweck asks teachers to simply help students develop a growth mindset and become aware of these moments when their fixed mindset takes over. Docktermann, [Cited in Sparks, 2013] points out;

> *The thing is kids don't mind failing … When kids play video games, they fail 80% of the time. They look at failure there as an opportunity to learn* [pg21].

Dweck suggests praising students for strategy, focus, effort, persistence, and improvement. This will *"take the spotlight off fixed ability and put it on the process of learning"* [Cited in Sparks, 2013, pg21]. Docktermann also suggests setting out problems from a completely new unit of light. For example, instead of saying "*Let's start with an easy one*", which can discourage students who initially struggle, he suggests saying *"This may take a few tries".* This simple change can make the big difference to those pupils who struggle and become easily defensive.

Dweck (2010) in her article "*Even Geniuses Work Hard*" points out some additional classroom strategies to implement in order to develop a growth mindset.

Firstly, "*emphasising challenge, not success*" [pg19]. Meaningful learning tasks need to be challenging to every student. If a student is able to *'coast'* easily through a number of problems, this can create the fixed mindset belief that you are smart only if you can succeed without effort, [Dweck, 2010]. Many teachers believe that lowering standards will give students a taste of success, boost their self-esteem and raise their achievement, however Bromley (2014) claims *"all evidence suggests that this doesn't work...instead it leads to poorly educated children"* [pg3]. Dweck (2010) suggests portraying highly challenging tasks as fun and exciting, and portraying easier tasks as "*boring and less useful for the brain*" [pg21].

Secondly, Dweck (2010) suggests giving pupils a *"sense of progress"* [pg21]. When students see themselves doing tasks they couldn't initially do, or understanding concepts that they previously couldn't grasp, they feel a sense of improvement. This sense of progress is exactly what gives learning meaning, and allows pupils to see that with application, they can become smarter [Dweck, 2010].

Thirdly, Dweck (2010) suggests giving a "*grade for a growth*". Davies (2017) tells of a high school in Chicago that instead of giving the grade '*fail*', they give the grade '*not yet'.* Dweck [Cited in Davies, 2017] states:

> *If you get a failing grade, you think, I'm nothing, I'm nowhere. But if you get the grade 'Not Yet' you understand that you're on a learning curve. It gives you a path into the future.*

Dweck (2010), claims that students are not ashamed of the grade '*not yet'*. They understand that they are expected to master the material eventually, and they realise that *"ability and motivation are fluid"* [pg20].

2.5 Criticisms of the Growth Mindset Concept

Chivers (2017), has widely criticised the work of Dweck and her colleagues, *"the findings of Dweck's key study have never been replicated in a published paper"*. Bates [Cited in Chivers,

2017] has been trying to replicate Dweck's findings for several years, yet claims "*We're running a third study in China…the results are just null*".

Dweck has claimed that, *"Not anyone can do a replication … We put so much thought into creating an environment; we spend hours and days on each question, on creating a context in which the phenomenon could plausibly emerge*" [Cited in Chivers, 2017]. Brown [Cited in Chivers, 2017] then further questions Dweck by asking "*If your effect is so fragile that it can only be reproduced under strictly controlled conditions, then why do you think it can be reproduced by school teachers?"*

Earlier this year, Dweck (2017) defended her work as she claims that the growth mindset concept does not rest on a handful of *'isolated studies'* like the ones carried out by Brown & Chivers. A meta-analysis published in 2013 found 113 significant studies conducted by many different authors and concluded that mindsets *"are indeed an extremely significant factor in people's self-regulation towards goals".* Dweck goes on to say that government data collected at country level [All 10th grade students in the country of Chile – over 160,000 students] *"showed that holding a growth mindset predicted academic achievement at every socioeconomic level".* Thus concluded that the growth mindset concept is not a *"phantom phenomenon*" [Dweck, 2017].

Whilst all the research about a growth mindset may in fact be true and reliable, Blad (2016) reminds us of the *"gap between knowing about growth mindset, and having the ability to incorporate it into their classroom strategies"* [pg1]. A recent survey conducted by 'Education Week Research Centre', found that 98% of educators believe that growth mindset has great potential for teaching and learning. However, only 20% strongly believe that they are capable of successfully incorporating growth mindset strategies into their classroom. There is clearly a need for more training and more resources to help classroom teachers foster and nurture a growth mindset.

MATHEMATICAL THEORY

2.6 A New Approach

Today's experts believe that success in mathematics is not merely found in one's natural ability or talent, but rather in the continuous development of those abilities. National Numeracy (2005) claims that, *"negative attitudes are at the root of our numeracy crisis"* [pg1]. Boaler & Dweck [Cited in Boaler, 2015] agree that mathematics is the subject most in need of a mindset makeover. The reasons are related both to teaching methods that prevail in mathematics classrooms, and also the fixed mindsets held by the majority of the UK population, Boaler (2015). One of the most damaging mathematics myths propagated in classrooms is that maths is a gift. Boaler (2015), claims that this is idea is strangely cherished in the Western world, but is virtually absent in Eastern countries such as China and Japan which are currently top of the world in mathematics achievement.

2.7 Moving Away from Traditional Methods

Boaler (2010) states that one of the biggest problems with mathematics teaching in the UK is the desire to label children, assign them a level, and prejudge their achievement. Schools are now deciding which children can and cannot do maths, at only 4 years old. Labelling children, and prejudging their achievement unconsciously encourages teachers to adopt a '*fixed mindset'.* Heggart (2015), points out that teachers may often see these *'lower ability'* or *'challenging'* pupils as not sufficient, bright or talented enough to understand the concept at hand. Thus they may easily give up hope and expectation for this student. Boaler (2010) agrees with such claims, and states that when pupils get put into the '*low*' set, 88% of them stay there until they leave school

Another problem faced today within the teaching and learning of mathematics, is that the subject has been reduced to simple '*can or can't do*' exercises, [Boaler, 2010]. In the classroom, students only aim to remember a particular method/trick in order to get the question

right. Sullivan (2011) claims that there is too much emphasis on success and not enough emphasis on challenge, mystery and thought. The teaching of mathematics needs to challenge every student in some way; otherwise pupils will be immersed in the fixed mindset belief that you are only smart if you can succeed without effort, [Dweck, 2010].

If we continue to *'drill'* our students with routine operations, we will completely misuse our opportunity as educators entirely as we not only kill their interest in mathematics, but also hamper their intellectual development. Instead, we need to challenge their curiosity set them problems proportionate to their knowledge and help them solve problems by offering them stimulating questions, Poyla (1971) [Cited in Boaler, 2010]. By moving away from these traditional methods of teaching, we …

> *Free our young people from the crippling idea that they must not fail, that they cannot mess up, that only some students can be good at math, and that success should be easy and not involve effort. We introduce students to creative, beautiful mathematics that allows them to ask questions that have not been asked, and to think of ideas that go beyond traditional and imaginary boundaries* [Boaler, 2015. Pg 7]*.*

2.8 The Topic of Time

The topic of time is often overlooked in its complexity, and underestimated in its difficulty. According to Burny (2012) [Cited in Metelerkamp, 2013], time is a *"complex and multifaceted concept that has shown difficult for learners to understand due to its abstract nature and the absence of concrete representations"* [pg17].

Martin (2005) claims that little difficulty occurs within the teaching of digital time, most children can read the digital clock since, *"you just read the numbers"* [pg13]. In recent years, the rise of technological devices has meant that a lot of pupils are already familiar with reading digital time. Reading the analogue clock is one that often poses difficulty for learners, yet it remains a compulsory element in NI Curriculum. Cierco (2017) claims that in general, pupils aged 5-7

[*i.e. Key Stage 1 pupils]*, struggle the most with learning to read analogue time. Merz (2014) asks us not to undervalue its importance:

> *I believe that the analogue clock can provide a vivid representation of time that digital*
>
> *clocks cannot. Analogue clocks are great for teaching time management concepts,*
>
> *including the passage of time, how much time we have left to complete something etc…*

2.9 Misconceptions within the Topic of Time

Harris (2000) points out two of the most common misunderstandings experienced by pupils when learning to read time. These will become the primary learning focus in the creation of the resource.

1. Pupils are likely to "*attribute hours and minutes to the wrong hand*" [pg17]
2. Pupils are likely to use *"the dial numerals for reading the minutes as well as the hours"* [pg17].

   (Instead of reading the time as "*5 minutes past 3*", they may read "*1 minute past 3*")

Hernandez (2007) suggests creating a '*giant*' clock with the pupils. The idea here is to show them up close, that as the minute hand strikes each dash, 1 minute passes. This should continue until 5 minutes pass. Pupils will then see that when the minute hand eventually reaches 1, 5 minutes have actually passed. This activity not only appeals to all three types of learners *[visual, audio and kinaesthetic]*, but it also fulfils the NIELB ALPS model since pupils are immersed in action, language, pictures and symbols.

Once pupils overcome this misconception and acknowledge that the dashes are representative of the minutes past. They may use this knowledge to overcome the first misconception of attributing minutes/hours to the wrong hands. Ms K (2013) provides an alternative and useful way of remembering the difference between them offered by one of her third grade pupils. The pupil explained that he thought the long/minute hand was long because

it was trying to reach these dashes that represent the minutes. However, the hour hand is short because it is only trying to reach the number on the clock, which represents the hour. This sensible visual representation will enable pupils to make connections between their own experience and mathematical concepts. (Post & Cramer, 1989). This is what allows pupils to gain insight and understanding into such abstract mathematical ideas like time (Duval1999; Flevares & Perry, 2001)

RESOURCE THEORY

2.10 The Need for a Resource

Dweck [Cited in Sparks, 2013], claims that some teachers often confuse *"teaching a growth mindset and exhorting kids to try hard"* [pg21]*.* Even whenever there is a clear understanding of the concept, there is still misunderstandings and confusion whenever it comes to implementing various strategies into the classroom. Blad (2016) points out that although 77% of teachers said they were familiar or very familiar with growth mindset, 85% of them said that they felt they needed more professional development in the area. There is a clear demand, and need for extra training and for extra resources.

2.11 Why a Story Book?

According to Myers (2012), storytelling is one of the most enjoyable school activities, *"all children love to hear a good story"*. Dweck (2010) when talking about how to nurture a growth mindset, claims that it is majorly about conveying the right messages to our children. Boaler (2015) agrees and states *"the right messages can truly propel children to the highest levels"* [pg4]. So what better way to deliver moral and academic messages to our students than through story? Rather than '*preaching*' a growth mindset to our children, or '*exhorting them to*

try harder', a story can provide them a foundation to discuss, to communicate and to divulge the meaning of mindset for themselves.

2.12 Teaching Mathematics through Story

The task of learning mathematics seems quite remote from anything to do with storytelling. However, Zazkis & Liljedahl (2009) tell us not to underestimate the potential of stories in the teaching and learning of mathematics.

Egan (1986), points out that the purpose of story is "*to establish meaning*" [pg37]. Zazkis & Liljedahl (2009) agree and point out that the central thread in mathematics is also to establish meaning. Students often get so caught up with manipulating symbols, that they forget the true meaning of the mathematics. Thus story can be used as an excellent tool in fully and effectively explaining a mathematical concept so that pupils can establish meaning. Zazkis & Liljedahl (2009) claim that stories can encourage students to analyse, learn and understand mathematics, rather than just '*do*' mathematics. Like Boaler (2015) said, mathematics should be seen as a "*learning subject*" and not a *"performance subject*" [pg5]. Story re-enforces this concept since there is no great pressure to get the answer in a short space of time.

As pupils are immersed in the questions arising from the book, not only are they probed to view the mathematics from a different light, but they also get the opportunity to discuss their thinking with others. Through the in-depth natural discussion which arises from story, pupils get the opportunity to engage in critical and creative mathematical thinking as they ask questions which may not have been asked before, and fully clarify any shortcomings.

Finally, through listening to the ideas of others, pupils are not only are they given the opportunity to "*compare their ideas and methods of working with others"* [Northern Ireland Curriculum, 2007.pg64], but they may also become introduced to alternative ways of thinking, and encouraged to adopt alternative strategies. Zazkis & Liljedahl (2009), claim that this type of mathematical teaching and learning will "*convey passion and enthusiasm*". In the long term, this may very well create and nurture a greater love for the true beauty of mathematics.

Boaler (2010) claims that "*far too many students hate mathematics"* [pg1]. However if we begin to incorporate story into the teaching of mathematics, we may find that the story can "*spark interest, assist in memory, and reduce anxiety*" [Zazkis & Liljedahl, 2009].

2.13 What makes a '*good*' story book?

A '*good*' story book is one which is of suitable length, not too long, not too short. Briggs (2014) claims that the average 5-7 year old, holds an attention span of approximately 10-15 minutes.

Shepherd (1998) additionally claims that there are a set of distinct elements that makes a story, a '*good*' story.

Firstly, the theme. According to Webster [cited in Letourneau, 2014], a theme is *"a particular subject or issue that is discussed often or repeatedly".* Shepherd (1998) warns writers not to get '*too preachy*' with the theme. Instead the theme should grow out of the story, readers should feel as if they've learned it for themselves.

Secondly, the plot. Zazkis & Liljedahl (2009) claims that the plot is the "*conscious effort on the part of the author to create a story line that will fulfil his or her purpose*" [pg9]. When teaching mathematics through story, the plot should not revolve around capturing the students' attention through adventure, drama, tragedy or comedy. What is important is …

> *Not that the students hear a story that contains mathematics, but that they engage in the mathematics that emerges out of the story. The plot is our most powerful tool for achieving this.* [Zazkis & Liljedahl, (2009). Pg9].

Thirdly, the characters. Shepherd (1998) claims that the main character should be someone that the reader can connect with. Perfect characters are not very interesting, and difficult for children to connect with [Shepherd, 1998]. Prudchenko (2017), claims that a writer creates a convincing character by giving him a particular motivation or desire. As the character follows

his/her true nature and struggles with their inner motivations, he/she begins to "*resemble a real person*".

Shepherd (1998) also re-emphasises the importance of style and tone when writing children's stories. Cali (2017) tells us that "*style is not a matter of right and wrong but of what is appropriate for a particular setting and audience"*. Shepherd (1998) then claims that we should only use language that feels right for the story, "*Always use the best possible word— the one that is closest to your meaning, sounds best, and creates the clearest image".*

Finally, Shepherd (1998) emphasises the importance of '*setting*' and '*structure*'. The setting of the story should be one which is '*familiar'* or *'interesting'* to pupils. Benedict (2013) warns writers not to underestimate the importance of setting, especially since it can "*help set the mood, influence the way characters behave, affect the dialog, foreshadow events, invoke an emotional response, reflect the society in which the characters live, and sometimes even plays a part in the story".*

Brain Scientist Paul Zak [Cited in Duffy, 2016] sums it up when he says; "*Stories are powerful because they transport us into other people's worlds but, in doing that, they change the way our brains work and potentially change our brain chemistry".*

With all this in mind, my aim is now to create a storybook tackling the complicated KS1 topic of time, using and integrating the previously outlined '*growth mindset'* strategies.

3. METHODOLOGY

3.1 The Creation & Planning of the Resource

The literature previously reviewed will underpin all of the planning of the resource, particularly in the terms of the content, the presented mathematics, and the growth mindset strategies adopted.

Dweck's previously mentioned growth mindset strategies; "g*rade for growth", "praise for intelligence"* and *"sense of progress"'* will be implicitly integrated throughout the book in attempt to develop within pupils, a growth mindset attitude.

The mathematics will be presented in a way which aligns with many educational learning theories. As the book progresses, the reader will be led effortlessly through Piaget's processes of '*accommodation*' and '*assimilation'.* The book will aim to consistently immerse the reader in action, mathematical language, pictures and mathematical symbols [*i.e. the NIELB ALPS model*], which is directly based upon Bruner's 3 Modes of learning. Pupils will also be immersed in Vygotsky's *'social constructivism'* theory as they think and talk to one another about the mathematics at hand. Pupils will additionally be immersed in his *'reciprocal teaching'* theory as they are constantly encouraged to question, predict, clarify, summarise and scaffold their learning. The decision to approach the book from a mixed theory approach, stems from McLeod's (2007) belief that no one perspective is totally correct, each has their own strengths and weaknesses and each brings something different to our understanding of human behaviour:

> *Only with all the different types of psychology, which sometimes contradict one another, overlap with each other, or build upon one another, can we understand and create effective solutions when problems arise.* [McLeod, 2007]

Appendix 1 gives a brief overview of the story. Appendix 2 &3 give a much more detailed account on how the book was created, and also gives a much more precise account on how

exactly the book was planned and designed to retain the reader's attention, develop a growth mindset, and to teach the mathematical concepts using different learning theories whilst overcoming the targeted misconceptions.

The following chapter will now describe and justify the research methods proposed in initially piloting the resource to make effective changes, and then trialling the resource to evaluate and assess its effectiveness.

3.2 Research Context

Colibao [Cited in Shuttleworth 2008] defines research in a broad sense when he defines it as "*any gathering of data, information, and facts for the advancement of knowledge*". Bassey (1995), expands on this definition by defining research as the "*systematic, critical and self-critical inquiry which aims to contribute to the advancement of knowledge*" [pg2]. The use of words such as '*critical*' and '*self-critical*' implies that the data collected should be "*closely scrutinised*" by the researcher, who must also be critical of their own choices, [Wellington, (2010)].

3.3 The Research Questions

After planning and creating the story book, in attempt to effectively evaluate the extent of its value and usefulness, the following 2 research questions were constructed.

1. Can the book truly help change pupils' attitudes towards the learning of mathematics and help them develop a *'growth mindset'*?

2. Can the book help pupils overcome the two common misconceptions involved in learning to read time?

   (Attributing the hours/minutes to the incorrect hand & Reading the dial numerals for minutes as well as hours)

3.4 Research Methods

Prior to deciding on the most suitable method of data collection, I felt it was necessary to understand the distinction between the two types of data: *qualitative* and *quantitative*.

According to Denzin & Lincoln (1994), qualitative research is "*multi method in focus, involving an interpretive, naturalistic approach to its subject matter*" [pg2]. Typically, qualitative researchers approach their study in an exploratory manner, they seek to understand the social reality of individuals, groups and cultures, [McLeod, 2017]. In contrast to this, quantitative research gathers data in numerical form which can be measured and put into categories, or rank order. Quantitative researchers typically aim to "*establish general laws of behaviour and phenomenon across different settings/contexts. Research is used to test a theory and ultimately support or reject it*", [McLeod, 2017].

Whilst the decision to use qualitative or quantitative data will depend majorly on the nature of the study and the level of detail required, there are various strengths and limitations to both types. Qualitative data not only plays an important role in suggesting possible relationships, causes, effects and dynamic processes, but it can also allow for ambiguities in the data, which may be a reflection of social reality [Denscombe, 1999]. However, due to the time and costs involved, qualitative data does not generally draw samples from large-scale data sets. Due to this, and due to the subjective nature of qualitative data, it is difficult to apply conventional standards of reliability and validity, [McLeod, 2017].

Quantitative research on the other hand, is often represented and interpreted statistically; this approach is often viewed as scientifically objective, and thus seen as *'rational'*, (Carr, 1994). Quantitative research due to its measured values, can also be checked by others since numerical data is less open to ambiguities of interpretation, [McLeod, 2017]. However, quantitative data does not allow participants to explain or elaborate on the choices they made. Denscombe (2010) additionally points out that within quantitative data, large ample sizes are

needed for more accurate analysis, small scale quantitative studies may be less reliable. This affects the ability to generalise study findings to wider populations.

Regardless of the strengths and weaknesses associated with quantitative and qualitative data, Creswell & Clarke (2007) state that they should not be viewed as "*rigid, distinct categories, polar opposites or dichotomies"*. Newmann & Benz (1998) point out that they only simply represent different ends of a continuum. With regard to my study, not only did I want to know statistically and numerically how many pupils developed growth mindset beliefs and how many pupils understood the mathematics at hand, but I also wanted to know about the teacher's opinion. Thus a decision was made to use a combination of both quantitative and qualitative data. This can actually improve an evaluation by ensuring that the limitations of one type of data are balanced by the strengths of another. The balance means that the *"understanding is improved by integrating different ways of knowing",* [Creswell & Clarke, 2007].

Initially upon creating the resource, the most effective method of data collection was considered to be through a focus group. Moderating a focus group would give a first-hand insight on how pupils think and feel about the resource. Further and flexible questioning could also be adopted to allow for a greater insight into why certain opinions are held. However due to ethical issues, and due to fact that pupils may be more honest and comfortable in sharing their opinions with their class teacher, I realised that this method would not work.

Instead the decision was made to pilot and trial the resource through the class teacher. Like other methods, this too has strengths and limitations. Not only will the pupils be introduced to the resource in a comfortable and familiar environment, but when it comes to discussing the book, they are more likely to be honest being the comfortable company of their peers and class teacher. One major limitation however, is that I myself will not be physically present when delivering the resource, thus I will not be able to evaluate and assess first-hand the

pupil's behaviour and responses. Due to this limitation, and in order to answer the research questions, it seemed obligatory to follow trials with a semi-structured interview.

According to Hardon, Hodgkin & Fresle (2004), the use of a semi structured interview not only allows for a great depth of information, but the flexible nature of the interview allows the researcher to change or ask extra questions as unexpected issues emerge. Not only does this allow for the natural and comfortable flow of ideas and opinions, but it also means that questions can be adapted according to topics arising which may not have been initially thought of or planned for. In contrast to this, Hardon, Hodgkin & Fresle (2004) also claim that the interviewer needs to be able to '*probe*' the interviewee without being directive or judgmental. They additionally claim that the open ended nature of the questions may cause problems in analysing the findings.

3.5 Overcoming the Difficulties

One primary concern, is the teacher's ability to deliver the book in the desired, envisioned, and imagined way. In order to overcome this, a short '*guidance booklet*' is to be created to accompany the book. Additionally, a short meeting may be held with the teachers before handing over the resource so that expectations can be discussed.

Care will need to be taken when constructing the semi-structured interview questions, and additionally when analysing them so that no bias occurs. It may also be noted that I have worked in the past with the teachers who are piloting, and evaluating the resource. Thus there are a few conditions which could affect the data. There could be some sense of bias since both teachers know that the resource was created by myself, they may feel reluctant to pass on any negative responses. However, I am pretty certain of the positive and honest relationship I have with both teachers, which is one of the reasons why I decided to trial it through them. However, in order to ensure that no bias occurs, the teacher will be asked to

make note of any significant responses, positive and negative. Furthermore, the interview questions will be purposely adapted so that some criticisms can be gathered.

3.6 Data Collection Procedures

Both teachers will be asked to determine and record, prior beginning the book, how many pupils already possess a fixed mindset. This will be done by reading a statement, and asking the pupils whether or not they agree with it. The teacher will be asked to determine this amount again after reading the book. This data will primarily answer my first research question, however the opinion of the teacher will of course also be taken into account.

In order to answer the second research question, and to get a broader view of the first research question, the semi-structured interview will be fully availed of. The interview questions will be themed according to the literature reviewed and the research questions. Using themes to categorise the questions will allow the interviewees to organise their own thoughts, compose their replies and keep on track for the remaining questions. Of the interview questions 14 will be open, and 4 will be closed. Using the two different response formats, will not only allow for the gathering of the opinions and thoughts of the teacher, but also allowed for the necessary statistical figures. This will hopefully enable the two research questions to be effectively and fully answered.

3.7 Ethics

In order to adhere to ethical considerations, an ethics form has been completed and signed.

4. RESULTS, ANALYSIS & CONCLUSION

The following chapter will present the results of the research, and provide an analysis of these results in the context of the literature. Conclusions will then be drawn at the end of the chapter. My research questions were as follows:

1. Can the book truly help change pupils' attitudes towards the learning of mathematics and help them develop a *'growth mindset'*?

2. Can the book help pupils overcome the two common misconceptions involved in learning to read time?

   (Attributing the hours/minutes to the incorrect hand & Reading the dial numerals for minutes as well as hours)

4.1 The Participants

The resource was piloted and evaluated within two inner city schools, School X and School Y respectively.

	Trialled by	Years of Experience	Based	Key Stage	Primary	Class Size
Pilot	Class Teacher	+20	School X	1	4	25
Evaluation	Class Teacher	+20	School Y	1	4	22

After the pilot and evaluation, a semi structured 1-1 interview was held. In attempt to keep the data as detailed and as accurate as possible, the evaluation interview was recorded. The teacher who piloted the resource did not wish to be recorded.

4.2 Data Organisation

Three key themes derived from the literature review. Firstly, it became apparent not only how crucial and beneficial the ability to adopt a '*growth mindset'* is. But also how unknowledgeable teachers typically are in their application and implementation of this concept. Secondly, the current trend and attitude towards the learning of mathematics made it distinguishably clear that mathematics was the subject most in need of a *'mindset makeover'*. Finally, the benefits of using story as a means of teaching mathematics became undeniably and undoubtedly clear.

With these three key themes in mind, the interview questions were grouped together into 4 categories; '*The Mathematics Entailed', 'The Growth Mindset Integrated', 'The Resource in the Classroom,* and '*The Use of the Guidance Booklet.*

4.3 The Mathematical Content within the Resource

When asked about the current attitude that pupils typically possess when learning mathematics, the teacher admitted that:

> "*I have personally witnessed a continuous negative attitude towards the learning of mathematics… more than any other subject; it is surrounded by this great sense of hesitation and doubt. Pupils are not confident, they're extremely afraid of the consequences and humiliation that comes along with being 'wrong'*".

This fully supports what was outlined in the literature review in that as a subject, mathematics is majorly disliked by pupils. It has the power to crush pupil's confidence, and to deter them from learning methods and skills important for future years. For this reason, it is in fact "*the subject most in need of a mindset makeover*", Boaler (2015).

When questioned on the average pupil's ability to grasp and understand the KS1 topic of *'analogue time'*, the teacher admitted that:

"Having taught for twenty years, I myself have noticed a distinct change in the ability to read and measure analogue time. This seems to be in some way linked to the advances in technology"

This again fully supports what was mentioned in the literature review. The 21st century has been described as the "*digital world*" [Coppock, 2016], and with constant exposure to digital time on computers, phones and other devices, pupils are seemingly able to '*coast*' through the topic of digital time. However, when it comes to learning to read analogue time, pupils often experience great difficulty, Burny (2012) [Cited in Metelerkamp, 2013]. Both points made above, fully support the need and demand for a *'growth minded'* mathematical resource.

When questioned on the presentation of the mathematics within the e-storybook, the teacher claimed:

"The mathematics was clear, coherent, logical, and structured in a way which was extremely easy for the pupils to follow. The language and the illustrations were simple but well adapted. I did not have to clarify any of the mathematics … the two targeted misconceptions were simply but effectively approached"

The use of clear and simple illustrations suggested by Hernandez (2007) in the literature review, has proved to be extremely successful with this class. Zooming into the clock, and focusing on the dashes which represent minutes, allowed the pupils to make sense of the learning for themselves. Using the definition from a third grade pupil, provided by Ms K (2013), meant that the language was easy for the pupils to follow and understand. Allowing the pupils to make such sensible visual representations ultimately enabled them to make their own mathematical connections. Following the ALPS model, and integrating action, language, picture and symbol together has seemingly made the learning extremely easy, so far so, that the teacher did not have to apply any additional input.

When questioned on how '*challenging*' the pupils found the resource, the teacher admitted that:

> *"This was not too challenging for my class, although I would consider them as high achievers. For a weak or even average class, I do see how valuable and beneficial this resource would be "*

This response contradicts with that was found in the literature review. Cierco (2017) claims that pupils in second grade (pupils aged 5-7) struggle the most with learning how to read and measure analogue time. Although the class is considered '*high achieving*', when piloting the resource, a similar problem arose. Both groups of pupils seemed to have '*coasted*' through the mathematics fairly easily. This led to the belief that the resource was not targeted appropriately at a suitable level, perhaps the resource should have been primarily and exclusively targeted at primary threes, as opposed to the initial general '*Key Stage 1*' class.

When questioned on the use of story as a means of teaching mathematics, the teacher admitted that:

> "*It was rare, something only really seen in foundation stage. However, seems extremely effective… The story held the pupils focus and attention throughout. I really liked how they were given opportunities to discuss and talk about the mathematics this is something that can be easily forgotten about in a typical or traditional maths lesson"*

This response completely coincides with what was written in the literature review, Flannery [Cited in Boaler (2015)] claims that children are not talking enough about the mathematics they are engaging in, she claims that it is vital for their understanding; *"There is a hell of a difference between…listening to maths being talked about and thinking that you understand it… and thinking about maths, understanding it and talking about it to someone else"* [pg32].

Finally, when questioned about any changes that she may make in regards to the mathematical content within the book, she answered:

> "*Possibly highlight how the pupils can use their 5 times tables".*

Although this is a fair idea, if it were to be implemented, it would contradict with what was said in the literature review. Dweck (2010) claims that if we are truly to develop a growth mindset and attitude towards the learning of mathematics, we must let these ideas grow out of the children, and lead them to see these patterns and relationships for themselves.
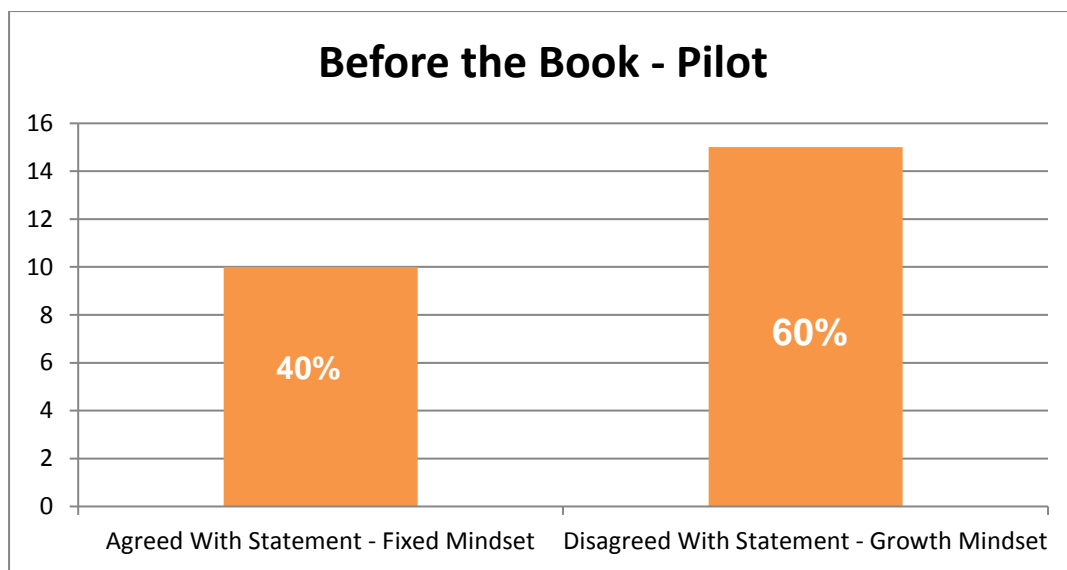
4.4 Using the Book to Develop a Growth Mindset

Both teachers who piloted and evaluated the resource, had no previous knowledge or awareness on the concept of '*growth*' and '*fixed*' mindset. Although this is only two of many teachers in Northern Ireland, it would seemingly imply that the literature review is correct in that there is nowhere near enough awareness surrounding Dweck's '*growth*' and *'fixed'* mindset concept. This lack of awareness could be possibly due to the fact that Dweck's research is still fairly '*new*' and is yet to properly surface, or quite possibly down to the fact that despite the various studies which prove academic success, some educators are still calling it a '*phantom phenomenon'*, [Dweck, 2017].
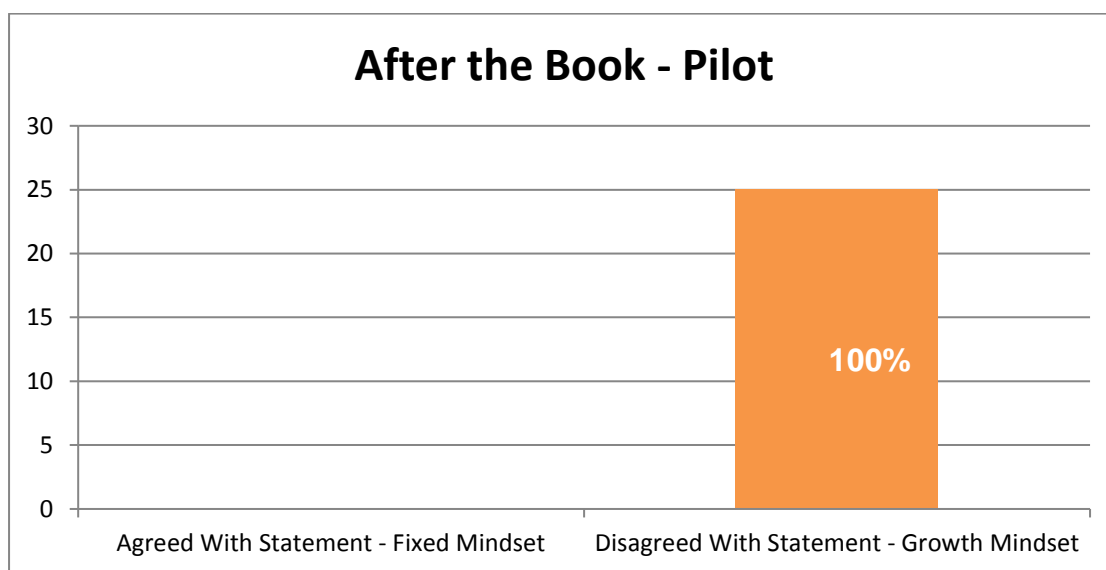
Before and after the book, I asked both teachers to record how many pupils agreed with the following statement:

> *"You are either good at maths, or you are not. There is nothing you can do to change this"*

The teacher who initially piloted the resource, found that before reading the book, 10 out of 25 of her pupils agreed with this statement, whilst 15 of her pupils disagreed with the statement. This meant that 40% of her pupils initially possessed a fixed mindset attitude towards the learning of mathematics, whilst 60% initially possessed a growth mindset.

Before the Book - Pilot

(bar chart)

- Agreed With Statement - Fixed Mindset: 10 (40%)
- Disagreed With Statement - Growth Mindset: 15 (60%)

However after reading the book, when the teacher read the same statement, 0% of pupils agreed with the statement, whilst 100% of pupils disagreed with the statement.
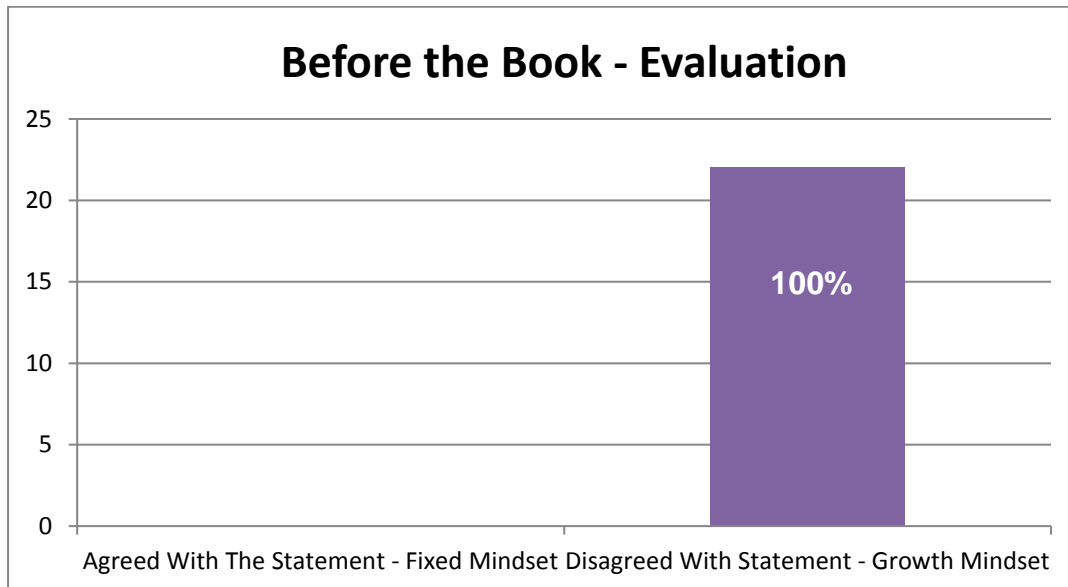
After the Book - Pilot

(bar chart)

- Agreed With Statement - Fixed Mindset: 0
- Disagreed With Statement - Growth Mindset: 25 (100%)

When questioned about the impact of book upon these statistics, the teacher admitted:

> *"The book and the insightful discussions which it created, in my opinion most definitely*
>
> *had an impact on the change which occurred, in the attitude and mindset of the pupils"*

I asked the teacher who evaluated the resource, to complete the exact same task. However, she found that before reading the book, the entire class had already disagreed with the

statement, and thus all of them had hypothetically already possessed a growth mindset attitude towards the learning of mathematics.

Before the Book - Evaluation

A bar chart titled "Before the Book - Evaluation" with a y-axis ranging from 0 to 25. There are two categories on the x-axis: "Agreed With The Statement - Fixed Mindset" (no bar) and "Disagreed With Statement - Growth Mindset" (a purple bar reaching about 22, labelled "100%").

This statistic contradicts findings from the literature review. Literature shows that as soon as children begin to compare themselves to others, which can be as young as 4 years old, they are extremely liable and probable in developing a fixed mindset, [Gross, 2016]. Whilst all the pupils in this class seemed to already possess a '*growth mindset',* the teacher admitted:

> *"The fact that every child disagreed with the statement, was a shock even to me. I know that this would not usually be the case had it been any other class in the school... However, whilst they all did disagree it did raise good discussions which proved to be extremely worthwhile"*

When questioned on how relatable the book was to the pupils, who had seemingly all already possessed a growth mindset, the teacher answered:

> *"Extremely relatable. There was actually an incidence in the morning just before reading the book. A child became very upset when although they had a great achievement, another child did slightly better. I was able to use the book to emphasise*

that they are in competition with themselves… The book helped to broach the topic in

a sensitive manner and let other children give their opinions"

Although the pupils all seemed to have a growth mindset, it became clear that there is a distinct difference in claiming that you agree with something *[the statement]* and physically putting this belief into action. The benefits from using story, which the teacher experienced was also supported in the literature review. Story is one of very few resources which can relate and connect to pupils in an emotionally meaningful way. This relation and connection which occurs can be used in a powerful and evocative way, to effectively cultivate values and moral messages to pupils, Boaler (2015).

4.5 The Resource in the Classroom

Whilst discussing the resource itself, the teacher was questioned on the physicality element of it. The teacher admitted:

"Since P1 or P2, the children had not been exposed to such picture books with so

much rhyme and alliteration. I think this is why the children liked the book so much.

They said they liked how it was bright and colourful…. they also enjoyed the moral of

the story"

The use and integration of such story telling techniques was supported and discussed within the literature review. Nedovic (2017) claims "*As a broad rule, young children often enjoy books*

that have good rhyme, rhythm and repetition. In fact, one of the primary ways in which children

learn, is through repetition and rhyme.

After reading the book, the teacher and the pupils were asked to rate the resource on a scale from 1-10. The teacher admitted:

> *"Me and the pupils agreed that the book would score a 9 out of 10. The book was extremely easy to follow… it was the perfect length and pupils found no problem in maintaining their attention and focus."*

The duration of the book was designed according to what was found in the literature review, in that children aged between 7 and 9 hold an attention span of no longer than 10-15 minutes.

When questioned on what could be done in order to improve the book so that it would score 10 out of 10, the teacher admitted:

> *"Some of the language may need adopted so that it can flow a little bit smoother. However in saying this… the book is still undeniably a valuable resource and something that I would most definitely consider using in the future"*

The importance of language, style and tone within a book was outlined and emphasised in the literature review. However from this response, it would seem evident that there was not enough time spent on this element.

When questioned on the format of the book being an e-book. The teacher admitted:

> *"It worked well in the sense that the e-book could be linked to the interactive whiteboard and shown to the whole class. This meant that not only was every pupil able to see the book, but they were also able to read the book and follow the words alongside me…. I found this extremely useful for my EAL students who often struggle keeping up with spoken English, but can follow with ease written English"*

The benefits of e-books in engaging the pupils in modelled, shared and guided reading were supported and outlined in the literature review. However, the benefits found to EAL students, although now easily acknowledged, were surprising since no reviewed research directly pointed to this.

When the teacher was questioned on the drawbacks of the e-storybook format, she did admit:

"You have to be careful not to lose the comfort, ease and security which is sensed when gathered up on the carpet reading a physical story book to the pupils. Especially since the book enables such sensitive discussions to arise, the pupils need to feel comfortable if they are to fully engage…. I found that bringing pupils down to the carpet, as opposed to keeping them at their tables worked well in overcoming this"

This limitation was not initially thought about since it did not arise in the literature review. However, as its relevance and importance appears seemingly obvious now, it is an idea which may be addressed or advised in the guidance booklet

4.6 The Guidance Booklet

When the teacher was questioned on the usefulness of the guidance booklet, she admitted:

"The guide proved useful in informing teachers about the theory behind the mindset concept however, in all honesty, I did not use the guide in delivering the resource. It may be useful to new or inexperienced teachers, but in a busy classroom I tend to go straight to the learning"

The teacher who piloted the resource was also of the same conclusion. It does support the literature in the sense that some sort of document was needed to inform the teachers of the psychological theory behind the book. However, there was no actual need for a guide to help the teachers deliver the resource.

5. CONCLUSION

After months of investigation and research, I can now confidently assert that I have not only gained a great insight into the way children's minds operate - affecting how they think, behave, and perform. But I have also gained great insight into how we as teachers can implement strategies to impact and influence their mindset, ultimately leading them towards greater success and achievement.

5.1 Research Findings

In attempt to evaluate the effectiveness of the e-storybook, the following two research questions were constructed;

1. Can the book truly help change pupils' attitudes towards the learning of mathematics and help them develop a '*growth mindset*'?

2. Can the book help pupils overcome the two common misconceptions involved in learning to read time? *(Attributing the hours/minutes to the incorrect hand & Reading the dial numerals for minutes as well as hours)*

In terms of the first research question, I do definitely believe that the resource holds some power, and some influence in encouraging pupils to view the learning of mathematics in a different light. The quantitative statistics taken from the pilot, [*60% holding a growth mindset before the book, 100% holding a growth mindset after the book],* would certainly imply that that after reading the book, and engaging in the insightful discussions which arise from the book, can actually help shift pupil's mindset from fixed, to growth. In saying this however, I am quite aware that mindsets do not change instantaneously. Altering pupil's mindsets is something which will take a lot longer than 10-15 minutes, and thus such '*growth mindset'* strategies will need to be continuously implemented and emphasised not only over the long term, but also across the curriculum.

In terms of the second research question, I do believe to a certain extent that this was achieved. During the pilot and the trial, both teachers agreed that the pupils had "*no issues*" in learning the mathematics at hand, and overcoming the targeted misconceptions. The teacher who evaluated it said that the pupils were perfectly able to grasp the mathematical content at hand, and that she *"did not have to clarify anything"*. Not only did this lead me to the belief that the book was successful in helping pupils overcome these two misconceptions. But it also gave me the idea that it could also be used as an independent study tool in the classroom, or even at home.

In contrast to the points made above, I am weary of the fact that the two classes in which this resource was trialled with were considered '*high achieving'*. It is possible that they could have overcome the outlined misconceptions without use of the book at all. Thus I am hesitant to conclude and confirm that the book will definitely help every single pupil in KS1 overcome the targeted misconceptions.

5.2 Improving the Project

If I had the opportunity to re-complete this project, or to do it over again, there are a few changes I would make. I would most definitely trial the resource with a '*weaker*' class, or even a primary three class. This would allow me to gather a more rounded and realistic view on how they coped with the mathematics. Perhaps then I could make a sounder conclusion on the second research question. Furthermore, I would most definitely allow myself more time to create and complete the resource. Using this extra time, I would spend more time on the language used in the book to ultimately improve the style and tone of the book.

5.3 Recommendations for Future Research

With the '*growth'* and '*fixed'* mindset concept only properly surfacing the education world in recent years, I seemed to come across a lot of interesting concepts which are not entirely

backed up with a ton of research. Particularly within the idea of the teacher having a '*growth*' mindset. The influence and impact that a teacher's mindset can have on her pupils is gaining more and more traction, and is something that I feel would be extremely beneficial to explore in regards to the teachers of Northern Ireland. Determining teacher's mindset, and comparing this with the mindset of their pupils, as well as their achievement is something I feel would be quite insightful. Heggart (2015) is of the opinion that the ability of teachers to adopt a *'growth mindset'* for themselves is crucial, not only for their own practice, but also for the success of their students.

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Appendix 1: The Story Line

Tony is just like any other turkey; he is fairly small and fairly happy. Tony like every other Turkey cannot read the time, however he has an impeccably strong devotion and love for dancing. Although everyone recognises the impressive dancing skills that Tony possesses, no one is really or truly jealous. It's clear that because of their mathematical in capabilities, no one really wants to be a turkey. Everyone knows that this deficiency is in their blood, it's genetic. No turkey has ever been able to tell the time.

Upon the hearing of the '*Annual Tennessee Dance Tournament'* coming to town, Tony quickly becomes discouraged and dispirited. Tony quickly concludes that due to his inability to tell the time, he will never know when "*Twenty Minutes Past 2*" is, and thus he will never make it to the dance tournament on time. On his way back home, he meets the '*Wise Old Sparrow'*. Initially Tony asks the sparrow to simply tell him when twenty past 2 is, however the Wise Old Sparrow refuses, he is keen to teach Tony how to tell the time. As the Wise Old Sparrow helps Tony overcome some common misconceptions associated with telling the time, he also develops within him a '*growth mindset'*, a belief that intelligence is not fixed and with persistence, flexibility, endurance, resilience and with the correct attitude, you can truly learn whatever you wish. Tony eventually masters the skill and realises that the time is 'Twenty Past 2' and thus makes his way to the dance tournament as quickly as possible.

Tony makes it to the dance tournament on time, he gets up on the stage and dances the best that he has ever before. When the winners' names are announced, Tony's name is not said. He quickly becomes upset and begins to doubt his dancing abilities. However, as Tony reflects back on the words of the Wise Old Sparrow, he realises that just because he hasn't won this year, doesn't mean he will never win. Tony without the help of the Wise Old Sparrow, puts his growth mindset into action. He realises that with more effort, a different routine, a bit more creativity, he may actually win. Tony eventually applies his growth mindset attitude to both academic and personal achievements and realises that failure is all part of life;

> *"It's impossible to live life without failing. Everyone will make a mistake or two. Unless you live so carefully small that you may as well never lived at all."*

Appendix 2: Planning the Resource

Planning the Storyline

The book will be designed to last no longer than 15 minutes since it was found from the literature review that children aged between 7 and 9, have an attention span of approximately 10-15 minutes.

The title of the storybook will be, "*Turkeys Can't Tell the Time"*. The main character being a turkey was purposefully chosen due to not only their social and playful nature, but also due to their common reputation of being '*dumb*' [Parsons, 2014]. It also allowed for alliteration within the title. Lorenz (2013) claims that using alliteration in book titles can help in people remembering your book since it "*helps your work stand out, and engages your reader before they even open the book*".

In the beginning, the reader is to be introduced to Tony the Turkey. They not only learn about his devotion and his love for dancing, but they will also learn about his mathematical difficulty. According to Kieffer (2016), the key to creating a relatable character, is to make the reader aware of their internal struggles, this makes the character *'real'* for the reader. In the beginning, the setting will also be announced. Tony will be set in a ranch in Tennessee, this will place him in the company of other animals who can tell the time. Again this relates to the 'struggling' child, he/she could well be sitting in the classroom unable to tackle a particular mathematical concept, whilst everyone else in the class has been comfortably able to grasp an understanding of it.

Upon the hearing of the dance tournament, Tony will realise that due to his inability to tell time, he is unlikely to be punctual. This will give those readers with a fixed mindset, a chance to sympathise and emphasise with Tony. They will still believe that because Tony is a turkey, and because Turkeys cannot tell the time, that Tony simply does not and will not ever have the ability to read time.

The Wise Old Sparrow, will be the voice of the '*growth mindset*'. His role is not only to help Tony overcome the common misconceptions involved in reading analogue time, but also to help Tony to develop a growth mindset as he fills Tony with his enthusiasm, motivation and words of wisdom.

When Tony doesn't win first place at the dance tournament, he remembers the words of the Wise Old Sparrow and puts his own growth mindset into place. Tony remembers that anything is possible, and with more practise, technique, effort and persistence, Tony might win next year. This not only re-enforces the concept of growth mindset to pupils, but it also applies it to other situations, outside of the classroom. Dr. Lavey Friedman [Cited in Savacool (2017)] sums it up when she says

> *Teaching resilience now sets kids up for success because they learn that failure isn't the end of the world. It's just a chance to try again.*

Planning the Mathematics

According to the NI Curriculum by the end of Key Stage 1, pupils should be able to read and *"recognise time on an analogue clock"* [pg63]. In order to fully master this, pupils must understand and overcome the two common misconceptions previously outlined in the literature review.

→ Pupils often use the dial numerals for reading the minutes, as well as the hours.

→ Pupils often attribute hours and minutes to the wrong hand.

[Harris, 2000]

These two misconceptions will be the mathematical focus of my storybook, however before pupils jump in to overcoming these, it may be useful for the class teacher to revise and review some prior time telling concepts. Bennett (2017) claims that pupils should be comfortable in

counting to 12 (hours) and also counting to 60 (minutes) in 5's. Thus it may be useful for the teacher to revise the 5x tables beforehand. Bennett (2017) also claims that before learning to tell the time within 5 minute intervals, pupils must be able to tell time to one hour, half-hour, and quarter hour. Throughout the book, before reaching the '*new*' learning I have purposely placed, a few clocks with these '*basic*' times on it. As the reader moves through the book, they should be encouraged to calculate and read the time on these clocks, in preparation for the new learning.

The first misconception explains that pupils often read the dial numbers as minutes. In the book, Tony falls for this misconception as he reads the time as "*1 minute past 3*" instead of "*5 minutes past 3*". Instead of telling the reader straight away why this is wrong, the wise old sparrow will ask Tony to think about <u>why </u>this might be. This offers the pupils some thinking time as they consider the reason behind this concept. The Cockcroft Report (1982) agrees with this concept. It states in paragraph 321 that *"independent thinking needs to continue"*. The report encourages pupils *to "come to their own conclusions"*, and to use "*their mathematical thinking to reach a high level of independence*".

Incorporating visual representation, the Wise Old Sparrow will point out the dashes between the numerals which represent the minutes. Within this visual representation, the pupil/reader is implicitly shown <u>why</u> we say '*5 minutes past'.* However, instead of revealing the conclusion explicitly to the reader, the Wise Old Sparrow will probe the reader through the same questions again. This will allow pupils/readers to consider their prior knowledge and create a "*network of connections"* [Haylock & Manning, 2014]. This is what ultimately allows pupils to explicitly engage in Piaget's (1953) process of '*accommodation*' and '*assimilation*', as they take their existing knowledge, and adopt it to '*connect*' with the new incoming learning, [Cited in McLeod, 2017]

 If we are to truly develop a growth mindset and a love of '*true*' mathematics within the pupils/readers, now is not the time to reveal the trick "*Yes we count in 5's as we go to each*

numeral". Instead in the book, the Wise Old Sparrow will repeat the process as he counts 6/7/8/9/10 minutes past. Once the minute hand reaches the 2 for 10 minutes past, the sparrow will ask Tony if he notices any sort of pattern. To which pupils again should be allowed some time to <u>talk</u> and discuss any patterns that they see. Vygotsky emphasised the importance of '*social constructivism'* when pushing pupils to the '*Zone of Proximal Development'*. Atherton (2013) points out that children learn better when working in collaboration with a MKO [More Knowledgeable Other]. This isn't because the MKO is showing or teaching the pupil how to do the task, but rather the process of engagement is enabling the learner to refine their thinking. Boaler (2010) points out that all pupils benefit through working alongside a peer and engaging in mathematical talk. "*The students who are talking are able to gain deeper understanding", as they reconstruct the mathematics in their minds, and "the ones who are listening are given greater access to understanding"* [pg44].

Once pupils accept this concept and connection, the second misconception can be overcome quite easily. In the book, Tony will eventually show full understanding of why we count in 5's going around the clock, however he will get mixed up in attributing the hours and minutes to the correct hand, *"I know that its either 5 past two, or ten past 1"*

Again, the Wise Old Sparrow will ask Tony and the reader to think of ways in which we can distinguish between the hour and minute hand. This discussion is particularly important as pupils themselves adopt and use specific mathematical language to reason and justify a particular method of their very own. This ties in with Piaget's & Bruner's idea of '*discovery learning*'. Discovery learning, focuses on the idea that children *"learn best through actively exploring"*, [McLeod, 2017]. As the pupils actively explore, and come up with 'rules' or 'tips' to distinguish between the two clock hands, they also get the opportunity to hear the ideas of their peers. Cully (2016) agrees and claims that, *"children need regular opportunities to engage in purposeful mathematical dialogue and it is essential that children have opportunities for mathematical discussion at all stages of their learning".*

After this discussion, the Wise Old Sparrow will reveal how he distinguishes between the hour and minute hand. That is, that the minute hand is long since it's trying to reach the dashes, that we now know, represent minutes. However, the hour hand is short, because it only needs to reach the numeral on the clock which represents the hour, [Ms K, 2014].

Throughout the book, the pupils/readers are constantly engaged in the NIELB ALPS model, since they are continuously exposed to <u>the</u> four elements; *action, language, picture and symbol*. They engage in '*action*' as they immerse themselves in the story, familiarise themselves with characters and relate themselves to the plot. They engage in '*language*' through the constant discussion and questions posed throughout the story. '*Picture*' is continuously used in the book to illustrate and explain mathematical concepts, this will help pupils create mental images which will help in the recollection and recall of mathematical facts. Finally '*symbol*' is used as pupils are encouraged to recognise the 12 numerals on the clock, which are regarded by the hour hand as just that. However, pupils are encouraged to manipulate the minute hand and regard these symbols/numbers as groups of 5. This model explicitly relates to Bruner's three models of learning – *enactive, iconic and symbolic* [Bruner, 1947]. Pupils are "*experiencing in real form the mathematical concept…in a real world context*", they are ultimately given the greatest opportunity to "*engage in meaningful learning*" *(*Teaching Learning Model, 2006).

Planning the Growth Mindset

The title "*Turkeys Can't Tell the Time*" was chosen since it instantaneously places the reader into a fixed mindset, they realise that it isn't just Tony who is unable to tell the time, but the whole turkey species. This may relate to some pupils especially those who say, "*I'm not a maths person since I'm like my mum and my mum isn't good at maths*".

As the reader is introduced to Tony, they are unconsciously immersed in his '*fixed mindset traits*'. Tony has "*always been a good dancer*", it's a natural talent of his. However, Tony

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happily accepts that he can't tell the time, he isn't bothered at all since he realises that no Turkey has ever been able to tell the time. When Tony hears that the dance tournament is on at twenty past two, he becomes disheartened quickly is clearly "*discouraged by failure*" [Sparks, 2013]. Tony would rather give up immediately than challenge himself and risk failure. Immediately those pupils who believe that ability is inherent and unchangeable, will relate to Tony's feelings as they themselves have sacrificed significant learning opportunities in the past all because it *"required them to risk performing poorly, or admitting deficiencies"* [Blad, 2016 pg1].

On Tony's way home he stumbles across the Wise Old Sparrow. The purpose of this character is help Tony overcome the common difficulties associated with time telling, whilst integrating and nurturing a growth mindset through the strategies previously mentioned in the literature review.

The Wise Old Sparrow will purposely give Tony throughout the story, a "*clear sense of progress*". In the beginning, the sparrow makes it clear to Tony that mastering the skill of time telling, may take a few tries. This will help Tony/the reader understand that the '*fastest*' learning isn't always the best, deepest or most meaningful learning. Applying this to other aspects of numeracy, those pupils who are usually defensive in the face of failure, can see that "*those students who take longer sometimes understand things at a deeper level",* [Dweck, 2010].

Furthermore, in order to motivate and encourage Tony/the reader to continue in their progress, even in the face of failure, the book aims to '*create a culture of risk taking'*, [Dweck, 2010]. Thus, instead of praising Tony for his '*ability*' or for his '*intelligence*', the sparrow will praise him for the processes in which he engaged in, for the effort he applied, the strategies he adopted, the choices he made, and finally he persistence he displayed. Even in the face of failure, instead of exhorting Tony to '*just try harder'*, he will point out the positives in his failing *"There are no such things as failures, just discoveries"* and *"You haven't failed, you have just*

found one way that doesn't work, so well done!". This will hopefully portray to the reader that mistakes are not '*humiliating*' or '*embarrassing*' but rather, they are evidence of effective learning.

Thirdly, the Wise Old Sparrow will *"emphasise challenge not success".* Initially, Tony is reluctant to even attempt to read the time, he wants the sparrow to simply tell him when twenty past two is, instead of learning it for himself. The Wise Old Sparrow will portray these challenges as fun and exciting, whereas getting the answer straight away, is *"boring and less useful for the brain".* When Tony initially struggles and makes mistakes, the Wise Old Sparrow will encourage him to see it as an opportunity to learn and grow and to try different strategies. This will hopefully portray to the reader/pupils that it's perfectly normal not to know something, but it's not ok, not to try.

Lastly, the wise old sparrow will incorporate and give tony the *"grade for growth".* When Tony fails, he becomes easily discouraged and constantly complains that he "*can't tell the time!*" .Upon hearing this, the wise old sparrow will add the word "*yet*", to the end of his sentence. This habit that the wise old sparrow possesses' is simple, yet extremely effective. The reader will see that although Tony is a Turkey, and regardless of the fact that Turkeys could never tell the time, by using the word '*yet*' they are reminded that Tony is expected to master the material eventually. Hopefully this will portray to the reader/pupils the idea that ability and motivation are both fluid.

 As the story comes to an end, Tony participates in the dance tournament but unfortunately doesn't win the dance competition. Although the wise old sparrow is no longer present, the '*voice*' of the growth mindset remains with Tony as he realises "*oh this is a chance to grow*". Tony then realises that for next year, he is going to try a new routine, he's going to ask for the advice of others, and he's going to practise extra hard, then maybe he will take away the crown.

Appendix 3: Creating the Resource

I decided to create my story book online at mystorybook.com. After researching and evaluating a few possible websites, I decided that not only was this one the easiest to use, but it also received some excellent reviews from currently practising teachers.

Using the site was extremely easy to follow and use. I found that the text and images already on the system looked extremely well, and fitted in with my theme and target audience, I had to add little of my own images and backdrops, from which I mainly got from ClipArt and Google Images.

After browsing the website a little, I found that not only was the website designed for classroom use by teachers, but also by pupils! In the '*library*' section of the website, there are endless amounts of books created by children of all ages. It seems like a lot of teachers integrate the website into the ICT & Literacy classes. Thus, if I was able to familiarise myself and train myself up in how to use the website efficiently and effectively, I myself could deliver this and incorporate the programme into my own lessons as the pupils use the programme to create their own books.