The Scientist in Fiction

How Do Primary School Children Engage with
Fictional Representations of Science and Scientists?

Elizabeth Delaney

A thesis submitted to the University of Huddersfield in partial fulfilment of the requirements for the degree of Doctor of Philosophy

The University of Huddersfield

June 2018

"Every kid starts out as a natural-born scientist, and then we beat it out of them. A few trickle through the system with their wonder and enthusiasm for science intact."

Carl Sagan (1934 – 1996)

Abstract

Although for decades attempts have been made to persuade young people toward careers in science, there still exists a global shortage of science and engineering graduates. As there is growing evidence to suggest that young children's early childhood experiences can influence career choices, this research explores how primary school children's engagement with fictional representations of science and scientists may be shaping their perceptions of the same. In this regard, the research seeks to frame interventions, using stories, to encourage more positive impressions of a life in science.

The qualitative methodology draws upon reader response theory wherein the reader is positioned as the maker of meaning for any text; and also upon the associated theory of interpretive communities which acknowledges that the ways in which the reader comes to create/recreate meaning are drawn from the interpretive communities to which she or he belongs.

The research engaged 46 primary school children, 9-10 years of age, from two Year 5 cohorts, over two years, in a school in the North of England. By writing, reading, sharing and discussing their own and others' stories about science and scientists, the children were encouraged via two unstructured and four semi-structured group interviews to share their thoughts and ideas about their own and others' fictional scientists, and about how they felt those ideas related to real scientists in the real world. The children's words were transcribed, thematically coded and analysed, and emerging themes further explored.

The children felt that 'being a scientist' presents a lonely and unhappy landscape, devoid of friends or family, as one's life remains dedicated to the pursuit of doing good in the world at the expense of one's own happiness. They felt, too, that 'doing science' for a living is a lot of work, dangerous and can even kill you and, although the children felt that it isn't particularly intellectually difficult work, it is still something that 'other people', smarter or more maths-oriented people, do.

Primary school children do not think about putting science and scientists into stories – and they are never asked to do so. When asked, specifically, to write a story within which at least one character has to be a scientist, the aesthetic as opposed to efferent stance with which the children re/create their texts, precipitates unique de/reconstructions and re/creations of meaning with respect to not only what it might mean to do fantastic fictional science and be a fantastic fictional scientist but with respect to what it might mean to do real science and be a real scientist, too.

When asked to share their stories about science and scientists, the children, by calling into being texts re/created by others as well as themselves, re/create and re/generate – both as authors and as readers from within their own unique interpretive communities – fresh cascades of fluid meaning about both fictional and real science and scientists.

If we wish to persuade more young people toward careers in science and engineering, we could harness this phenomenon: in encouraging children to re/generate cascades of de/reconstructions and re/creations of meaning about science and scientists, the identity that is 'scientist' will come to be de/reconstructed many times, as will the identity of the child herself or himself in

association with the same; and if ideas about one's life design begin in childhood, any interventions developed in order to encourage young people toward a life in science might best be employed, therefore, at primary school.

Hence, the first intervention is a reflection of the research itself, wherein, using their own unique aesthetic transactional stance, children are given the opportunity – that is, they are specifically asked – to create, share and discuss their own and others' stories about science and scientists. The children, thereby, will call into being myriad cascades of fresh, unique, fluid meaning about doing fictional and real science and about being fictional and real scientists – meaning that, otherwise, would never occur.

The second intervention – requested, in part, by the children themselves – engages both an aesthetic and an efferent transactional stance simultaneously. As long as fictional (literary) stories about science and scientists are rare, more are needed. These stories, however, besides being aesthetically pleasing should also embrace an efferent informational stance; that is, the children felt that if fictional stories about science and scientists incorporated some real science, they might be more inclined to engage with the same and might re/consider the idea of being a real scientist doing real science in the real world.

In both these interventions, because the children clearly understood the fictional evil or mad scientist to be a story trope, the Scientist in Fiction – the character that is the evil or mad scientist – should remain as she or he already is as their *raisons d'être* lie entirely in the making of the type of fun or funny, exciting and entertaining stories that the children are interested in reading.

Table of Contents

List of Figures

Chapter 1 – Context and Aims of the Research

Introduction

For decades it has been understood that there are challenges associated with encouraging young people to choose a career in science (Bodmer, 1985; Hirsch, 1958; Smith & Gorard, 2011). There is growing evidence, too, that suggests that experiences in early childhood can influence career choices (Gysbers, 1996; Hartung, 2015; Watson, Nota, & McMahon, 2015). This research embraces these two ideas and focuses upon how young children's views of science and scientists might be formed long before they make definitive career decisions.

In particular, the research considers how primary school children's engagement with fictions may be shaping their perceptions of science and scientists.

It is hoped that a better understanding of what these perceptions are and how children construct these perceptions will shape the development of interventions that draw on fictions to encourage or strengthen more positive views of what it means to be a career scientist.

The research is informed by literary theory, particularly the reader response school of thought that establishes the reader as an active participant in the making of meaning. The research also looks to the theory of interpretive communities, a concept stemming from reader response theory, that suggests that the ways in which a reader interprets texts and creates meaning are an effect of the interpretive communities to which she or he belongs.

For this reason the research goes beyond the analysis of specific fictions, and seeks instead to devise creative approaches to exploring the ways children make meaning from fictions and particularly from those literary fictions connected with science and scientists. In this regard, the children taking part in this research are asked to not only recall science and scientist stories they are already aware of, but are also asked to write, share and discuss their own and each others' stories about science and scientists.

I chose to focus upon fictional stories about science and scientists rather than non-fictional stories because my experiences as a professional writer (of fiction) have served to illustrate not only the power of the written word but also how, upon reading, speaking or acting them out, written words can call into being different meanings for different people, and the same words can be re/interpreted far away from their intended meaning and/or the spirit in which they were meant.

My studies in science, particularly the study of space, time and cosmology (the nature of the origin and the evolution of universe), have opened my mind to realities that can be as fascinating, as provocative and as mysterious as fictions. When doing research with children, however, I still feel that it is by using constructs that are familiar to them – that is, stories and the children's calling into being of their own imaginative fictions – that we may better explore children's ideas about science and scientists. We exist in an amazing space, in an amazing time and it is the children of current and future generations that, using the power of their imaginations, will push past and explore beyond the boundaries of existing knowledge to create new scientific realities – that is, of course, if they choose to embark upon a life in science.

Most significantly influential, however, are my experiences as a mother and as a volunteer primary school 'library lady' helping and watching children engage with and thoroughly enjoy the fictional worlds of both the stories they are told and the stories they tell. These children and all their wonderful tales and ideas are treasures that I feel privileged to have encountered; they have had an immeasurable impact upon my way of being in the world and, having done so, have inspired me and guided me toward this research.

In coming to define the research aims, however, it is important to first outline the social, political and economic context within which the research originates. Hence, from the governmental concern about the public understanding of science brought to a head in the 1980s, this chapter first outlines the past and present concerns about science education and the Science, Technology, Engineering and Mathematics (STEM) pipeline in the UK, and then lays out the state of play with respect to the shortage of STEM graduates and technicians, both before and after the global economic downturn of 2008. The shortage of graduates is then traced backward through the STEM pipeline, from undergraduate degree level back through to GCSE and A Level candidacy, then further back to earlier still in the STEM pipeline: to examine primary school science and compare the Standard Assessment Test (SAT) scores that children were achieving before the Government abolished Key Stage 2

Science SATs with the Teacher Assessment scores that primary school children are attaining after the abolition.

The 'encore' career paradigm is then discussed wherein, in a rapidly changing world where people are living longer working lives, a person might expect to have more than one career in her or his lifetime. Evidence emerging that the seeds of one's life design are sown in early childhood is then examined together with the idea that, faced with the possibility of having multiple careers and needing different skills and behaviours for each, one must begin preparing for one's life design as early as possible in life.

This chapter then outlines how the narrative form might present a possible means of engagement that might better prepare young children for – or inspire young children toward – a career in science. The power of children's own imaginations is then discussed wherein, both independently and by use of the reader response framework, it is suggested that reading and the neuroplasticity of the human brain are well suited to enable that engagement.

A small-scale pilot project that sought to analyse the shift, if any, in the appeal of science as a career choice from before to after three cohorts of primary school children read and talked about a story about science and scientists is then discussed. The results of this project, consistent over three years, suggested that the place to start inspiring children toward a career in science is in the primary school years, and in the light of this albeit marginal evidence that stories can make a difference to how some children feel toward a career in science, an analysis of children's fiction books in one industrialised country's (Australia's) municipal libraries is drawn upon to highlight the scarcity of such stories.

The chapter concludes with the idea that what is being perceived as a 'decline in interest' in science as a career may actually be something else. The decline could be realised as a 'lack of interest', or even as an 'inertia', wherein the idea of doing science is so entirely tenuous or abstract to a young student, that the thought of becoming a scientist does not even register in her or his mind.

With this and the evidence of the shortages of STEM graduates and technicians in mind, and with respect to the lifespan career development for children, the conclusion finally emphasises the importance of exploring young children's, that is, specifically primary school children's, career development as a priority above the career development of adolescents, young adults and older adults.

The discovery of the gap in knowledge, the bridging of the gap and this research's original contribution to knowledge is then outlined, and the consequent aims and objectives of the research defined.

Social and Political Context

Commissioned by the Royal Society in 1985, the Bodmer Report sought to evaluate the apparently dire state of the public understanding of science at the time (Bodmer, 1985). Consequently, with regard to formal education, the report recommended "that much greater priority be given to laying the foundations for a sound understanding of science through appropriate science courses in all primary schools" (p. 32). As a result, science education was made, and remains, compulsory for all 5-16 year olds in the United Kingdom.

Highlighting the Concern about Science Education

Over twenty-five years later, in a report part funded again by the Royal Society (and by the Economic and Social Research Council), Smith and Gorard (2011) analysed a series of pertinent research projects carried out between 1986 and 2009. They recognised that the "well rehearsed problem" (p. 160) of falling levels of engagement with science, technology, engineering and mathematics subjects appeared to be both a local and an international issue persisting across myriad administrations (see also Becker, 2010; Lang, 2009; Sansom & Shore, 2008).

Specific to the UK, though, Smith and Gorard (2011) examined the passage of young scientists through the STEM pipeline beginning with students' compulsory schooling, through post-compulsory secondary education, tertiary education and their finally entering into the career market. With respect to compulsory and immediately subsequent post-compulsory schooling, they found that

> once students are faced with a choice of how to study science (usually at around age 14 in England) or whether to study science at all (usually post-16), there is a dropping off of participation, especially in physics and

> chemistry. Most students, given the chance, do not study the 'hard' sciences. This is not a new phenomenon. (Smith & Gorard, p. 164)

Indeed, in the late 2000s in the UK, the persistent shortage of science graduates could be evidenced in the demand for graduates that was not being met.

Shortage of STEM Graduates and Technicians

Before the global economic crisis and downturn of 2008, in a report surveying publications from employers on their need for STEM skills, the Department for Innovation, Universities and Skills (DIUS, 2009) revealed STEM employers reporting insufficient UK STEM candidates in particular areas of the biosciences, engineering and IT at graduate level – and found, for instance, that at all levels (apprentice, technician, graduate, post-graduate, experienced) some 59% of businesses employing people with STEM skills were experiencing difficulties in recruiting (see also the Confederation of British Industry (CBI), 2008).

The impact of the economic downturn remains far-reaching. The extent to which both local and global economy, business and education has been impacted remains immeasurable. Despite this, however, the demand for STEM graduates still seems to be out-stripping supply with the Confederation of British Industry (2013), for instance, reporting

- STEM skills are in widespread demand and nearly two in five firms (39%) that need employees with STEM skills and knowledge currently have difficulties recruiting staff

- shortages of STEM-qualified technicians (29%) and graduates (26%) are widespread among firms in the engineering, hi-tech/IT and science areas and are expected to intensify as economic recovery gathers pace.

(CBI, 2013, pp. 18-21)

Both pre and post economic downturn, the pattern emerging appears to be that the economic need for STEM graduates is real; the shortage has been sustained over decades; and the expectation is that future demand, although likely to increase, is unlikely to be met.

Earlier in the STEM pipeline: GCSE and A Level Candidates

The supply of STEM graduates is naturally dependent upon the supply of students who choose to take up the prerequisite GCSE and A Level (or equivalent) qualifications.

In the ten years preceding the economic crisis, the number of young students taking A Levels in Chemistry, Biology and Mathematics had remained, in absolute terms, largely flat (DIUS, 2009, pp. 43-47). The overall number of young students taking on A Levels in this period, however, had risen 18.5% – hence this plateau actually represented a decline in the overall proportional uptake of Chemistry, Biology and Mathematics at A Level.

Physics had fared much worse. The number of students choosing to study Physics had fallen from 28,400 in 1996 to 23,932 in 2007 – an absolute decline of almost 16% through the decade. This is besides the 18.5% increase in cohort size and is representative of a steady 25 year decline for Physics wherein, for instance, 53,365 students chose to study Physics in 1983 against 23,932 in 2007 – a decline over those 25 years, in absolute terms, of just over 55% (DIUS, 2009).

In their *Evaluation of Science Education in England from 2007 – 2010*, however, Ofsted (2011) noted that the introduction of the three separate science GCSEs and one vocational science GCSE at Key Stage 4 in September 2006 provided enough diversity in the science curriculum to meet the needs of a wider range of students. They felt that this had allowed a greater number of higher-attaining students to study the sciences separately and this had contributed to an increased uptake of the separate sciences at A Level.

By 2009/2010, though, undergraduate science more than most other subjects was still struggling to recruit (Smith & Gorard, 2011, p. 169). So, despite the revitalised uptake, for most of these young students, A Level was actually as far as their study of science would go.

In their *Survey into Science Education in Schools of 2010 – 2013*, Ofsted (2013) again felt that the new GCSEs provided the greatest range of routes for students to further access the study of post-compulsory science. They realised, though, that

> [n]ot enough subject leaders analyse why pupils of both genders either continue or stop studying science subjects after the age of 16. [One reason] pupils gave to inspectors to explain why they did not wish to continue studying science … was not seeing the purpose of what they were studying, other than to collect examination grades. (Ofsted, 2013, p. 5)

So despite the argument that separate science GCSEs may better prepare young students, vocationally or academically, to take on science A Levels, it still appears that not even higher-attaining students who can 'do' science and get good grades at A Level will develop an inclination to engage with a science degree and so pursue a career in science.

Hence, in the UK, at the end of a young student's compulsory science education at 14-16 years of age, the taking on of core science or separate science GCSEs does not necessarily mean progression to the same or other science studies at post-compulsory AS and/or A Level.

Furthermore, even if post-compulsory progression to science A Level does take place, this is no guarantee of a student's taking on an undergraduate degree in science. In fact, the taking on of science GCSEs and any subsequent science AS and/or A Levels appeals, to many students, merely as a means of accumulating academic grades in order to smooth the path to an alternative, non-science career.

In considering possible causes of any decline in interest in a career in science, therefore, we must look to earlier still in the STEM pipeline, to before GCSE and AS/A Level choices are made at secondary school or college: to primary school, where science is still required to be taught, but is no longer as formally assessed.

Earlier Still in the STEM Pipeline: Primary School Science

In May 2009, when the Government abolished Key Stage 2 Science Standard Assessment Tests, the Royal Society responded that it was

> delighted that SATs in science for 10 and 11 year olds are to be abandoned. [T]his type of testing was stopping teachers from inspiring children with the wonder and excitement of science. At a time when developing future generations of scientists could not be more important to the UK's economy, engaging students at the very start of their education is fundamentally

> important. (Sir Martin Taylor, Vice-President of the Royal Society (RS)/ Science Community Partnership Supporting Education (SCORE), 2009)

The children 'benefitting' from this less formal, more teacher-led science education model wherein teachers are "free from 'teaching to the test' and [now have] further opportunity to deliver inspirational practical science lessons" (Royal Society of Chemistry (RSC)/SCORE, 2009), have been in the primary school STEM pipeline since (and during) the 2009/2010 academic year.

For these young students, who subsequently started secondary school in the 2010/2011 academic year, decisions to take on core science or separate science GCSEs will have been made, almost three years later, toward the end of the 2012/2013 academic year, ready for the commencement of their Key Stage 4 education in 2013/2014. Decisions to take on AS and/or A Levels will have taken place another two years later, ready for the 2015/2016 – 2016/2017 college years and any decisions to take up undergraduate science will so take place in the 2017/2018 academic year. These decisions to take on, or not take on, AS/A Level and/or undergraduate science will not have impacted Ofsted's *Survey into Science Education in Schools 2010 – 2013* (Ofsted, 2013), for example, and so will be more likely to impact *2013 – 2016* (unavailable at time of writing) and *2016 – 2019* (future) statistics and assessments, instead.

In the absence of such formal appraisals, in looking to assess the impact of less "teaching to the test" and more "engaging" (RS, SCORE, 2009) and "inspirational practical science lessons" (RSC, SCORE, 2009), we can examine instead the Teacher Assessment model as a representation of primary school children's engagement with and/or achievement within the primary science curriculum.

Although, for primary science attainment, the Teacher Assessment model has replaced the National Testing model since 2009/2010, the Department for Education's (DfE) *National Curriculum Assessments at Key Stage 2 (2015)* (DfE, 2015) collated data in teacher assessed attainment at Level 4 and above and Level 5 and above in English, Maths and Science from 2007 through to 2015.

Based upon the Department for Education's data, Figures 1 and 2, below, illustrate the percentage change, year on year, in teacher assessed student attainment at Level 4 and above (Figure 1) and at Level 5 and above (Figure 2) in English, Maths and Science.

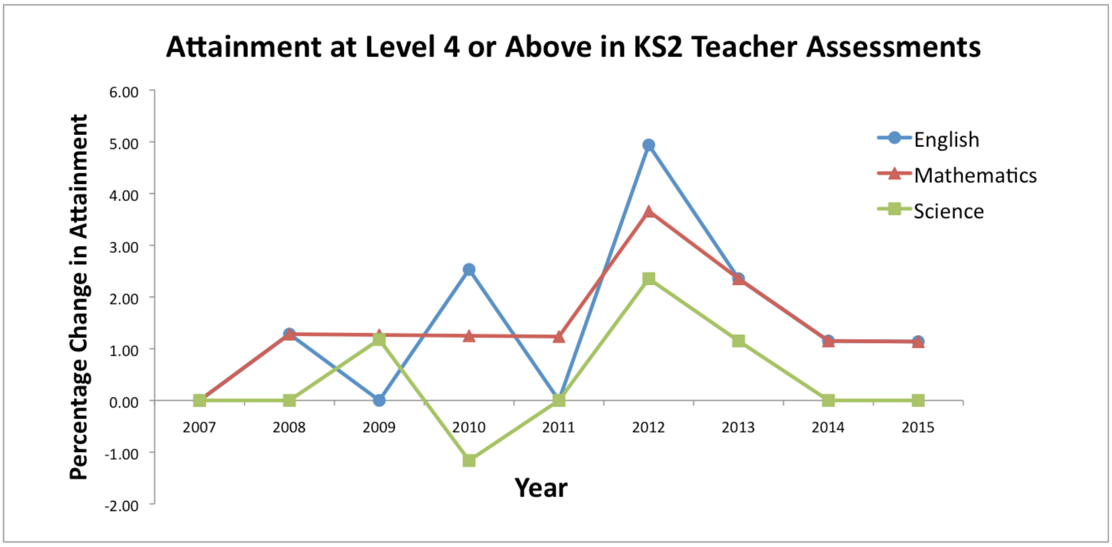

Figure 1: Attainment at Level 4 or Above in KS2 Teacher Assessments

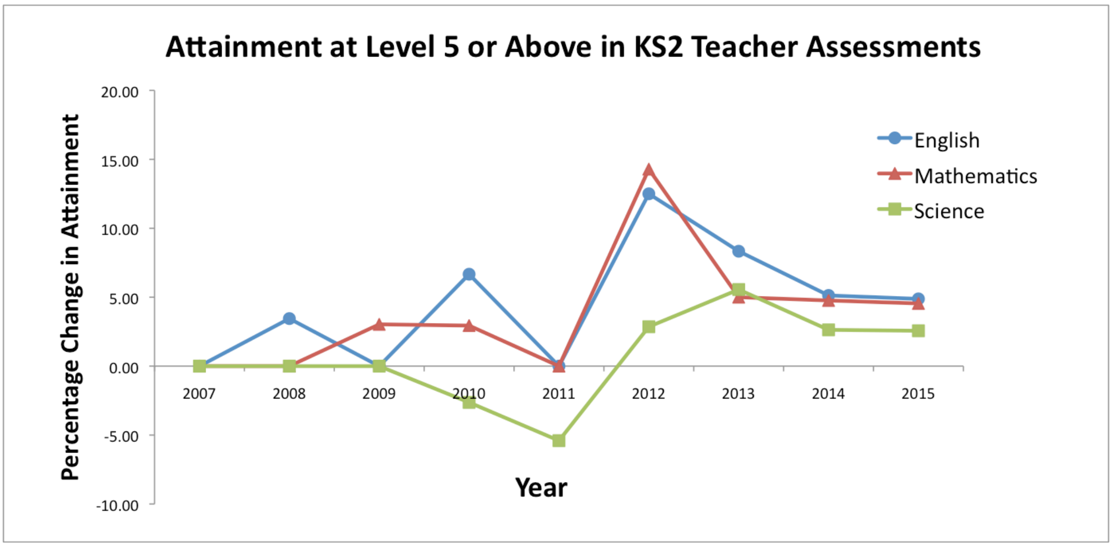

Figure 2: Attainment at Level 5 or Above in KS2 Teacher Assessments

In 2010 and 2011, the first and second years after formal SATs assessments were dropped and the government encouraged – or allowed – primary school teachers to teach science more freely at Key Stage 2, an overall drop in teacher assessed Science attainment occurred both at Level 4 and above and at Level 5 and above.

In 2010, for both Level 4 and above and Level 5 and above, this drop was contrary to the overall rise in teacher assessed attainment in English and the non-movement of teacher assessed attainment in Mathematics.

In 2011, for Level 5 and above the decline in Science attainment continued and at Level 4 and above, although Science attainment had begun to rise, it had not reached the previous 2009 level.

Since 2011, however, teacher assessed attainment in Science has, in the main, followed the same general rise (2012), fall (2013) and levelling out (2014 and 2015) as that of teacher assessed attainment in both English and Mathematics.

It might appear, then, that in 2015, five years after the governmental relaxation of the formal teaching of science, there has been no significant increase in teacher assessed attainment in Science: Level 4 and above attainment has even dropped back to 2007 and 2008 levels – and Level 5 and above attainment could be seen as reflecting only the same overall general fluctuations, that is the same trends to rise, fall and level out, as the attainments in English and Mathematics – and, even then, to a lesser degree.

If teacher assessed Science attainment can be recognised as a marker of students' engagement or success with science, then the abandonment of formal SATs and the subsequent opportunity to teach primary school science more inspirationally might not yet seem, five years later, to have made a measurable or perceptible impact upon that engagement or success. It is still early days, though, and there could be any number of reasons for this: having not had to 'teach to the test' and/or not feeling judged by league tables, for example, teachers may be being too hard on themselves and their students when assessing students' work as an outcome of, or a reaction to, suddenly freer teaching styles.

Nevertheless, upon the abandonment of teaching to the test for decades (since 1985), an opportunity has now arisen to more properly consider the effects of freer, more inspirational or practical teaching upon young children's engagement with primary school science.

The 'Leaky' Pipeline – or Gender Filter

Clark Blickenstaff (2005) employs a metaphor – the 'leaky pipeline' – that is often used to describe the evidence that women are under-represented in STEM courses and careers (p. 369). He argues that although the STEM pipeline leaks science students of both genders, it is a well established phenomenon that it leaks more women than men and this differential, in effect, sets up a gender-based filter through which many women are drawn away from the path to a life in science. He says

> [n]o one in a position of power along the pipeline has consciously decided to filter women out of the STEM stream, but the cumulative effect of many separate but related factors results in the [gender] imbalance in STEM. (Clark Blickenstaff, 2005, p. 369)

Clark Blickenstaff found that the issue of the lack of women in science, this gender gap, had been the subject of an enormous amount of research in many and varied academic fields, and in his meta analysis of the literature he found diverse explanations as to why girls and women move/are moved away from careers in science. Eschewing, rightly, 'biological differences' between the genders, other explanations included girls' lack of academic preparation for or poor attitude toward a career in science – these latter two explanations being, perhaps, on account of a lack of positive experience of science in childhood. Cultural pressure to conform to 'traditional' gender roles, the lack of female STEM role models, curricula that were not relevant or interesting to girls were cited as explanations, too, together with the pedagogy and atmosphere of science classes favouring boys/male students and a worldview in scientific epistemology that was also intrinsically masculine (pp. 371-372).

Tyler-Wood et al. (2012) felt, particularly, that the literature suggested that

> the gender gap is less of an ability gap than a gap in perceptions of science careers. Indeed, girls achieve as well as or even better than boys on many indicators of educational achievement in elementary, secondary school, and college. (Tyler-Wood et al, 2012, pp. 46-47)

Vincent-Ruz and Schunn (2017), too, believing that far more research has to be done in order to understand how "internal and external factors interact … to demotivate girls and young women from pursuing science careers" (p. 790), studied girls' and boys' own scientific self-competency beliefs from Grade 6 (11-12 years old) to Grade 8 (13-14 years old). They found that as the boys got older their readiness to engage in (scientific) argument, debate and experience (during science classes) 'suppressed' the function of their competency beliefs on their scientific learning. As the girls got older, however, they seemed to require higher competency beliefs, the need for which suppressed their inclination to engage in argument, debate and experience. This does speak to some degree of 'masculinisation' in the science learning environment where girls, if they do suppress belief in themselves, face greater challenges in coming to more fully engage with science learning and, perhaps, thoughts about careers in science. Why girls should come to feel this way is, again, an enormous field of enquiry but Vincent-Ruz and Schunn felt that their results demonstrated that

> despite girls' willingness to participate in scientific argumentation and to take part in science experiences, they probably do not receive enough support in their environment to access the benefits of these experiences, and hence they have a stronger need to have high competency beliefs in order to achieve significant growth in science learning. (Vincent-Ruz & Schunn, 2017, p. 790)

Archer et al. (2010), studying younger children's, 10-11 year olds' (UK Year 6), constructions of science through the lens of identity, had found the children's interest in science to be "relatively high" (p. 621; see also Murphy & Beggs, 2005) – yet sensed beneath this enthusiasm for school science (independent of gender, ethnicity and class), the germination of (gender, ethnicity, class) distinctions (p. 636) that would duly burgeon and crystallize as the children got older and would then appear to steer children, girls and boys alike – but girls especially – away from a career in science. They felt that their primary school children had begun to re/frame the nature of real science as 'desirable' and 'exciting' in as much as doing science in the real world had become associated with doing science at secondary school where, for example, boys especially felt that they would be allowed to literally "play with fire" (Bunsen burners) (p. 623). Archer et al. suggested that their children thought that the relative safety of doing primary school science felt more restrained or, drawing on feminist poststructuralist theorizations of gender and binary oppositions, felt more "immature" was "not real science" and had become re/positioned as "safe" and "feminised" (p. 622). If this is the case, however, one might wonder why more boys, upon getting to relish non-feminised/ masculinised secondary school science, are still not taking on science as a career.

Notwithstanding boys' possibly suppressed competency beliefs and girls' possible need for high/higher competency beliefs (Vincent-Ruz & Schunn, 2017), Archer et al. also found that their young students, girls and boys alike, felt that "one does not have to be 'clever' to be good at science" (p. 629) but they sensed in the children, even at 10-11 years of age, the seeds of prevalent adult discourse that the doing of science is solely the preserve of 'clever' people (see also Carlone, 2004). Archer et al. suggested that this stirring, this imminent shift, in perspective could be explained by their children's parallel discourse of "natural interest" (p. 629); that is, a person having a natural interest in science and, by association, a 'natural ability' in science, might stand her or him in better stead toward a career in science. This discourse, Archer et al. felt, could in turn foster the notion that there is a type of person who becomes a scientist, a "science person" as it were, in possession of a "science mind" (p. 630) ideal for the taking on of that identity that is 'being a scientist' (see also Mendick, 2006, investigating masculinities in mathematics for constructions of a 'maths type' of person with a 'maths mind').

The idea of whether or not this 'scientist type' of person – girl, boy or fluid gender identity – exists, is important to this doctoral study as the notion of a scientist type speaks to the 'nature versus nurture' debate and suggests that a scientist type of person might simply come to 'exist', that is, is born not made. Archer's idea that prevalent adult discourse fosters the notion of a science type speaks simultaneously to the nature-nurture debate – in that this sort of adult discourse fosters the notion that scientist types are indeed born not made – and to the theories of reader response and interpretive communities in that how adults come to speak about a scientist type is constructed by their sociocultural backgrounds wherein the 'idea of a scientist type' is created. Chapter 3, *Theoretical Framework*, describes in detail the theories of reader response and interpretive communities and, in more fully exploring the nature versus nurture debate from these perspectives, answers the *'Are scientists born or made?'* question: A disposition toward science, any 'scientist type', any 'science mind' is socially constructed/learned; the scientist type is not born, she or he is made.

How these constructions and/or encouragements of a scientist type/science mind come to, over time, filter girls and women from the leaky STEM pipeline highlights the vital need for much more research in this area.

In this study, however, when thinking about primary school children and how they engage with representations of the fictional scientist, although the gender filter/ gender gap has to have some bearing on the work, it is not the focus of the work. I have held the gender filter factor in mind – it is impossible not to – and I do come to refer to Archer et al.'s work again when discussing my own findings. I come to refer to girls and boys separately, too, especially in how the girls and boys taking part in this research spoke about the idea of 'other people' being scientists – as the girls and boys did speak differently about the girls they knew and/or the boys they knew being (or not being) likely scientist types and I felt it important to take notice of their different ideas. These ideas may or may not have any bearing upon why girls and women are under-represented in science but they do have some bearing upon how the participant girls and boys saw themselves and others beyond primary school science and as real scientists in the real world.

Lifespan Career Development of Children

In these times of rapid economic, technological and digital evolution, the theoretical 'third career' (or multiple or 'encore' career) paradigm wherein a person might have several careers across her or his lifespan, is becoming more realised (Loretto & Vickerstaff, 2015; Simpson, Richardson & Zorn, 2012). Knowledge, too, and its creation, distribution and use, especially with respect to the immeasurable open source learning space that is the World Wide Web and its ever-expanding platform, the internet, is becoming more diverse and uncertain.

Adults of the future will require different sets of skills and behaviours than those of the last century or those of current times even. It makes sense, therefore, that for children of today to become fully prepared for a life with multiple indeterminate careers, preparations for the same should begin in childhood which, as Hartung (2015) suggests, "provides fertile soil for planting the seeds of attaining life design's core goals" (p. 99).

Studies in children's career development began to proliferate in the mid-nineties. Gysbers' (1996) review of the studies recognised the need for a comprehensive interdisciplinary approach to children's career theory and its research and practice, and offered a guidance and/or program approach as a way to integrate and operationalise the endeavours of career theorists, researchers and practitioners within schools.

Ten years later, however, further reviews of the literature (Schultheiss, Palma & Manzi, 2005; Watson & McMahon, 2004, 2005) revealed the failure of such attempts at integration – with Watson and McMahon (2008) believing that this no longer neophytic field still sought to "describe children's career development from a restricted and limiting base, whether this be theoretical, research or practice" (p. 81).

Both Hartung, Porfeli, and Vondracek's (2005) and Watson and McMahon's (2005) substantive reviews particularly, besides outlining the need for theory, research and practice to focus on the process (that is, the 'what do we do' and the 'how do we do it') of child career development, called for a more comprehensively "contextual understanding of children's career development within broader lifespan career development" (Watson, Nota, & McMahon, 2015, p. 176) and felt that a research and theory base could, especially, "inform intentional career learning during the elementary school years" (p. 177).

Sharf (2016) agreed. Recognising both the limited nature and the limitations of the same, Sharf felt that in comparison to the adolescent and young adult stages, the career development of young children "has been the subject of little research or theoretical development" (p. 437), and Hartung (2015), likewise, argued research emphasises career design in the adolescent and adult age groups and focuses only in very limited ways on career development in childhood.

Hence, although it is of vital importance to study, evolve and integrate the career development process of adolescents at secondary school and young adults at college or university, what might be of greater importance, still, is the need to more fully consider the career development of early years and primary school children. Indeed, "factors central to life design, such as vocational exploration, career awareness, occupational aspirations, and expectations, vocational interests, and career adaptability begin during the childhood years" (Hartung, 2015, p. 90). This research, of course, does not argue that children should be directed solely toward a career in science, but that the idea of a career in science might be presented alongside other occupational and/or vocational aspirations, expectations and interests.

Discovering The Gap in Knowledge

Our planet faces challenges: climate change, pollution, waste disposal, depletion of natural resources and the search for clean, green energy with which to sustain our evermore high-technologically advanced, digitally-dependent lifestyles. These challenges can only be met and overcome with science; science to discover what needs to be done, and science to determine how to do it.

The world, however, is facing shortages of science, technology, engineering and mathematics graduates and technicians. These deficits are nothing new, and governments have been worrying about them for decades. Measures to reset the balance, to bring a formal science education to all children from the age of 5 in the UK, for example, do not seem to have had any impact upon the shortfall, and evidence suggests that the decline in young people actively seeking to take on science as a career reaches right back through to the beginning of the STEM pipeline to children in primary school.

Diverse attempts have been and are still being made to draw children into science. Role-modelling, for example, by bringing real science and real scientists into schools (Grob et al., 2017; Zardetto-Smith et al., 2000) or taking classes of children to visit real scientists in their real working spaces in order to let children see, hear, feel and 'do' real science with real scientists (Boaventura et al., 2013). STEM weeks, too, with 'fun' and 'exciting' projects and experiments, bring specific short-term focus upon science to those institutions undertaking to engage with the same (Silver & Rushton, 2008a, 2008b). Child-orientated purposefully interactive science museums, as well, provide opportunities for science-based fun and entertainment whenever a child, a child's school or a child's care-giver might choose to visit (MacDonald & Bean, 2011).

As the shortfall in STEM graduates and technicians still exists, however, it seems that these various interventions have not worked, or have only worked to such an extent that maybe some children might have become inspired enough to take on a career in science as a result and hence the STEM shortfall is not as great as it might have been.

Among others, Watson et al.'s (2015) and Sharf's (2016) evidence suggests, however, that children make career decisions very early on in life. Not only this, but there is a likelihood that today's young person will have multiple careers in her or his lifetime, and Hartung's (2015) research recommends that it would be prudent to begin to prepare for the same, for one's life design and one's lifetime career development, in one's childhood years.

It would be advantageous, therefore, for young children to not only possess an adequate grounding in STEM subjects but to be also imbued with an affinity for or an aspiration toward training for a career in the same – if not immediately after school, college or university, then for retraining later in life.

Hence, not only does there exist a necessity to find a 'something' with which to stem the shortfall in STEM graduates and technicians, but a something that might be best implemented toward the very beginning of the STEM pipeline: in the primary school years.

A Means of Engagement

In the late 1980s, shortly after the instigation of the Bodmer Report's recommendations for schools, Millar and Wynne (1988) suggested a bold move away from the

> naïve rule-bound view of an inductive science method [toward] a perspective in which doing science is seen as the practice of a craft – based on a foundation of communicable skills ... containing significant tacit elements that cannot be fully articulated or directly taught. (Millar & Wynne, 1988, pp. 395-396)

Langer, Hatem, Joss, and Howell (1989) agreed and suggested that if children were initially introduced to information in a conditional rather than an absolute way, children appeared to be better able to deal with that information creatively.

Toward the end of the 1990s, however, the 'naïve' rule-bound inductive model remained in place. Fresh studies agreed with the findings of ten years earlier and similarly proposed "delaying the study of the conceptual and methodological apparatus of formal Science until a strong facility with vernacular science has been established" (Claxton, 1997, p. 45), as there had indeed come into being general agreement that formal and theoretical centred approaches "should not dominate the school science curriculum [as] such a tactic runs the risk of putting young people off science" (Thomas, 1998, p. 3).

So although calls for change were being made, practical instruments of change remained elusive. That is until Reiss, Millar, and Osborne (1999) reviewing a contemporaneous study of science curriculum analysis and reflection carried out by Millar and Osborne for the Nuffield Foundation (Millar & Osborne, 1998; Nuffield Foundation, 1998) and finding science education "too strongly influenced by the need to be a preparatory education for the small proportion [of students who might choose science as a career]" (p. 68), sought a means to provide teachers and students alike with more "meaningful examples of situations in which the worth of science education is apparent" (p. 69).

They proposed that science education

> should make much greater use of one of the world's most powerful and pervasive ways of communicating ideas – the narrative form – by recognising that its central aim is to present a series of 'explanatory stories'. By this we mean that science has an account to offer in response to such questions as ... 'How old is the Earth and how did it come to be?', and 'How come there is such an inordinate variety of living things here on Earth?' (Reiss et al., 1999, p. 69)

Whether or not such questions arise out of a child's natural curiosity or are simply laid before a child on account of curricula necessity, the idea that science education has an account – a story, a text – to offer a child in response to such questions, lends itself well to the concept that the teaching of science need not be rule-bound and inductive (Millar & Wynne, 1988, pp. 395-396) nor formal and strictly methodological (Claxton, 1997, p. 45; Thomas, 1998, p. 3). The use of the narrative form, instead, resonates with Langer et al.'s (1989) conditional as opposed to absolutist way with which children might be better able to deal with scientific information creatively and so come to engage with science in a more meaningful way.

In their particular field of biology, Reiss et al. (1999) suggested several curriculum oriented stories: about cells as the basic building blocks of all living organisms, for example, but made no suggestion as to how those stories should be "fleshed out" (p. 69) in detail. They proposed that the stories should be constructed in the light of the views, at the time, of the needs of schools' biology curricula, but did not, however, specify that the application of this innovative instrument of change, the narrative form, should especially involve non-fictional narrative – as opposed to fictional narrative – with which to both educate and inspire children toward a career in science.

Young children have the capability to understand both factual and fictional narratives and the skill to navigate between the two (Bruner, 1968, 1990, 1991), and children can be taught to understand the structure of those narratives and to navigate them at a very early age (Saracho & Spodek, 2010).

From a reader response perspective, non-fictional scientific or purposefully educationally scientific texts, of course, contribute to the construction of science and the scientist in the mind of a child, in as far as it is the child herself or himself who will uniquely construct those texts and be constructed by them (see *Chapter 3 – Theoretical Framework; Reader Response Theory*).

The same reader response perspective, however, better highlights that more meaningful engagement with science, or any other issue, might occur through fictional stories rather than factual presentations, not least because children have come across, have re/created and been created by, fictional texts before, and methodological scientific texts, that is, the child's re/creation of those factual texts, is likely to be less familiar.

In all likelihood, children have been raised on stories since birth and telling new stories, new stories about science besides stories about adventures or mysteries, fantasy stories or fairytales, might be felt, by a child, to be a more normal, more natural extension of their vast story-hearing, story-reading or story-telling experience.

The response-experience of new stories told now, can be more easily related to the response-experience of stories that have gone before. All that response-experience contributes to whatever it is that makes each child their individual unique selves, and it is this unique self she or he brings to the construction of the next story, and the next, creating an emotionally richer narrative/making of meaning, on account of having 'lived through' the same sort of experience before.

Hence, although this research does not presume that children's ideas about science and scientists are influenced any more by fictional stories than they are by non-fictional stories, and although the examination of purposefully educational scientific stories might prove to be engaging and rewarding for a child, in considering whether or not a particular means of informal engagement with science exists that might capture a child's imagination early on in the STEM pipeline, this research goes beyond the 'fleshing out' of factual narrative and instead looks to explore engagement with the fictional narrative form as a segue into science.

Consolidating the Means of Engagement

Children's Own Imaginations

At about the same time Reiss et al. (1999) were thinking about the power of the narrative form in science education, the first of a series of children's books was published: *Harry Potter and the Philosopher's Stone* by J. K. Rowling (1997).

The avid commitment readers of the Harry Potter books sustained over the series' ten years, and beyond, was phenomenal (Whited, 2002; Zipes, 2009, 2012).

Many children demonstrated their enthusiasm by extending their reading experience into imagining themselves, in the real world, as wizards and witches – boys, for example, dressing up as wizards; girls buying 'spell-books' and, most noteworthy, more boys and girls actually leaving home to attend boarding school as a direct result of reading about *Hogwarts School of Witchcraft and Wizardry*, the boarding school Harry Potter and his friends attended in Rowling's novels (Garner, 2001, 2004).

The Harry Potter phenomenon was, and still is, a far-reaching example of the influence of children's literature and goes a long way toward reinforcing the idea that children can be cognitively and emotionally influenced by what they read.

This influence, this power upon – or power of – the imagination of children to deconstruct and reconstruct both the texts they encounter and themselves, can materialise not only fresh perspectives but entirely different physical realities far beyond what a child is accustomed to – all on account of, simply, reading a book.

Reading and the Plasticity of the Brain

Although it is not strictly within the remit of this research to examine the biological or physical nature of reading, it is appropriate to pay some attention to pertinent studies being carried out in connection with the neuroscience of reading.

Wolf and Barzillai (2009), for example, specifically studying reading in children, examined the neuroplasticity of the brain. Neuroplasticity allows the brain to adapt, adjust and to reorganise itself; throughout her or his lifetime, subject to emotional, physical or environmental stimuli, a person's brain can create new neural pathways and connections and thereby permanently adapt to accommodate such stimuli. With respect to young person's reading, particularly, Wolf and Barzillai found that

> [i]n the case of reading, plasticity enables the brain to form new connections among the structures underlying vision, hearing, cognition, and language. This design feature means that the very organisation of the human brain enables it to go beyond itself. (Wolf & Barzillai, 2009, p. 132)

They argue, too, that reading "can help shape the development of an analytical, probative approach to knowledge in which students view the information they acquire […] as the beginning of deeper questions and new, never-before-articulated thoughts" (p. 135).

Although the physical bodily organ that is a child's brain might not be considered the same entity that is a child's mind, the neuroplastic ability of the brain to adapt and change, together with the idea that reading can inspire deeper questions and never-before-articulated thoughts, blends well with the reader response idea that each textual encounter a child lives through re/creates a never-before-articulated device, a text, that must so lead to Wolf and Barzillai's never-before-articulated thoughts and deeper questions. These fresh thoughts and questions deconstruct then reconstruct the child: the child goes beyond herself or himself.

Hence, fusing Wolf and Barzillai's findings with reader response theory, one could argue that a child's brain is physically built to re/create knowledge and re/create the child.

Pilot Project

It is likely that the thousands of children who elected to try out boarding school after reading the Harry Potter novels were aware they were not actually going to Hogwart's, and knew they were not going to train to become witches and wizards.

It is worth considering, however, that the motive power of these children's imaginations, the real life energy the children generated and expended in calling these new Harry Potter-like lifestyles into being, was a physical, cognitive and emotional, transformative effect of their reading of children's fiction. Something as 'ordinary' as a children's story moved the children to do extra-ordinary things. Fiction, the narrative form, therefore, carries the power to change lives.

With this in mind, and before this doctoral research was more fully designed, I took the idea that children's thoughts about doing science and being a scientist might be influenced by the narrative form, and made it the basis of a small-scale pilot project.

Thinking about children at the end of their primary school education, having undertaken Bodmer's 'formal science education for all' throughout their school life thus far, and just before the children left primary school and moved on to secondary school, the idea developed into questions of whether or not the children saw science as a potential career option before reading a story connected to science and scientists, and whether they or not they felt moved toward a career in science after reading the story. My pilot project's Research Question became: *Can the appeal of science as a career choice be influenced by children's literature?*

Over a period of three years – the 2007/2008, 2008/2009 and 2009/2010 academic years – focusing upon children in Year Six (10-11 year olds) at the very end of the school year when curricula work was complete and Standard Assessment Tests were finished, the pilot project sought to analyse the shift, if any, in the appeal of science as a career choice from before to after the children read and discussed a story connected to science and scientists.

The children were asked to complete questionnaires about which sort of careers they would like to have or what sort of jobs they would like to do when they grew up, both just before the reading and discussion of the story, and then some time (on average two weeks) after the reading and discussion.

The research sought to qualitatively assess the shift of appeal by comparing results from an active group of children who would read and discuss the literature with results from a control group of children who would not.

Results accrued from the pilot project's Year Six children, across all three academic years, consistently suggested that before the reading and discussion of the literature, the children, girls and boys alike, had very little inclination or no inclination at all toward a career in science. The boys, however, after reading and discussing the literature, became marginally more positively inclined toward a career in science, whereas the girls were not, even marginally, influenced toward the same.

It appeared that, at the end of their primary school education, although the idea of having some sort of job or career had occurred to the girls and the boys alike, the idea of having a job or career as a scientist either did not appeal to them – or had not occurred to them.

If it is true that children make decisions about careers early on in life, at primary school, then the results of the pilot research would suggest that by the time they leave primary school to go to high school, most children, girls and boys alike, seem already lost to science as a career.

Although these were the results of a small-scale research project, this doctorate, nevertheless, sought to examine more fully the idea upon which it was based and looked to further explore how young children's views of science, scientists and careers in science might have already been, or not been, formed in their primary school years. Particularly, this doctoral study focuses upon how children's engagement with stories about science and scientists might be shaping their ideas about what it means to be a scientist or have a career in science.

Apropos of stories about science and scientists, however, there is evidence to suggest that not a lot of these types of stories exist.

Science and Scientists in Municipal Children's Fiction

Holbrook, Panozza, and Prieto (2009), aware that children appear to make decisions about occupations early in life, responded to "concerns that engineering is a poorly understood occupation and that young people are exposed to stereotyped images of scientists and engineers at an early age" (p. 723).

Driven by findings that engineering had both an invisibility problem, in that the word 'engineering' may not even ever be said out loud in households until young people were expected to make career choices in adolescence (Reid et al., 2003), and an image problem stemming from the physical and emotional stereotypes associated with scientists and engineers (Eugster, 2007), they sought to find out how engineering and science were portrayed in contemporary junior fiction for ages 8-12 year olds.

Holbrook et al. (2009) examined some 4,800 stories in one region of New South Wales, Australia's municipal libraries and found that only 71 of the 4,800 titles (1.48%) contained any content connected to science or engineering.

Most (54%) of those 71 books were quarto or 'How To' illustrated books, 41% were paperbacks with illustrations and only 5% were stories without illustrations.

This 5% equates to 4 books in 4,800, that is 0.07%, less than one tenth of one percent, that were children's novels with story content connected to science or engineering. Holbrook et al. so concluded that children's stories involving science or engineering activities or characters are few and far between in children's literature.

The Gap in Knowledge

Jenkins believes it is possible to identify "two rather different traditions in the research undertaken in this field [of science education] in the past half century or so" (2004, p. 240).

The first is the "pedagogic/curriculum tradition", the primary focus of which "is the direct improvement of practice, practice being understood here as the teaching of science" (p. 240). The second he describes as the "empirical/theoretical tradition [which has] undergone important theoretical shifts in the past thirty years, with qualitative studies increasingly augmenting longer-established quantitative approaches" (p. 241).

Despite the theoretical shifts away from empirical quantitative studies toward more qualitative concepts, there appears to be limited research, empirical and qualitative alike, reflecting the reasons why primary school children, particularly, aren't engaging more fully with the idea of science as a career. There appears to exist limited research, too, on whether or not the writing, reading, sharing and discussion of stories connected to science and scientists in the primary years has any bearing on whether or not children might more fully engage with the idea of taking on science as a career and doing real science in the real world.

One reason for this might be that primary school children are neither required nor expected to think seriously about their future careers. Also, whatever it is that primary school children do think about, it is not expected to seriously impact their future career choices, not least because they are young children with six to eleven more years of compulsory education ahead of them.

Research in the area of young people's careers in science so tends to favour the search for possible explanations behind the decline in interest in science as a career and focuses upon adolescents and young adults and the choices, and the reasons behind those choices, they make at GCSE, A Level and degree level. Suggestion is rarely made that this decline might not actually be a decline at all and might instead be a singular lack of interest, or even some sort of an 'inertia', that precludes young people thinking about science as a career. As this inertia might not be seen to exist, so then its presence, its beginning, further back down the STEM pipeline to younger and younger children might not be noticed, either.

When reflecting upon children's ideas about science and scientists, many studies look to the personification of science, the fictional scientist, in existing stories and both the changing and the unchanging stereotypes of the same (see *Chapter 2 – Reality, Fiction and the Text; The Scientist in Fiction*). In these studies, focus tends to be upon the fictional scientist in the stories, not upon the children reading the stories. Focus is upon the stereotype as a potential reason, or excuse, as to why children might not want to take on science as a career, and not upon whether or not the children really do think that these stereotypes are real representations of real scientists or not, or whether or not the children think there might be something else, the doing of the actual science in the stories, for example, that might be putting them off a career in science.

When asked to think about science and scientists and their own perceptions of the same, children are often asked to draw (Chambers, 1983) and/or describe a scientist and/or to choose which pictures (that adult researchers have chosen) best represent how they see scientists (Avraamidou, 2013; Christidou, Bonoti & Kontopoulou, 2016; Koren & Bar, 2009a, 2009b; see also *Chapter 2 – Reality, Fiction and the Text; The Scientist in Fiction*). In these instances, the children are usually asked to draw or describe one single scientist, not two scientists or three or four. If a child was asked to draw a few or many scientists, then the child might have to go beyond the very first impression that comes to mind and delve more deeply into what alternative traits and attributes scientists might have. There is nothing wrong with the first impression; the first impression though, is not all that there is.

One way of getting past first and, perhaps, superficial impressions, however, might be to ask children to create their own stories about science and scientists. If the children were then asked to share their stories with one another, and then asked to discuss each other's stories and each other's different ideas about the science and the scientists in those stories, then all those first thoughts and first impressions might become supplanted by Wolf and Barzillai's (2009) never-before-articulated thoughts and those deeper, never-before-asked questions – all requiring answers and explanations.

From a reader response perspective, the writing of a single story with a single scientist in it, the reading of that same story and the sharing and discussion of that story, represent re/creation upon re/creation upon re/creation of both the story and the scientist in it; the story and the scientist are deconstructed and reconstructed, many times – as is the child who writes, who reads, who listens to or who thinks about the story (see *Chapter 3 – Theoretical Framework; Reader Response Theory*).

When lots of stories about scientists are written, read, shared and talked about in a classroom, then the re/creation of each separate text and the deconstruction and reconstruction of each of those separate fictional scientists, is lived through an exponential amount of times by every child present. Besides the great deal of interactive critical discussion that group work like this promises, there occurs, too, for each child, much individual reflection. As each fictional scientist is shared, compared and re-compared to all the other scientists in all the other stories, her or his de/reconstruction re/occurs many times in the child's mind. In sharing and discussing the stories they have written, and in being asked, for example, why the scientists in their stories are the way they are, the children are having to continuously re-think or re-imagine what a scientist might be like: what motivates the scientist; how does the scientist feel in the world; what might it mean to be a scientist. First impressions are long gone, as are second and third impressions.

It is believed that children use some of the same mapping and schema-building strategies to mentally construct both that which is real and that which is not real (Mackey, 2010); children are able to call into being both the idea of the real scientist and the idea of the fictional scientist. When putting a scientist into a story, the scientist a child generates will likely be some sort of mixture of the factual and the fictional narratives that the child has assimilated to date; a fusing of what is already known about real scientists, or what can be guessed at, together with all the fictional renditions of scientists in all the stories the child has already come across.

Children do understand the structure of factual and fictional narratives (Bruner, 1990, 1991), the structure of their own and others' stories (Saracho & Spodek, 2010), and have the power of mind and the skill to navigate those structures and to determine what is real and what is not real (Mackey, 2010; see also *Chapter 2 – Reality, Fiction and the Text; Fiction and Reality*). There is probably little danger, therefore, when getting children to put scientists into stories, that some sort of confusion might occur between the construction of the real scientist and the construction of the fictional scientist wherein the fictional scientist might seem 'too real' and, if unappealing, might forever put a child off thinking about taking up a career in science.

Also, as the fictional scientist is de/reconstructed, so too is the identity 'scientist'. What it might mean to be a scientist and to do science for real, is similarly de/reconstructed. This de/reconstructed identity that is 'scientist' and this de/reconstructed idea of 'doing science' are unavoidably absorbed by each child and, at some conscious or subconscious level, to some cognitive and emotional degree, are compared to each child's own emerging sense of self – and it is this sense of self, too, that may or may not foster the notion, good or bad, of what it might mean to be a scientist.

Hence, the narrative form is an exceptionally complex and powerful tool with which to discover perceptions and ideas, engage with perceptions and ideas, and re/create perceptions and ideas about science and scientists in children.

I believe it is a tool, which, in coming to discover, engage with and re/create primary school children's perceptions and ideas about science and scientists, has been under utilised.

Consequently, with respect to the identification of a gap in knowledge, I believe

1. *There is a gap in knowledge about how primary school children's engagement with stories connected to science and scientists may be shaping their perceptions of the same and, hence, may be shaping the children's ideas, or absence of ideas, about a career in science.*

2. *There is gap in knowledge, too, about whether or not the power of the narrative form, employed in the children's own writing, reading, sharing and discussing of stories about science and scientists, might reveal – or change – the children's deeper perceptions, or absence of perceptions, of science, scientists and ideas about a life in science.*

Bridging the Gap

Upon the abolition of Key Stage 2 Standard Assessment Tests for science and now that teachers no longer have to 'teach to the test', Jenkins' (2004) first research tradition, the pedagogic culture, the drive to improve the teaching of science, has been given an unprecedented opportunity to embrace more non-traditional, more inspirational, more radical techniques with which to engage primary school children with science.

At primary school, although writing, reading and sharing stories are hardly radical undertakings, it could be that what children write, read and share in connection with science and scientists, might change the way a child comes to feel about science and/or scientists for the rest of her or his life.

The multiple deconstructions and reconstructions that the real and the fictional scientists go through in the mind of a child when writing and reading stories about science and scientists, and the exponential deconstructions and reconstructions that occur when those stories are shared and discussed, can serve only to thoroughly re/articulate the thoughts and the feelings a child already holds – or does not hold – in connection with science and scientists.

There is little evidence to suggest that the writing, reading, sharing and discussion of stories about science and scientists might better engage primary school children with the idea of becoming a scientist in later life. The idea of multiple deconstructions, reconstructions and multiple making-of-meanings of 'scientist' when a child is doing that writing, reading, sharing and discussing, however, makes very good sense – not only from the perspective of reader response theory but from a common sense perspective, too, as the more children are asked to think about something, the more likely they are to engage with it.

Besides Jenkins' (2004) first pedagogic/curriculum tradition to necessarily improve the practice of teaching science, is his second empirical/theoretical tradition, the philosophical shifts of which have reached out, beyond the quantitative, to qualitative studies and thus highlighted the need for research concepts and techniques to be more than positivistic and to utilise instead ideas that cannot be empirically measured but that can just as effectively, or more effectively, satisfy a study's aims.

This research embraces both traditions. Free to evolve the teaching of science by alternative means of engagement instead of teaching to the test, this research embraces the use of qualitative research methodology and design in order to explore an alternative means with which to better engage primary school children with science and scientists, not least when teaching science and/or encouraging children to think about science as a career.

An Original Contribution to Knowledge

The alternative means of engagement is the use of the narrative form, particularly, narrative fiction, wherein the children themselves are asked to write a story, one of the characters in which has to be a scientist. The children are then asked to read, to share and to discuss each other's stories and so share their ideas about science and scientists.

The deconstructions and reconstructions of the scientist in the minds of the children through writing, reading, sharing and discussion of their stories, and the rearticulated thoughts, feelings and fresh ideas that come to make new meaning about science and scientists for the children, cannot be quantitatively calculated. The children's discussions are instead analysed using foundational thematic analysis, and the emerging themes examined in greater depth.

It could be argued that new thoughts and feelings might be just as likely to have negative as opposed to positive effects upon how children come to think about science and the possibility of being a scientist. However, new ideas about the identity that is 'scientist' and children's relationship with and assimilation of that identity, whether negative or positive, could at least serve to shift children out of any inertia or any lack of awareness with respect to careers in science. This change could filter forward, channelling up through the STEM pipeline to such an extent that the idea of choosing (or actively rejecting) science as a career, in time, becomes as ordinary a thing to do as choosing (or rejecting) any other sort of career.

If the idea of choosing science as a career becomes as ordinary a thing to do as choosing any other career then, as the world's scientific challenges change and proliferate, choosing a career in science might even become the expected thing to do, and the shortfall in STEM graduates and technicians that the world has worried about for decades would cease to exist.

I have outlined two gaps in knowledge, the first being in connection with how primary school children's engagement with stories connected to science and scientists may be shaping their perceptions of the same and so may be shaping the children's ideas (or absence of ideas) about a career in science; and the second being connected with whether or not the power of the narrative form, employed in the children's own writing, reading, sharing and discussing of stories about science and scientists, might reveal – or change – the children's deeper perceptions (or absence of perceptions) of science, scientists and ideas about a life in science.

My original contribution to knowledge will be in the exploration and generation of new knowledge in connection with both these ideas.

However, as current interventions – role-modelling, lab visits, STEM weeks and science museums, for example (see above) – do not seem to be drawing young people into science careers, it is also my intention to further contribute to knowledge by suggesting an intervention – or interventions – with which to better engage primary school children with more positive and appealing ideas about a life in science.

By using the power of the narrative form, this doctoral study seeks to explore how primary school children engage with fictional representations of science and scientists. It is hoped that the new knowledge generated in utilising the narrative form in this way, might reveal new means of empowering and engaging primary school children more fully with the idea of a career in science. This new knowledge might so lead to a better future, not only for the planet as its current and future challenges are met and overcome, but for the world of science, too, wherein the many bright capable minds that otherwise might have not even remotely entertained the idea about a career in science are, instead, moved to think about the very real possibility of becoming a scientist.

Conclusion

Formal governmental national testing and national and global business reports can only interpret or be interpreted so much. Still, it could be argued that although the Royal Society and Bodmer's formal "proper science education for all" (Bodmer, 1985, p. 17) has achieved a great deal, it might not have achieved what it set out to and, despite science now being compulsory for all 5-16 year olds in the UK, there still exists a declining interest in science as a career.

It is worth considering, however, that what governmental and business statistics represent or interpret as a 'declining interest' in science may not mark a decline at all and could instead be reinterpreted as a 'lack of interest' in science as a career – especially, perhaps, in the face of burgeoning career alternatives.

In such case, we might consider that students collecting scientific grades toward a non-scientific career are not shying away from a career in science particularly, rather, they are simply not at all inspired by the idea of a scientific career. Instead, there might exist an inertia; that is, decisions regarding science as a career are being made neither one way nor another because 'doing science' as a career is something that might not even be thought about and so is moved neither away from, nor toward. The construction that is 'science as a career', perhaps like the construction that is 'scientist', might be something that feels entirely nebulous or indefinable to a young person – or is so remote as to be rendered almost absent – and so is not even felt at all.

This research seeks to explore what it is that young children feel or think they feel about science and scientists upon creating and encountering fictional texts about the same, and whether or not this will have some bearing on how the children feel or think they feel toward a career, or encore careers, in science. In this way, "the need for preventive career interventions for elementary school children that could remediate career behaviour in later career development stages" (Watson, Nota & McMahon, 2015, p. 176) may be met.

The Aims of the Research

It has been argued that with respect to children's science education particularly, we would do well to "make much greater use of one of the world's most powerful and pervasive ways of communicating ideas – the narrative form" (Reiss et al., 1999, p. 69).

With this in mind, the research sought to examine whether the engaging of primary school children's imaginations with the fictional narrative form, particularly fictional representations of science and scientists, could be a 'something' that might re/create the idea of 'science' and 'scientist' in the children's minds and so better inspire them toward the idea of taking on a career in science. Hence, it was necessary to look more deeply into how primary school children's engagement with stories about science and scientists might be constructing their ideas about the same.

The study's research question so became

> *How do primary school children engage with fictional representations of science and scientists?*

From the perspective of reader response theory, encounters with texts of any nature are exceptionally active, conscious and subconscious, enterprises, and the consequences of such encounters can be veiled and immeasurable. To what extent a child goes beyond herself or himself to create new meaning, new knowledge and a new self on account of these narratives is unknowable. In trying to find out how a child feels about encounters with fictional representations of science and scientists, therefore, the best way might be to simply ask the child.

The research so sought to gain a greater depth of feel for children's own attitudes to and perceptions of science and scientists by asking children themselves what their thoughts and feelings were about science and scientists. In order to gain a more 'truthful' insight into how the children felt about science and scientists, it was important, too, to not make my own summations about the same but to ask the children for their own point of view as to why they think they feel the way they do about science and scientists. Also, rather than asking children about existing fictions, in the light of the many deconstructions and reconstructions of 'science' and 'scientist' that are likely to occur when a child is asked to share and discuss their thoughts and feelings about the same, it made better sense to ask children to create their own fictions and to share and talk about their own and each others' works, besides any other fictions they could remember.

Hence, in order to satisfy the research question, the research aims became to understand

- *i) how children feel about science and scientists*
- *ii) whether children have any insight into why they feel this way and*
- *iii) how children engage with representations of science and scientists through writing, reading and discussion of fictions about the same.*

With these aims the research sought to explore not so much a dissociated observation of children's ideas about scientists that techniques like 'Draw A Scientist Tests' (Chambers, 1983), for example, might garner, but rather a deeper, more intimate exploration not only of how children feel about science and scientists and why they think they came to feel that way, but how children might engage with both fictional and real science and scientists.

In order to achieve these aims, it was therefore necessary to set in place some objectives to initially support them. These objectives were:

- *A. to examine how engaged children are with fiction (of any nature)*
- *B. to investigate whether children are familiar with science or scientists in fiction*
- *C. to explore whether children think they are influenced or inspired by fiction.*

In order to answer the research question, the research methodology and method were designed around these research aims and objectives (see *Chapter 4 – Methodology* and *Chapter 5 – Method*).

Chapter 2 – Reality, Fiction and the Text

Introduction

One might believe, for example, that we shape our own personal narrative and, in doing so, establish our reality – or, alternatively, one might believe that 'reality', our being in the world, is thrust upon us and it is how we deal with that and live through it that creates our personal narrative. That is, do we shape reality or does reality shape us; do we create our personal narratives or are we created by them? Yet, still, are our own personal realities and narratives one and the same?

Adding fictional worlds to the mix, with their own special rules, narratives and realities, might seem to pile layer upon layer of complication and uncertainty upon these philosophies – especially when trying to establish how children feel about fictional science and fictional scientists, and how the way they feel comes to construct what they believe and how they will behave about the same in reality.

Fiction and Reality

In examining how fictions affect our lives from a very early age, however, this chapter first proposes that the two, our narratives and our realities, are inextricably interwoven and, in thinking about science and the scientist in fiction, offers an idea as to how what is real and what is fiction might be constructed in the mind of a child, and suggests how a child might make sense of the same.

The Scientist in Fiction

Stemming from 1950's research in the U.S.A. – research undertaken on account of the very same concerns then that we have today; that is, young persons' negative attitudes towards careers in science and corresponding worries about actual and future shortage of scientists and engineers – the chapter then examines the original explorations of the image of the scientist in fiction and the perceived stereotype of the real scientist at the time.

Several multicultural large-scale studies carried out during the sixty years or so since the 1950s are then examined to look at how those images and stereotypes, fictional and factual, both have and haven't changed.

The chapter then presents the basic premise of the research argument by defining what is meant by children's fiction and 'whatever it is' that children are reading.

The potential for meaning in the text, in the author and in the reader as maker of meaning is then examined, and this begins to outline the applicability and congruence of reader response theory as the theoretical framework with which the research is underpinned.

Fiction and Reality

In Bruner's (1991) exploration of how human beings construct and represent their interactions and realities, *The Narrative Construction of Reality*, he argues

> we organise our experience and our memory of human happenings mainly in the form of narrative – stories, excuses, myths, reasons for doing and not doing, and so on. Narrative is a conventional form, transmitted culturally and constrained by each individual's level of mastery and by his conglomerate of prosthetic devices, colleagues and mentors. (Bruner, 1991, p. 4)

and suggests that this understanding of narrative "is among the earliest powers of mind to appear in the young child and among the most widely used forms of organizing human experience" (p. 9; see also Bruner, 1990; Bruner & Lucariello, 2006). This conventional form – these stories, myths, excuses, reasons – include both factual and fictional narratives; narratives that in historical, cultural or social transmission can be passed on visually, orally or by means of the written word, for example.

Focusing specifically upon children's written down stories, Saracho and Spodek (2010) agree. Undertaking a meta-analysis of family literacy studies, they concentrated particularly upon parental storybook reading wherein a parent or other adult family member not only reads books to young children but also talks about the books before, during and after reading the story. They found that this particular literacy experience had significant effects. Besides advancing children's literacy development by promoting reading ability, and vocabulary and comprehension skills, they felt that the children also "develop a positive awareness of the structure of stories, the language of stories and the nature of reading behaviour" (p. 1385), the influence of which they thought may be felt through into a child's primary school years. "Children," they concluded, "can become immersed in stories at a very young age and have the ability to identify, organise and understand the story" (p. 1381).

Mackey (2010) believes that this ability to identify, organise and understand stories and story structure can translate into a child's real life strategy for making sense of the world. She suggests that at about the same time in life children are learning to read, children are learning to negotiate their physical and emotional environments and "some of the same mapping and schema-building strategies inform each activity" (Mackey, 2010, p. 323; see also *Chapter 3 – Theoretical Framework; The Development of the Child Within the Theoretical Framework*).

If this is so, if children use some of the same strategies to both learn to read (and identify, organise and understand stories) and navigate and make sense of the material world, stories could so be seen to be able to play a significant part in a child's cognitive development and in the shaping of her or his emerging identity.

Mackey further argues that as children develop and grow and their capabilities and understanding of their physical and emotional environments expand "their relationship with fiction may become more complex" (2010, p. 323). This could be because, as Chappell (2008) suggests, when reading and thinking about stories and the actions and reactions of the stories' characters and personalities, it is "through the characters' choices and realizations, young readers are introduced to the complexities and ambiguities of the contemporary world" (Chappell, 2008, p. 281).

As a child gets older and life becomes more complicated, so too do the stories a child reads or hears become more complicated. The actions and reactions of the characters and personalities in these stories become more nuanced; nuanced both in the connotational and subtextual writing of the story, and in the child's understanding of those connotations and subtexts. By virtue of a child learning to recognise and understand these subtleties, a child's relationship with fictions, fictitious characters and fictitious worlds, also becomes more subtle and refined.

This specialist identification, organisation and understanding of that which is fiction, besides being a critical skill in itself, serves to support an understanding of that which is not fiction. There cannot be that which is 'real' without that which is 'not real' and it is in the negotiation between the two that a child may create some sort of meaning and so continue to develop her or his own sense of self. As a child's life becomes more complicated and multiform, so, too, does this symbiotic relationship between fiction and fact become more complicated and multiplex.

The Construction of the Real and the Fictional Scientist

Hence, when thinking about the position of science and the scientist within stories and within real life, one could argue that children use similar mapping and schema-building strategies to construct both the fictional scientist and the real scientist; the idea of the fictional scientist and the idea of the real scientist are interdependent and reciprocal and it is in the skilful negotiation between the two that a child's sense of what it might actually mean to be a scientist or to do science emerges.

This sense of what it might mean to be a scientist can therefore embrace lots of different ideas about real science and real scientists as counterparts to lots of ideas about fictional science and fictional scientists. It is in the iterative mediation between all these contrary ideas that some notion, some fresh idea, of what it means to a child to be a real scientist and do real science in the real world may emerge.

The Construction of the Scientist Within the Theoretical Framework

It fits very well with reader response theory (see *Chapter 3 – Theoretical Framework; Reader Response Theory*) that some of the same mapping and schema-building strategies are used to construct both the real scientist and the fictional scientist. These strategies and the strategies of interpretive communities, upon a child's encounter with a text, are used to create the text and make some meaning or construct some idea(s) about real and fictional scientists. In the negotiation between what is real and what is not real, and between the child and her or his creation of the text, meaning of some sort has to be made. Any meanings that emerge, any ideas, for instance, about what it might be like to do science for a part or the whole of one's working life, will always be fresh and will always be fluid because as a child re-approaches, rereads, recreates a text, a new sense of self is brought to each re-approach, to each re-reading, to each re-creation of that text – and the idea of 'scientist', both real and imagined, is re/generated.

The Scientist in Fiction

In 1958, in an investigation into the image of the scientist in science fiction, Hirsch analysed stories published between 1926 and 1950 in American science fiction magazines. The study cited a then contemporaneous "practical" (p. 506) relevance in that there was an "increasing concern about the shortage of scientists and engineers in the United States" (p. 506) and perhaps the reading of such fiction was a plausible cause of high school students' negative attitudes toward a career in science.

The Image of the Fictional Scientist

The analysis indicated that the stories in these magazines had undergone significant changes, some of which seemed to reflect actual historical and social trends; that is, times of Prosperity (1926-29), Depression (1930-33), New Deal (1934-37), Fascism and War in Europe (1938-41), World War II (1942-44) and the Post-War period (1946-50).

The number of scientists as major characters in these stories steadily declined from 1926 to 1950, as did the proportion of scientists who were heroes rather than villains. However, far from it being scientists who became more villainous, Hirsch found that it was "businessmen" (p. 509) who were and who remained, proportionally, more villainous than scientists.

Hirsch found, too, that the occupational setting of the scientist became less independent and more bureaucratic wherein

> the 'gentleman scientist', unencumbered by problems of 'human relations', is slowly replaced by the scientist involved in a network of interpersonal and institutional pressures ... [reflecting] a relatively realistic picture of the setting in which contemporary scientific activity takes place. (Hirsch, 1958, p. 510)

The social role of the scientists within these stories also began to change. The "more or less conventional themes" (p. 510) such as *Frankenstein* (Shelley, 1818) (scientist as 'mad' man) and "Scientist as Saviour" (Hirsch, 1958, p. 510), began to decline in favour of themes of hubris or the "Scientist as Martyr" (p. 510) until, towards the end of the post-war period, these story scientists came to be "real human beings who are facing moral dilemmas and who recognise that science alone is an inadequate guide for the choices they must make" (p. 512).

However, although the social role of the fictional natural scientist seemed to change with the times, the role of the fictional social scientist did not. This wasn't because real changes weren't occurring in real social science, but more noticeably because

> the number of social scientists was negligible. ... We had expected a substantial increase in the number of social scientists, but their proportion of the total number of major characters never exceeded 4 per cent. Patently, the popular conception of the scientist as one who deals with 'natural' rather than 'social' phenomena is also found in the image presented in science fiction. (Hirsch, 1958, p. 506 & p. 509)

Hence, although stories about science and scientists of the time seemed to feature scientists that mirrored the role and the position of real scientists in real society, the scientists being mirrored were natural not social scientists. It is interesting to note, of course, that whenever STEM shortages are referred to, it is only shortages in the natural/physical sciences that are being thought about, and not any shortages in the social sciences.

The Image of the Real Scientist

Concurrent with Hirsch's research was Mead and Métraux's 1957 pioneering study of 35,000 American high school students' perceptions of real scientists. They discovered the popular and still pervasive image of the scientist as a middle-aged or elderly white male with facial hair (a beard), wearing spectacles and a white laboratory coat, working alone at a laboratory bench using bottles, test tubes and chemicals as he performs dangerous experiments (Avraamidou, 2013, p. 92; Koren & Bar, 2009a, p. 144; Mead & Métraux, 1957, pp. 386-387).

Mead and Métraux's revelation of the perceived real scientist seemed to be at odds with the way scientists were being portrayed in popular science fiction stories of the time (in 1957). They were not Hirsch's 'relatively realistic' scientists living within 'a network of interpersonal and institutional pressures'. Mead and Métraux's perceived scientists seemed closer to those fictional scientists at the very beginning of Hirsch's study (1926) wherein the fictional scientist was seen as the emotionally detached, lone, and alone, "'gentleman scientist' unencumbered by problems of human relations" (Hirsch, 1958, p. 510).

Hence, in 1957, American high school students' perceptions of real scientists seemed to reflect neither the popular genre-pertinent fictional scientists of the time nor the real natural scientists of the time, but instead seemed to embrace fictional representations of thirty years earlier.

The Persistent Perception

Since Hirsch's and Mead and Métraux's original research, many studies have examined children's, high school students', student teachers' and teachers' perceptions of and attitudes toward science and scientists and have found "worldwide stereotypic commonalities" (Christidou, Bonoti & Kontopoulou, 2016, p. 497) with Mead and Métraux's perception of the scientist.

In 2009, Koren and Bar undertook a meta-analysis of the physical and social image of the scientist among school children, student teachers and teachers throughout the intervening fifty years since Hirsch's and Mead and Métraux's studies.

Although they found that the Mead and Métraux perception of the scientist "was widely held in the western world regardless of country or age" (Koren & Bar, 2009a, p. 144), they also discovered that studies in the early and mid 2000s had begun to recognise and then emphasise the influence of social, economic and cultural background on the sociological perception of the scientist (Finson, 2002; Fung, 2002; Koren & Bar, 2009a; Song & Kim, 1999).

Buldu (2006), too, taking particular account of children's age, gender and socio-economic status, recognised that

> [w]hile children of parents with lower socio-economic status drew more stereotypical scientist images, children of parents with higher economic status drew different images of scientists, a result which showed us that the scientist perceptions of young children differ with socio-economic status. (Buldu, 2006, p. 122)

Sjøberg (2002), in a study of 12-13 year old students in 20 countries, also determined that industrialised/developed countries had a different perception of the scientist than that of developing countries.

In developed countries, the Mead and Métraux image predominated and, although students believed that scientists did want to help people, there also existed the perception of the 'mad' scientist (Koren & Bar, 2009a; Sjøberg, 2002).

In developing countries, however, scientists were seen as "heroic, brave, and intelligent, helping other people, curing the sick, and improving the standard of living for everybody" (Koren & Bar, 2009a, p. 145); they were perceived as "helping the poor and underprivileged, they are servants of humanity, and heroes of society" (p. 145; see also Anderson, 2006) – and the notion of the 'mad' or 'evil' scientist was not prevalent.

Whether the past perceptions of scientists in developing countries have changed, or will change, from the hero or servant of society, to include the mad or evil scientist, and whatever it is that brings about any change in perception, might be a matter for further research. Koren and Bar's own studies in 2009, however, showed that in the developed West, attitudes among young students were beginning to change.

High School Students

Koren and Bar studied high school students' (14-18 years of age) attitudes to science and scientists by referring to representations of the same in some classical works and some popular works of science fiction dating from the beginning of the 18th century to the end of the 20th century.

Besides asking the students to write essays (as Mead and Métraux had done), they used closed questionnaires and semi-structured collective interviews about the stories in order to determine more closely "the personality behind the physical stereotype" (2009a, p. 141). They found:

> A few of [the students] stated that the scientist is isolated from any social framework, from the family web, and interaction in the political world. Others stated that the scientist is connected to society, possessing good communication skills and is open to others' views. In addition to the characteristics that refer to the scientist's intelligence – stubbornness,

> hardworking – the scientist was presented as enthusiastic, open to the beauty of nature, and some possessing excellent social talents. They describe scientists that can move large groups, to convince people of different fields, to help them and to raise money for the execution of research projects. (Koren & Bar, 2009a, p. 159)

Amongst high school students, therefore, more complicated and mixed images of the scientist had begun to emerge – with Koren and Bar feeling that contemporary high school students were, indeed, "pro-science and regard[ed] science as a useful area of society" (2009a, p. 142).

Yet, high school students having positive attitudes towards scientists and regarding science as having a worthy function in the world was still not leading them toward careers in science. One reason for this could be because unappealing ideas about scientists – scientists being "isolated from any social framework" or being too "hardworking" (Koren & Bar, 2009a, p. 159), for instance – might have been putting students off a career in science, and this is something I wanted to explore.

Elementary/Primary School Students

Chambers, in 1983, about twenty five years after Mead and Métraux's studies (and at about the same time the Royal Society was commissioning the Bodmer Report in 1985), undertook a large-scale study with elementary school children.

Pioneering the 'Draw a Scientist Test' (DAST) with 4,807 American children from kindergarten to grade 5 (aged 5-10 years), the Chambers' study produced similar results to Mead and Métraux: the scientist as a white male, with spectacles, peculiar hair and/or a beard wearing a white lab coat and working alone in a laboratory surrounded by test tubes and bottles. Furthermore, Chambers found that the stereotypical perceptions of the scientist emerged as early as second or third grade, that is, at 7 to 8 years of age. Chambers repeated the study in the People's Republic of China and found that the images drawn by Chinese students closely matched those from Western culture (Avraamidou, 2013; Chambers, 1983).

The DAST, subject to refinement, became a widely used tool in determining young children's perceptions about scientists and many studies using the technique confirmed Chambers' initial findings (Boylan et al., 1992; Christidou et al., 2016; Fort & Varney, 1989; Schibeci & Sorensen, 1983).

In the mid 2000s, however, Buldu (2006) suggested that the predominance of the Mead and Métraux image had begun to change for young children, too.

Buldu (2006) found that since the Mead and Métraux and the Chambers studies, the body of research examining children's perceptions of science and scientists was burgeoning (Finson, 2003; Koren & Bar, 2009a). When working with young children, this body of research, in the main, used children's drawings to discern children's perceptions of scientists and again found "pervasive, but questionable, preconceived ideas of scientists among all age levels of children" (Buldu, 2006, p. 122); children in these studies "generally perceive scientists as males with glasses, beards and strange hair, and wearing white lab coats: individuals who work in the laboratories, generally messing about with chemicals" (pp. 123-124; see also Fort & Varney, 1989; Huber & Burton, 1995; Schibeci & Sorenson, 1983).

Buldu's own study, working with children 5-8 years of age, using the DAST technique however, revealed that

> unlike previous studies, around 35% of the scientist figures drawn were of the social scientist type. ... [Children] drew scientists as journalists who type on a typewriter, together with novelists/poets, artists who paint and university professors who teach in class, rather than stereotypical images of scientists as drawn in previous studies. (Buldu, 2006, pp. 121 & 126)

Christidou, Bonoti, and Kontopoulou (2016) achieved similar results. Besides their findings being consistent with Chambers' (1983) study, in that "even second- or third-grade [7-9 years old] pupils have developed a fairly clear image of scientists and science" (Christidou et al., 2016, p. 515), working with 8 year old Greek and American children they, too, used the DAST together with a picture selection exercise and found

> [s]tudents' drawings and picture selections indicate that the participants apparently adopt aspects of an enduring image of scientists, which has remained unaffected by radical scientific development during the last decades. On the other hand, other features of the stereotypic image have been found to fade. (Christidou et al., 2016, p. 519)

More specifically, with respect to these both enduring and fading features, they found that the stereotypic indicators were more evident in the picture selection exercise but the DAST, as Buldu's research had done, revealed more diverse images and a fading of the stereotype. Although the scientists the children drew were "in their vast majority of European origin (87.9%)" (p. 508), they were only "more frequently male (59.3%) than female" (p. 508). Also, although the scientists were still mainly depicted as working in laboratories (74.7%), they were

> in majority represented in casual clothes (76.9%), without eyeglasses (73.6%), or peculiar facial hair (90.1%) ... individuals largely appeared to be young (95.6%) and their facial expressions mostly implied positive feelings and a friendly mood (81.3%). (Christidou et al., 2016, p. 508)

Evidentially, non-stereotypical perceptions of scientists are beginning to emerge among young and primary school children, too, wherein, although ethnicity ('mainly white') and working environments ('laboratories') are still similar to Mead and Métraux's and Chambers' findings, the children's image of scientists' gender, attire, appearance, age and demeanour are all beginning to change.

Children's Fiction and the Text

In considering the ways in which fictional representations of scientists might shape children's attitudes toward science and the possibility of being a scientist, this research is mindful of the complex processes involved in creating perception and in making of meaning.

Stories about scientists constitute only a proportion of the information that children receive about scientists and science. Other ideas and representations, such as those offered by teachers and care-givers, for example, may help to shape the way in which science and scientists are viewed and experienced.

Factual stories exist alongside fictional stories, too, and messages from non-fictional sources such as news items and film or television documentaries together with any significant others' perceptions of the same – how friends and family, for instance, articulate their thoughts and feelings about a current news issue – may come to bear upon how a child's perceptions about science and scientists are constructed.

This research does not suggest that children's ideas about science and scientists are influenced more by fictional stories than by non-fictional stories. Nor does it imply that fictional stories influence children expressly – in as much as it is not presumed that a child reads a story about a scientist and simply believes that the story is a true representation of reality.

Hence, the research does not contend that fictional stories about science and scientists have the greatest impact upon a child's perception. Rather, fictional stories are one element only amongst myriad representations and experiences – each a unique encounter – with science and scientists that will help each individual child shape the concept 'scientist' and relate that concept to their own emerging sense of identity.

When thinking about children's ideas about existing fictional stories connected to science and scientists, although aware that science and scientists can be represented in texts of various forms – paintings and sculptures; music and sound; film and television, for example – the texts around which this research is designed are more specifically – but not to the exclusion of other texts – those fictional written texts that the children were aware of and/or may have read in the past and could remember, and those stories that the children might have been reading or thinking about reading at the time.

The research makes no distinction between those written texts that might be thought of as 'literary' children's fiction and those that might be thought of as 'popular' children's fiction; it makes no judgement as to which texts might be considered 'lofty' and those that might be considered 'ordinary', and therefore holds no preference for one over the other. This is because, whether lofty or popular, any type of story a child reads and connects with will have its own particular and perhaps transformative effect.

The research therefore embraces fictional stories, from any social, historical or cultural background, that may be identified as 'children's fiction' but are probably more roundly realised as 'whatever it is' that the children were not only physically or electronically reading or having read to them, but what they were seeing, hearing, thinking, talking about or otherwise assimilating in connection with fictional stories about science and scientists in the research climate.

The Text

In considering how these fictional texts might contribute to the construction of the scientist in the mind and in the imagination of a child, it is necessary to examine what texts are and what their role is in the making of meaning.

Chapter 3 (*The Theoretical Framework*), outlines in depth the ideas embraced by reader response theory and the theory of interpretive communities in the making of meaning. Before meaning can be made, however, the texts themselves exist as unique entities that have 'meaning' or what I have chosen to describe as 'potential for meaning'.

Literary theorists (for example Arnold, 1864/1995; Coleridge, 1814, 1817; Eliot, 1920) originally argued that the potential for meaning lay within the text itself. In the 1960s and 1970s, however, the potential for meaning began to shift away from the written down words of the text toward the author of the text; whatever it was the author wanted to say, whether she or he was consciously aware of it or not within the social, cultural or political climate wherein she or he was writing, was where a text's true meaning lay. Some modern literary theorists (Barthes, 1967/1977; Bleich, 1980; Derrida, 1967/1997; Fish, 1970, 1976, 1980; Holland, 1975; Iser, 1974, 1978; Rosenblatt, 1938/1970), however, believe that no one true 'universal' meaning exists and, instead, each unique reader not only creates a text's meaning but, in bringing her or his own uniqueness to the transaction, actually creates the text itself.

The Text As In Itself It Really Is

In the latter half of the nineteenth century, upon the institution of the humanities as an academic discipline in Britain and the United States and their subsequent introduction into high school and university curricula (Klages, 2006, p. 28), Matthew Arnold sought to establish the study of literary theory upon the same academically rigorous foundation as that of the natural sciences.

From his humanist perspective, Arnold felt that the fundamental principle in any interpretive criticism of a text was to "see the object as in itself it really is" (Arnold, 1864, p. 1). That is, in order to provide a detached and objective interpretation of a text, it was only the text itself that should be scrutinised, entirely independent of any political, social or historical stimuli outside of it. This principle became central to what would become the British and American practical criticism or New Criticism method of literary criticism, analysis and interpretation.

Inspired by the poetry and criticism of T. S. Eliot and Ezra Pound, the New Criticism movement of the 1920s (Eliot, 1920; Richards, 1929), 1930s (Empson, 1930; Pound, 1934; Brooks & Warren, 1938) and 1940s (Ransom, 1941), valuing literature as high art although, in the main, preferring the poem above the novel, also believed that the text was all that mattered in the construction of meaning.

A text existed entirely by itself, outside of time and place, and remained uninfluenced by the cultural setting within which it was created or within which it was read.

Nor did the past or current biographical experiences of the author of the text bring anything important to bear upon the interpretation of her or his work. An author's intent or opinion was just that – simply an intent or an opinion: "the relevant part of the author's intention is what he got actually into his work" (Brooks, 1951, p. 75) – and "the design or plan in the author's mind" (Wimsatt & Beardsley, 1946, p. 469) was entirely irrelevant to the interpretative method and the making of meaning.

The New Critics instead maintained that it was only by 'close reading' of the text, that is, by closely examining a text's form and devices – its metaphors and ambiguities; its ironies and paradoxes; its juxtapositions and harmonies – could objective assessment be made and stable, unchanging universal meaning be found.

In the 1960s and 1970s, however, reacting against the New Critical method, a hermeneutical shift began to emerge in the methodology of the interpretation of the text.

The Death of the Author

Although Hirsch in his *In Defense of the Author* (1967, pp. 41-50) agreed that the text "is an entity which always remains the same from one moment to the next ... it is changeless" (p. 46), from his (also humanistic) perspective, he suggested that it is only the author's intent that matters in determining or interpreting the meaning of her or his text.

By removing the text and instead positioning the author at the centre of the interpretative method, Hirsch vigorously defended authorial authority against New Critical theories of "authorial irrelevance" (p. 42) and insisted that it is only by establishing authorial intent and keeping that intent stable and unchanging that subjectivity, relativism and "a chaotic democracy of readings" (p. 5) can be held at bay and a structuralist-like "objectively valid interpretation" (p. 2) can be made.

The Geneva School of Literary Criticism, too (Poulet, 1956; Richard, 1954), had emphasised the value and significance of recognising the author's presence within a text. Although again focusing upon the text itself without reference to any biographical trends, the Geneva School advocated a more phenomenological approach to interpretation wherein one might discover not only the author's intentions within the text but where one might also find a sense of the author's own consciousness and her or his presence in and experience of the world.

By the end of the 1960s, however, the progress and influence of deconstructionist theory (Derrida, 1967/1997) began to supplant structuralist schools of thought. Hence, the position of the author at the centre of either Hirsch's hermeneutic objective technique or the Geneva School's more subjective phenomenological method began to change.

A deconstructionist analysis of a text would instead disclose the possibility of many meanings arising from the text. These meanings were volatile, unstable and uncertain – both on account of the meanings of the words and expressions themselves, and also on account of how different meanings might arise within different readers.

Attention so began to shift toward the reader as a significant contributor to the making of meaning.

In his seminal essay, *The Death of the Author* (1967/1977), Roland Barthes marked both his own and the field of literary theory's transition from structuralist to poststructuralist patterns. He argued against any reliance upon the intentions and/or biography of an author to extract or make meaning from a text, and considered instead that it is only the impression a text makes upon its reader that matters. A text's true meaning, he felt, lies in the reaction of its audience alone. "[T]he birth of the reader," Barthes wrote, "must be at the cost of the death of the Author" (1977, p. 148).

The Reader as Maker of Meaning

Hence, in the 1970s and 1980s, reader response theorists began to suggest that the text does not embody meaning; nor does authorial intent or biography play any part in the finding or in the making of meaning. Rather, it is the reader, each and every unique reader, who *creates* meaning; meaning that is, in the strictest sense, entirely singular to each and every individual reader. Furthermore, it is a reader's active and subjective engagement with a text, together with her or his temporally progressive interpretations of the same, that not only creates literary meaning but that also, in effect, creates the text itself (see *Chapter 3 – Theoretical Framework; Reader Response Theory*).

This research seeks to examine how children engage with fictional representations of science and scientists, that is, how children engage with fictional texts about science and scientists. The idea of the child-reader subjectively engaging with those texts and playing an active part in not only the creation of meaning but in the creation of the texts themselves, lends itself well to the exploration of this idea.

Furthermore, the idea that the children not only engage with fictional texts in the creation of those texts and in the making of meaning therein, but could also, in doing so, engage with each other, lends itself to an even richer exploration of how children come to create their ideas about science and scientists from within their own interpretive communities – that is, from within interpretive communities that are, for example, 'children' and 'children who are engaging with fictions about science and scientists' (see *Chapter 3 – Theoretical Framework; Interpretive Communities*).

Hence, in seeking to explore how primary school children engage with fictional, textual, representations of science and scientists, and in order to be theoretically robust, it was important that the research be designed to work with children as a group, an interpretive community, rather than with children as individuals.

The research instrument was designed so that the children would work both as a class group and within smaller groups within the class, rather than individually, when re/creating texts and making meaning about science and scientists. In this way, the children's interactions and engagements with one another, with their own stories and with each others' stories within the research environment, although already immensely subjective and active enterprises when realised individually, would become even more subjective and re/active, more enhanced and enriched, as interactions and engagements being enacted from within the excitement of the children's own interpretive community.

Conclusion

Not only do young children have the power of mind to understand factual and fictional narratives and the skill to navigate between the two (Bruner, 1990, 1991; Bruner & Lucariello, 2006), but specifically proactive literary experiences can teach children to understand the structure of those narratives and to navigate them at a very early age (Saracho & Spodek, 2010).

A child's recognition and assimilation of those narratives and structures (Mackey, 2010) can shape a symbiotic relationship between what is real and what is not real.

With respect to reader response theory particularly, the negotiation of this symbiotic relationship flourishes when a child's unique encounter with texts connected to science and scientists, for example, re/creates those texts and generates new meanings.

These fluid meanings help shape the personal framework within which a child comes to make sense of the real and the unreal with respect to their own individual reality. She or he may so come to find some degree of stability when developing her or his own sense of identity; an identity that, to some degree, embraces the idea of she or he being 'scientist' in the real world.

Hirsch's study found that the representation of science and scientists in fiction had regularly changed, as a sign of the times, at least from 1926 to 1950. Mead and Métraux's work found that the perception of real scientists hadn't mirrored those changes though, and had remained entrenched in the fictional images of the mid 1920s. Evidence now emerging, however, suggests that the Mead and Métraux perception of the scientist, dominant since the late 1950s, is at last beginning to fade and a new perception is taking shape.

For high school students and primary school students alike, scientists are now being recognised as social scientists as well as natural scientists – although, with particular respect to social scientists, the image, as such, is not changing because there was no dominant representative social scientist image to begin with; instead, social scientists, in as much as they do not wear lab-coats or work in a lab with chemicals and are being depicted as using typewriters, artists materials and working in classrooms, are at last simply gaining recognition as people of science.

Not only that, the gender of these social and natural scientists is becoming more evenly distributed, and the appearance and demeanour of the scientist is shifting away from an 'old and lonely' type of person toward a 'young and friendly' type.

Throughout the sixty years since Hirsch's and Mead and Métraux's studies, however, and despite the positive shift in young people's perceptions, enduring concerns have existed, and still are high, that students have adverse attitudes toward embarking upon a career in science (Bodmer, 1985; CBI, 2013; Hirsch, 1958; Smith & Gorard, 2011; see also *Chapter 1 – Context and Aims of the Research*).

Hence, it seems that if the perceived stereotype of the scientist does have any bearing on a young person's attitudes to real scientists and so to a career in science, then the fading of a negative stereotype and the emergence of a more positive type does not seem to be having any impact upon better persuading students toward careers in science.

Mead and Métraux's stereotype was not at all reflective of either the real or the fictional scientists of the time – nor may any new stereotype be.

Looking to Reader Response Theory

At 9-10 years of age, a child's sense of identity is far from being fully formed, as is a child's concept of 'scientist'. If a child has already read stories about scientists and science, some degree of meaning making – what it means to be a scientist, work with science or 'do' science outside school, for instance – may have already occurred. Still, an active participation in open discussions about their own and others' stories and ideas about science and scientists may afford a child an opportunity to challenge or build upon this existing concept. She or he might then come to realise, or to relearn to some degree, what it is they mean when they think about the scientist and, from there, upon consciously or subconsciously re/articulating what they think or how they feel, might refashion some part of their own sense of identity in relation to whatever it means to do science or to be a scientist. Indeed, it is perhaps only through subjective engagement and active participation in this way – with each other and with each others' stories; with how they feel about those stories and whether or not they have any insight into why they feel that way – that the children's meanings and feelings about what it means to be a scientist can be re/articulated and can flourish.

Whether we interpret stories in the light of our own life experiences or whether we interpret life in the light of the stories we know, our own lives and our own narratives are intricately and inextricably interwoven. Hence, one might expect children to think about their lives in the light of the stories they encounter and create, as

> [t]he secondary worlds created in fantasy encourage the reader to compare and contrast the real world with the imaginary. In this way, fantasy as a genre can be transformative. (Lea, 2006, p. 51)

With respect to science and the scientists in fiction, this research embraces these ideas, and so looks to reader response theory to frame and theoretically underpin the research.

Chapter 3 – Theoretical Framework

Introduction

This chapter outlines the concept of reader response theory and the idea that it is the reader of a text who not only creates meaning from the text but who creates the text itself. Stemming from the theory of reader response, is the concept of interpretive communities, and this idea, too, and its place within the theoretical framework, is described.

The idea of children as readers of stories connected to science and scientists within these interpretive communities is then discussed together with the position of the child within the theoretical framework.

Both classic and more modern theories of children's cognitive development are discussed, wherein it can seen how Piaget's stage theory, Vygotsky's social development theory, Bruner's processes of cognitive growth theory and nascent developmental systems theories could be felt to resonate alongside a reader response and interpretive communities framework.

The relative impact of nature versus nurture upon a child's development is then considered with a view to answering the question *'Are scientists born or made?'*

The chapter concludes with the idea that from a reader response and interpretive communities perspective, there can be no generic or universal reader nor, consequently, any generic or universal meaning – and any stance, efferent or aesthetic or any mixture of the two, that a reader may take in coming to re/create a text serves to re/create meaning that is entirely unique to the reader.

Finally, the theories of reader response and interpretive communities, by their very nature, are seen to so preclude the idea that 'scientists are born not made' as a person's sociocultural positioning in the world (the interpretive communities of which she or he is a part) and the way in which a person makes meaning of any sort (reader response theory) ensure that the person is perpetually, albeit sometimes imperceptibly, re/created; that is, a person, scientist or non-scientist, is not 'born' but 'made'.

Reader Response Theory

As early as 1938, Rosenblatt argued that "[t]here is no such thing as a generic reader or a generic literary work; there are only the potential millions of individual readers of the potential millions of individual literary works" (Rosenblatt, 1970, p. 25).

Each reader, she said,

> brings to the work personality traits, memories of past events, present needs and preoccupations, a particular mood of the moment, and a particular physical condition. These and many other elements in a never-to-be-duplicated combination determine his response to the peculiar contribution of the text. (Rosenblatt, 1970, pp. 30-31)

She felt that each literary experience, each experience of reading a text, could never be the same from one reader to the next, and neither could a rereading of the same text by the same reader ever be the same; it would, instead, be an entirely different experience.

Drawing upon John Dewey's ideas about the process of inquiry or knowing (Davidson, 1993), Rosenblatt suggests that reading is a "transactional" (Rosenblatt, 1986, p. 122) operation. The reading experience, she says, evolves as "a transaction, a two way process involving a reader and a text at a particular time, under particular circumstances" (1982, p. 268; see also Brooks & Browne, 2012, p. 77). Furthermore, what is created – the meaning or the knowing this unique literary experience generates wherein the reader and the text dynamically, continuously interact with one another – is an experience that the reader is "living through" (Rosenblatt, 1969, p. 39) from one moment to the next; this new experience, this new text, is not an entity in itself, rather, Rosenblatt feels "[it] must be thought of as an event in time" (1978, p. 12).

Rosenblatt further argues that the nature of this transaction, this event, depends upon the approach or 'stance' the reader takes when living through the event. An "efferent" (p. 24) stance is likely to be taken when a reader reads in order to take away information: the reading of a newspaper, a text book, a DIY manual, for example. In contrast, in an "'aesthetic' stance ... the reader's primary concern is with what happens during the reading event" (p. 24), that is, what thoughts, feelings, emotional reactions and responses naturally come to bear upon the reading experience.

Within the aesthetic transaction in particular, Rosenblatt felt that the transaction with the signs of the text – signs as in both the semiotic signatures of words and the markings upon the page – "activates a two-way, or, better, circular, stream of dynamically intermingled symbolizations which mutually reverberate and merge" (1986, p. 123).

The aesthetic event, then, is emotionally richer than the efferent – but no less important.

To illustrate the difference between the two, Rosenblatt recalls a story wherein a first grade teacher told the class to learn the following verse

> *In fourteen hundred and ninety-two*
> *Columbus crossed the ocean blue.*

When called upon the next day, one child recited

> *In fourteen hundred and ninety-three*
> *Columbus crossed the bright blue sea.* (Rosenblatt, 1982, p. 269)

When asked why she had changed the rhyme, the child said she simply liked it better that way. Rosenblatt feels that this represents a difference in stance; the teacher wanted the child to read efferently in order to retain/carry away information – but the child read aesthetically, preferring her own more qualitative responses to the images and sounds and letting her own imagination come into play.

Iser, too, recognised and emphasised the transactional character of reading (Harkin, 2005, pp. 412-413). He favoured the aesthetic stance particularly – and the impact and influence of a reader's imagination. Iser (1978) also highlighted the idea of the 'aesthetic response' underlining not only the transactional operations but also "the unique, imaginative capacity that the reader brings to the text" (Ward, 2006, p. 9). Iser felt that the aesthetic response, brought about by the text, drew into play "the imaginative and perceptive faculties of the reader, in order to make him adjust and even differentiate his own focus" (Iser, 1978, p. *x*).

Crucial to that response, though, was also what was also *not* there in the text. 'Blanks' or 'gaps' within the text – the sudden advancement of the story to another time or another place or another speaker for example – "by impeding textual coherence" Iser says, "[these blanks] transform themselves into stimuli for acts of ideation" (1978, pp. 194-195). The reader then uses her or his own imagination to literally 'fill in the gaps' and order/reorder or construct/reconstruct the text to create their own virtual world, and because each reader brings their own "past experience and present personality" (Rosenblatt, 1978, p. 12) to the ideation and re/creation, each newly re-imagined virtual world is, of course, unique to each reader.

In tandem with Rosenblatt's hermeneutic approach and Iser's more phenomenological method, Holland (1975) and Bleich (1980) favoured a more psychological design (see also Wolfreys, 2006).

From Freudian roots, wherein artistic creativity might be seen as a therapeutic device through which our unconscious drives, desires or fears can be imaginatively remodelled into socially acceptable and representable activities (Wolfreys, 2006, p. 35), Holland argued that just as authors create texts that are expressions or extensions of their unconscious drives, desires or fears so, too, might readers "work out through the text [their] own characteristic patterns of desire and adaptation" (Holland, 1975, p. 816).

As readers, Holland feels, "[w]e interact with the work, making it part of our own psychic economy and making ourselves part of the literary work – as we interpret it" (p. 816). Each reader, he says, unconsciously seeks out the issues that concern her or him, making sense of the text or rather reconstructing the text in such a way as to deal with or solve the arisen issues in order to create a coherent, satisfying, literary experience.

Holland argues, "[I]dentity re-creates itself ... all of us, as we read, use the literary work to symbolize and finally to replicate ourselves" (p. 816). Hence a psychological consequence of a reader reading/constructing a new text, Holland feels, is that the reader effectively constructs a new self, a new identity.

That is, just as the reader constructs the text, so too does the text construct the reader.

Bleich (1980), as well, suggests that reading is an essentially psychological process. In a design apart from Holland's ego-based theory of response, Bleich recognised the importance of language "as the articulation, both mediating and objectifying, of the self" (Wolfreys, p. 36). Bleich believes the realisation of the text as a meaningful literary experience depends upon "the capacity and desire for symbolization on the reader's part [where] the reader's initial response ... is followed by a secondary symbolization" (Wolfreys, p. 36). This is Bleich's "motivated resymbolization" (Bleich, 1980, p. 134) wherein the reader, by negotiating and interpreting "symbolization[s] and resymbolization[s]" grounded in her or his own psychology, creates their own "subjective syntheses" (Bleich, 1980, p. 145) of the text as they go along.

Whereas Holland feels that a reader's interpretation is a function of identity, Bleich feels that interpretation is a function of language as symbol and, as such, is not a purely individual or arbitrary process. A reader's discernment of a symbol, Bleich believes, both derives from and leads to a community agreement/articulation as to what that symbol represents. That is, although a reader reaches her or his own unique experience, the symbolic discernments and decisions a reader makes toward that experience are grounded not only in the reader's own psychology but also in the collective psychology of the language community within which the reader is situated.

Hence, although great differences in literary events might occur, so too might different readers experience similar events.

Fish (1976) agrees, and regarding reading as an activity that one 'performs', in accounting for both why different readers might perform similarly when reading the same text, and why one reader might perform differently for any set of texts she or he reads, Fish believes that both this stability of interpretation and this variety of interpretation are "functions of interpretive strategies rather than of texts" (p. 481). That is, Fish does not believe that we use our interpretive strategies to draw the hidden meaning out from the text, rather, a reader imposes their own meaning upon the text – and she or he does so by using strategies that are derived from and articulated by diverse "interpretive communities" (p. 483).

Interpretive Communities

Fish (1976) argues that a reader's disposition toward the text, deciding what the text's genre is, for example, or what themes she or he might look for within the text, constitutes the set of interpretive strategies that become "the large act of reading" (p. 481). That is, our interpretive strategies are not put into use after the text is read, rather our interpretive strategies "are the shape of reading, and because they are the shape of reading, they give texts their shape they, making them rather than, as it is usually assumed, arising from them" (p. 481). Hence a reader's set of interpretive strategies effectively rewrite the text or "call into being" (p. 484) another text in order to make satisfactory meaning.

Hence, a second reader using a different, her or his own unique, set of interpretive strategies upon the same text would rewrite or call into being another, different, text than that which was rewritten or called into being by the first reader. The first reader could use, for example, deconstructionist interpretative strategies to create meaning and the second reader, interested in reader response theory, might use psychoanalytical interpretative strategies to create meaning. The same text then, would be rewritten into two different texts; that is, two new texts would be called into being wherein two separate and distinct meanings are made.

Different readers, too, using similar sets of interpretive strategies on the same text might call into being two new similar texts; that is, two different deconstructionist readers, for example, using similar interpretive strategies might call into being two new but similar texts.

As to why a single reader is able to use different sets of interpretive strategies, though, and why different readers with the same set of strategies might agree, Fish believes that this is because of the various "interpretive communities" (p. 483) to which readers belong.

Interpretive communities are "made up of those who share interpretive strategies not for reading (in the conventional sense) but for writing texts, for constituting their properties, and assigning their intentions" (p. 483). A reader can inhabit one or many different cultural communities and so employ different sets of interpretive strategies. Many readers, too, could inhabit the same community and, using that community's set of interpretive strategies, so similarly rewrite/call into being/make similar meaning within the same text.

A reader who is both a mother and a motor engineer, for example, might interpret her child's go-cart design using interpretive strategies from both the interpretive community that positions her as 'mother' and the interpretive community that positions her as 'motor engineer', and she so might call into being two different responses.

A reader's interpretive communities are woven into her or his own contextual social and temporal position and, as such, perpetually shift and change. Being part of one's own ever-shifting context, the interpretive communities to which one 'belongs' are, in the moment, inescapable – a reader cannot 'step outside' of the context that is her or his own interpretive community or set of interpretive communities; there exists no position from which a reader can interpret the text using interpretive techniques from another reader's interpretive community.

This research, itself, is so shaped by many contexts and interpretive communities – some of which are entirely unknowable, some of which are partially knowable and some of which are constituted by the research itself.

Hence, when thinking about how children engage with fictional representations of science and scientists, it is important to be mindful that the systems and interpretive communities wherein the child and the researcher might engage, and the interpretive strategies that will be employed are unpredictable; they are knowable only to a degree, and the environment that the research itself creates will call into existence an interpretive community and interpretive strategies all of its own. Within the research environment, the interpretive strategies that are the actual shape of the children's reading, will call into being texts about science and scientists that cannot be thought to embody any 'true' or 'universal' meaning about science or scientists. Rather, in writing, reading and sharing stories about science and scientists, the children will each call into being fresh unique texts and fresh unique meaning singular to each and every child.

Children as Readers within the Theoretical Framework

Thus, any making of meaning lies within the literary experience or "the event" (Rosenblatt, 1978, p. 12) that occurs when a child first reads or encounters a text – or, rather, whenever a child constructs/is constructed by the text upon such an encounter.

Not only that, but when a child is called upon to remember such a past event ('*Can you remember any stories you've read that have Scientists in?*', for example), a new text, a new literary experience, a new event will come into being as the child lives through the experiencing of the text/event recall as both no longer the person she or he was, back then – and as a new person, as it were, reconstructing and being reconstructed, in the new moment, by this re-imagining of the original event.

Through the complex uneven lens of her or his memory, through all her or his life experiences real and/or imagined since the original event, and in her or his "particular mood" (Rosenblatt, 1970, pp. 30-31) of the new moment, a child will both recreate this reading of a story about science/scientists, this text, this experience, this event, whilst simultaneously creating a new reading, text, experience, event – and, moment to moment, the child is reciprocally re/created by it.

Both the old and the new literary experience – that each incorporate and burgeon freshly constructed ideas of 'science' and the identity of 'scientist' – serve to reciprocally reconstruct the child and the child's own sense of scientific or non-scientific identity by way of those experiences and ideas.

This continuously interdependent interaction between the child and the text, this perpetual "transactional" operation (Rosenblatt, 1986, p. 122) that is the literary experience/event creation, renders the making of meaning – and the examination and the interpretation of the same – a complex issue; an issue which, itself, is a transactional, constructed and constructing thing.

Using Rosenblatt's concept of the transactional 'stance', though, might help to more clearly define and interpret the nature of the transaction.

Children taking an 'efferent' stance – or being expected to take an efferent stance – is more likely to occur where teachers are, for instance, 'teaching to the test'. Here children are required to read in order to take away and retain for assessment at a later date, information: facts and figures, for example. Here Reiss et al.'s (1999) "restricted contexts designed to ensure marker reliability" (p. 69) come into play and, as historic and current studies attest, seem to have contributed to a decline in interest in or a lack of motivation toward the consideration of science as a career.

With the 'aesthetic' stance however, "what happens during the reading event" (Rosenblatt, 1986, p. 124) is of primary concern; an aesthetic stance seems to offer a richer, more emotionally engaging, literary experience in as much as a child's feelings, reactions and responses might be allowed, or even actively encouraged, to come to bear upon the experience.

In finding a way to mitigate a child's lack of interest in science as a career it might seem more effective to eschew the efferent transactional stance and instead favour the aesthetic.

Given that the research aims are to understand how children feel about science and scientists, whether children have any insight into why they feel this way and how children engage with images of science and scientists through writing, reading and discussion of fictions about the same, an aesthetic transactional stance lends itself very well to the exploration of these aims. The actual research act of asking the children to recall or consider or create or discuss stories about science and scientists, sets into motion Rosenblatt's dynamic stream of mutually intermingling symbolisations of science and scientists – or rather, the symbolisations that have come to be known, in the research's and the children's interpretive communities, as science and scientists – and it is perhaps only through an aesthetic approach that these symbols, what they mean and what they come to mean to the children in the moment, can be more fully explored.

The Development of the Child Within the Theoretical Framework

Besides considering children as readers within the theoretical framework, it is important to consider them as actual children – entities in themselves, reading or non-reading – within the same. All the primary school children taking part in the research are at a significant developmental stage in their lives and any framework within which we choose to study them must take this into account.

Although the children within a particular year group could be said to be at the same or a similar stage of cognitive development, the actual developmental age of one child relative to another within the group can vary significantly. This idea is reflected in the children with whom this research was undertaken. One cohort, the Year 5 children of 2012, were described by the Head of School as 'mainly August birthdays' – by which she intimated that not only were many of the children physically younger than would be expected for an average year group but their being so made them less cognitively developed: they appeared to have shorter attention spans and were regularly more cheeky and more naughty than was to be expected. This is not to say that more cognitively developed children couldn't have similarly short attention spans or be just as cheeky or as naughty but rather, in the decades-long experience of the Head of School, in any year group – especially Year 5 and Year 6 groups where more is asked of the children with respect to, for example, English, Maths and Science SATs – she felt that the younger children, especially younger boys, tended to be more behaviourally challenging and, academically, often found it harder to keep abreast of their older peers.

Nevertheless, primary school children are immersed in learning – at school, at home and when out and about, for example, with peers or other significant others – and so it is important to think about the ways in which children learn and develop and whether or not these ways are compatible with the theories of reader response and interpretive communities.

Many theories of cognitive development exist. They present sometimes divergent, sometimes conjoining or crossing beliefs about how children learn and develop and so offer different ideas about what it is that influences that learning and development. Any theory so advocates specific factors that forge a child's belief systems, values and attitudes – or at least the beginnings of the same.

Thinking about how these factors might be significant to reader response theory and the theory of interpretive communities would go some way toward reinforcing the strategies with which this study is undertaken, strengthening not only the theoretical framework itself but also rendering its contribution to knowledge yet more robust.

Recognising the compatibility of the framework with both classic and more modern theories of cognitive child development will not only deepen the exploration of a child's approach to reading, the re/creation of texts and the re/creation of a child's belief systems, values and attitudes – but might also enrich the study of the re/creation of the beliefs, values and attitudes a child has about science and scientists.

Classic Theories of Cognitive Development and the Theoretical Framework

Although it is, of course, not the intention of this research to redefine any existing theory of development, it is interesting to consider that both classic Piagetian (Piaget, 1923/2002, 1925/2007, 1950/1955; Piaget & Inhelder, 1950/2000) and Vygotskian (Vygotsky, 1930-34/1978, 1998) philosophies of cognitive development, together with other theories – Bruner's processes of cognitive growth in childhood (1968; Bruner et al., 1959), for instance – seem to resonate well with the philosophies of reader response and interpretive communities.

Depending upon how one chooses to define a text or an interpretive community, the idea of a person using the interpretive tools at her or his disposal in creating/ recreating that text, making meaning and so creating/recreating herself or himself could, to varying degrees, lend itself to many theories of cognitive development.

Piaget's (1955) theory of adaptation, for example, suggests that at each stage of a child's development new knowledge once taken in and understood (Piaget's 'assimilation') finds its place within the child's existing mental schema (Piaget's 'accommodation'), and thus a child adapts to the new knowledge or experience. The idea of a child adapting in this way could be considered to resonate with the ideas of reader response theory: the new knowledge/experience/text a child lives through calls that knowledge, that experience, that fresh text into being and new meaning is made. The calling into being of the new knowledge or the making of new meaning therein – or both – resonates with Piaget's 'assimilation'; the fresh meaning, in finding its place within the child's existing mental schema, that is, in the child's 'accommodation' of that fresh meaning, both the mental schema and the child are de/reconstructed and the child, so learning and developing, is changed/adapts.

Vygotsky's sociocultural theory of development (1998) suggesting that a person's cognitive learning and growth is a lifelong socially collaborative process (as opposed to Piaget's more individualistic stage and adaptation theory) could also be considered to resonate with the ideas of reader response and the theory of interpretive communities. The social interactions that Vygotsky felt progressed a child's cognitive development – the reading of a book to a child or a simple conversation, for instance, or any social exchange – represent both efferent and aesthetic transactive texts or events, and the interpretive communities of which Fish (1980) speaks are very much socially, culturally and historically constructed.

Vygotsky's and Bruner's (1968) ideas of instructional 'scaffolding', too – wherein a child's more knowledgeable parent, carer or peer supports (scaffolds) the child in the mastering of a task or in the understanding of a concept until the child fully internalises the same and is able to complete the task/articulate the concept without support – also resonate within the framework of the interpretive communities theory.

A scaffolded interaction could be thought of not only as a social exchange/an interactive – efferent rather than aesthetic (though not to the exclusion of the aesthetic) – transactional text or event but could also be defined as an actual interpretive community in and of itself. When a child is being shown a specific task or being taught a particular concept, one-to-one, for example, social interactions/textual transactions must occur in order for the child to somehow master that task or concept. For the child, both on account of the structure and from within that structure, strategic interpretive techniques begin to burgeon and progress. The child uses, adapts and reuses these interpretive strategies to internalise the scaffolded knowledge by deconstructing then reconstructing her or his own schema until the task is eventually mastered. This scaffolded interaction could be looked upon as an interpretive community, albeit an intimate community of only two people (the child and the more knowledgeable other). It is both its specificity and its non-specificity that makes it so: its specific intention to teach a task and its non-specific 'unintention' to originate organic strategies for the child to interpret/self-teach that task and so create new meaning. A mere series of textual transactions is elevated to a self-sustaining, though temporary, interpretive community in itself. The child 'lives through' the pedagogic transactions within this intimate community, simultaneously developing/redeveloping techniques and deconstructing/reconstructing that which is already known – to the inclusion of new meaning. When new meaning is made the scaffolding is removed: the intimate community is no longer needed and it ceases to exist. The loss of this intimate interpretive community is of little consequence to the child as she or he wasn't aware of its existence; it has served its purpose in that the child has reconstructed her or his self and is not in need of it anymore; and in all likelihood another intimate interpretive community will be along in a moment.

Hence, dependent upon how one defines texts, interpretive communities and their temporal and/or temporary existences, one might consider that reader response theory and the theory of interpretive communities present ideas that mesh well with Piaget's, Vygotsky's and Bruner's ideas of cognitive development.

Nonetheless, whichever cognitive theory of development one favours or however one may choose to re/define its ideas within the terms of alternative frameworks, it is interesting to think, too, about the long-standing debate as to what it is exactly that, in the very beginning, first energises, galvanises and advances a person's development of any kind: is it nature or is it nurture? That is, with respect to this research's core motif: Are scientists born or are they made?

It is important to think upon this question here because, if scientists are only ever born not made, then the idea of shaping interventions to better persuade children toward a career in science becomes somewhat moot.

Nature versus Nurture: Are Scientists Born or Made?

The field of human development is huge and constantly evolving. Advances in genetics, therapeutics and imaging technologies stand us, for instance, at the cutting edge of cognitive neuroscience wherein new concepts, theories and methodologies are beginning to emerge and flourish.

Many fields in the social sciences, the natural sciences and in engineering and technology, besides addressing the prevention, treatment and cure of disease, for example, or how we might better understand the world, are more specifically trying to figure out how we might better understand ourselves.

Why we are the way we are – and why our children are the way they are – is the essence of the nature versus nurture debate.

As individuals, are we the way we are because it is our inherent nature to be so, that is, we were born this way, with intrinsic, inbuilt abilities and predispositions towards maths or science, for example? Or are some or all of our traits nurtured in us as a consequence, direct or indirect, of all our life experiences; any predisposition toward maths being a consequence of our having being introduced to maths early on in our lives say, or having carers who loved science and talked about it a lot, or having maths or science teachers that truly connected us to the subject?

Spencer et al. (2009) believe that modern theories of human development should put an end to the debate and "the nativist commitment to the idea of core knowledge and endowments that exist without relevant postnatal experience continue to distract attention from the reality of developmental systems" (p. 79).

What Spencer et al. describe as developmental systems could be looked at in terms of reader response theory and the theory of interpretive communities – dependent, again, upon how one chooses to define texts and interpretive communities. They argue that

> the developmental systems approach embraces the concept of epigenesis, that is, the view that development emerges via cascades of interactions across multiple levels of causation, from genes to environments. This view is rooted in a broader interpretation of experience and an appreciation for the nonobvious nature of development. (Spencer et al., 2009, p. 79)

The idea that cognitive growth is a result of cascades of interactions across myriad levels of causation fits well with the idea of a person living through what could be thought of as cascades – fluid iterations, say – of efferent and aesthetic transactions within the isolated, concentric or overlapping environments that are a person's interpretive communities. The theories of reader response and interpretive communities could so be seen to contribute, in this way, to Spencer et al.'s 'broader interpretation of experience' and their concept of the 'nonobvious' nature of cognitive development.

In direct response to Spencer et al.'s call for the rejection of the nativist-empiricist debate, however, Spelke and Kinzler (2009) argued that the nature-nurture debate was still very relevant. They felt that the dialogue (dialogue as opposed to debate) is in fact

> entering a new and exciting phase, in which new methods of controlled rearing and of cognitive neuroscience, and new conceptual tools for understanding learning, allow exploration of how human concepts emerge through the interaction of innate cognitive structures shaped by natural

selection, with statistical learning processes shaped by specific encounters with the world. (Spelke & Kinzler, 2009, p. 96)

The statistical learning processes that they refer to are primarily those of language acquisition wherein an infant begins to recognise the regularities and patterns that exist in the language she or he hears. An infant so comes to determine the relationships between specific syllables and will predict statistically – in as much as which relationships/patterns are more likely to occur than others – which syllables will form which individual words (Pelucchi, Hay, & Saffran, 2009; Saffran, 2003).

The concept of statistical learning is not limited to language acquisition though and encompasses any learning process wherein a person consciously or subconsciously perceives regularities, patterns or connections in the world and uses these relationships to make sense of the same.

If one were to identify an encounter with the world as a text, an event, a transaction, the 'living through' of which necessitates the employment of a child's interpretive strategies to make sense of the same, one might see, with respect to their exploration of how human cognitive and emotional concepts emerge, that the theories of reader response and interpretive communities offer similarities with a more generalised Spelke and Kinzler's statistical learning point of view, too.

The interpretive strategies that are the shape of reading, that call into being a text and its meaning, could be seen to echo learning strategies that come into play when a child has to shape an encounter with the world, and has to call that encounter and its meaning into being. Both types of strategies entail deconstruction of that which is known and, drawing on past experiences, assimilation/reconstruction, re/creation, of the new experience in order to make new meaning.

However, whether or not cognitive development is brought about on account of the 'interaction' of statistical learning processes with 'innate cognitive structures' as Spelke and Kinzler's suggest, however, is still a matter for debate.

Spencer et al.'s affirmation of the rise developmental systems theory and Spelke and Kinzler's concept of an interaction between that which is innate and the consequential processes of learning, remain at odds with one another.

Parallels with this debate could be drawn between Piaget's and Vygotsky's theories of cognitive development. Though Piaget would not have called himself a nativist nor Vygotsky an empiricist, the juxtaposition is similar. Piaget's stage theory arguing that a child has to be innately (especially in the very beginning) psychologically mature enough to undertake or fully understand a specific assignment, is at odds with Vygotsky's sociocultural development theory arguing that it is perpetual social interaction and language that urge a child along what will be a lifelong continuum of development (Vygotsky, 1986). Again the question is raised as to whether or not an individual's inclination toward science is innate or socially and culturally constructed.

Whether psychological development precedes learning or social learning precedes psychological development, Spelke & Kinzler believe that the dialogue, or perhaps the drive of the supporters of each side of the dialogue to prove each other wrong, seems to be fuelling modern advances in cognitive neuroscience. They say

> the dialogue between nativism and empiricism is a rich source of insight into the nature and development of human knowledge ... [and] fosters new, interdisciplinary research that promises to increase dramatically understanding of human knowledge. (Spelke & Kinzler, 2009, p. 96).

The continuing nativist-empiricist dialogue is not to be eschewed then – and in the spirit of interdisciplinary research, the theories of reader response and interpretive communities can be seen to fit well both with classic theories of cognitive development and with the more modern theories arising on either side of the nativist-empiricist argument.

However, for this study, in thinking about how we make meaning, how we are and who we become – our fluid, changing selves being a consequence of all the texts we create/transact with and all our encounters with the world/how we are socially constructed – the philosophies of reader response and interpretive communities respects the concept of innatism and the ideas and developments of the nativist side of the debate, but favours the empiricist concept of developmental systems theory.

Conclusion

The theories of reader response and interpretive communities shape our ideas about how meaning is made. There is no 'generic reader' and there is no 'generic meaning'. A reader's encounter with a text, not only shapes the text itself in calling it into being, but that encounter, through iterative transactions using interpretive strategies particular to the reader's own interpretive communities, shapes unique meaning for the reader, too.

In looking to shape an intervention that might evoke in children more positive impressions of a life in science, the use of an aesthetic as opposed to efferent transactional stance in the shaping of meaning might have greater sway in that the aesthetic evokes richer and perhaps deeper engagement than the more informational efferent stance.

As to whether an individual's inclination toward science is innate or learned, this research and the theoretical framework that underpins it favours the idea that an individual's environment – her or his sociocultural positioning in the world, the interpretive communities of which she or he is a part – have an enormous impact upon a person's cognitive and emotional development and upon one's 'being in the world'. Hence a disposition toward science, if any, is socially constructed/learned – or, from a reader response perspective particularly, is continually re/constructed and re/learned. That is, scientists are not born, they are re/made.

Chapter 4 – Methodology

Introduction

The important empirical/theoretical shift in research tradition in the field of science education that Jenkins' (2004) argues has seen, since the 1970s, "qualitative studies increasingly augmenting longer-established quantitative approaches" (p. 241), is fully embraced by this research as, although some quantitative methodology, methods and findings are employed, these are few and serve only to augment the qualitative methodology, methods and findings.

What we think we know and how we do that thinking, shapes us. It defines our own sense of reality and what that reality means to us. What we think we know about other people, though, does not shape other people or define what other people think about their own sense of reality and what that reality means to them. That is, our own reasoning, even 'research' reasoning, cannot truly define another person's personal sense of being in the world; we can only allude to what we think it might be like, to be that other person; and we cannot measure or quantify another person's sense of self. When thinking about children, for instance, and how they might really feel about doing science or being a scientist in the world, we will always be in the wrong reality; ill-positioned, too far outside of any child's own sense of self to fully grasp what it might mean for that child to do science or be a scientist in the world – or what it might mean for that child to even have to think about such things.

Hence, where other people are participants in one's research – and especially, perhaps, when those people are children – it is important to acknowledge that the participants may have very different knowledge, very different ways of thinking and behaving, and very different views of the world both from one another and from oneself, and this knowledge and these ways of thinking and being are not readily or easily accessible. If they are accessible at all, they are far from quantifiable in any empirical or positivistic sense.

For this reason, any research seeking to explore what or how people think or how they see themselves and others, must be firmly grounded in congruent ontological and epistemological philosophies that stimulate, strengthen and support qualitative data collection and analysis.

This chapter first outlines that ontology and epistemology, and the congruence between the two. It describes, also, how these philosophies correlate with and fully integrate with the research's theoretical framework.

Evidence that children are not only aware of their own and others' ontological positions – or are, at least, able to allude to such positions – but are also able to reflect upon the same and articulate as much, is then presented and discussed.

In order that the children's thoughts and ideas are properly and respectfully considered within a robust research framework, the necessity for methodological coherence is examined and the commitment to qualitative rather than quantitative data collection and data analysis is explained.

I go on to present the argument for an interpretive thematic analysis of the data highlighting the importance of the use of a method of analysis that fits well with the research's theoretical framework and its ontological and epistemological foundation.

The suitability of thematic analysis in and of itself is presented; its theoretical independence, its flexibility and its inductive approach is discussed and is shown to fit particularly well with the investigative challenge that working within the framework of reader response theory and the creation of multiple fluid meanings fosters.

The chapter concludes with an overview of how the research's methodological approach, coherence and choice of methods of data collection, analysis and interpretation present a robust conceptual framework wherein children's engagement with fictions about science and scientists and children's thoughts and ideas about the same can be considerately and thoroughly explored in order to satisfy the research aims.

Ontological and Epistemological Position of the Research

Reader response theory suggests that texts do not come into existence until, at a specific moment in time, a person transacts with them. Each person creates a text, an image or a sound that is unique to them, and in these transactions meaning is made.

These meanings or personal 'truths', create a reality that is unique to each person. Just as these meanings or truths can be fleeting – in as much as, when the same reader interacts with the same text again or with another text, new meaning is made – so, too, can the realities that these meanings create be fleeting.

It is the very nature of reader response theory, therefore, to defer to a relativistic ontology that acknowledges that reality is different for everybody.

Furthermore, not only is reality different for every person but every person might be seen to create *multiple* different realities. These realities could be thought of as existing linearly, as in consecutively, each fresh reality usurping the old one whenever a new transaction is made; or, all together, these multiple realities might be better imagined as one fluid reality wherein the iterative nature of transacting with texts and encounters with the world creates iterative fluid meanings.

An ontological extension of this idea is that, just as a reader creates texts, a reader, a person, 'creates' encounters with the world; from within our own interpretive communities, our own interpretive strategies shape the world, create meaning, and so shape ourselves.

Ontologically reflective of Heidegger's (1927/1967) *Dasein* or Being-in-the-world, what our selves are, and the realities our selves create, depend upon one another to exist; interdependent, they create a fluid reality, a fluid way of existing in the world, that cannot be 'stepped outside of'. Hence, the self, the reality, the context that is one person's *Dasein*, cannot, from an ontological nor phenomenological point of view, be experienced by another reader, another self, who relies entirely upon their own *Dasein* to existentially 'be'.

In other words, Derrida says, "there is no outside-text" (1967/1997, 1997 p. 158): it is all context, and there exists no ontological or phenomenological position from which I, as a researcher, can use my own interpretive strategies (from within any of my own interpretive communities) to come to experience the world as the children who undertook the research with me did.

However, the nature of the research, that is, both the research question

> *How do primary school children engage with fictional representations of science and scientists?*

and the research aims

i) *how children feel about science and scientists*
ii) *whether children have any insight into why they feel this way and*
iii) *how children engage with representations of science and scientists through writing, reading and discussion of fictions about the same*

speak to some form of phenomenological enquiry into the nature of the children's experiences in the world and their beliefs in connection with science and scientists, and these experiences and beliefs must be somehow investigated and communicated to readers of the research.

From the research's qualitative standpoint, hermeneutic techniques are best employed to try to present the world as others, as the children, see it. In fact, hermeneutic techniques are 'ideal' for research founded upon the ideas of reader response theory and interpretive communities: 'interpretive communities' and 'interpretive strategies' are in and of themselves 'hermeneutic'.

Hence, when thinking about how children engage with representations of science and scientists, I employed interpretative techniques in order to, myself, create meaning and shape 'answers' with which to satisfy the research questions and aims (see *Methodological Coherence; Data Collection* and *Data Analysis*, and *Thematic Analysis*, below).

The theories of reader response and interpretive communities lend themselves well, too, to the epistemological basis of the research. They could, in fact, be considered to be one and the same; that is, the theories of reader response and interpretive communities *are* the epistemological basis of the research, as reader response theory in itself constitutes and advocates the creation of knowledge or ways of knowing – especially if one equates the making of meaning directly with the making of knowledge/ways of knowing. Also, the interpretative strategies that one uses to shape texts and encounters with the world, could themselves constitute actual 'ways' of knowing and how we come to create meaning/knowledge and understanding.

From within one or many of a person's interpretive communities, she or he might call into being a text or an encounter and so make meaning by using sets of interpretive strategies significant to her or his respective communities. Depending upon the efferent or aesthetic stance taken, efferent or aesthetic (or a mixture of both) meaning is called into being, as is the actual experience (efferent, aesthetic or a mixture) of that meaning.

Hence, besides being seen as a phenomenological occurrence or transaction, this creation of meaning can also be seen as an epistemological experience in as much as an active transaction has been achieved, meaning has being made and so new knowledge or ways of knowing have, too, been called into being and made sense of. Texts, events, encounters are made sense of epistemologically – in that knowledge/knowing is created and becomes part of one's fluid reality – and the same texts, events, encounters are simultaneously (simultaneous with the knowledge/knowing creation) sub/consciously processed and experienced phenomenologically, too.

By virtue of the nature of reader response theory and its fluidity with respect to the making of meaning, the re/creation of efferent and aesthetic knowledge and ways of knowing, and the shaping of our unique fluid realities, this research's ontological, phenomenological and epistemological foundations are hence intimately interwoven and, as such, constitute a congruous methodological base upon which to design the research.

Children's Awareness of Their Own Ontological Position

Although the research is framed by reader response theory and underpinned by a relativist concept of reality, it is important to acknowledge that the participants in the research might not, or might be unable to, accept the idea that everyone making their own meanings and experiencing different realities at any one time is a true reflection of what is going on in the world. For children particularly, the intellectual enormity of conceiving of, for example, the social construction of reality or the strategies of an interpretive community, much less agreeing or not agreeing with these ideas, is likely to be too great a challenge.

It is entirely acceptable that a person might believe that their own reality is the only one true reality, as children probably do, and this research, although not designed, carried out or interpreted from that perspective, concedes the idea that other people may feel that way. This does not make other people's views and ideas, the participants' views and ideas especially, any less valid. These views, however, from whatever ontological principles they were occasioned, are to be interpreted from the relativist perspective of the theories of reader response and interpretive communities. Any juxtapositions serve only as interesting and exciting opportunities for the interpretation, reinterpretation and creation of new meanings, the performance and accomplishment of which speaks to the very essence of reader response theory.

Children, however, although they may be unable to fully understand the concept of their own or another person's multiple or fluid realities, are still able to consider that other people may or may not think or feel the same way about the world as they personally do. Greig, Taylor, and MacKay (2007) found that children as young as 3 years of age are able to appreciate in others as well as in themselves "the world of mental states, the world of ideas, beliefs, feelings and desires" (p. 32). Bosacki and Ota, too, drawing on contemporaneous theory of mind research, also found that

> young children have the ability to attribute mental states to self and others. That is, by age 5 children are able to understand that other people have mental states such as beliefs and intentions that influence our behaviour" (Bosacki & Ota, 2000, p. 209).

Despite this being the case, for the purposes of this research, it was important to be sure that children who were 9-10 years old (the age of the research participants), besides having the capacity to conceive of their own and others' thoughts, emotions and behaviours, would also have skills enough to articulate as much.

Hay and Nye (2006) researching the spiritual awareness of 6 and 10 year olds in England, found that children possessed a "relational consciousness" (p. 109). The children demonstrated "an unusual level of consciousness or perceptiveness" wherein the children were able to articulate their thoughts and feelings within "a context of how the child related to things, other people [and] him/herself" (p. 109).

Bosacki (2001), too, studying spirituality, gendered subjectivities and education in Canadian 9-12 year olds, found that the children were not only able to but "were eager to engage in conversations about deeper philosophical, existential and ontological issues" (p. 213).

This research relies, then, not only on the consideration that children have unique world views, but also on the idea that children are able to understand that other people hold other world views. Not only that, the research relies just as essentially upon the belief that children are indeed able to articulate how they feel about both their own and others' views.

Methodological Coherence

It is important that the approach to the research design, that is, how one addresses the methods of data collection and data analysis, be consistent with the research's theoretical framework and its ontological and epistemological underpinnings (see also *Chapter 5 – Method; Validity, Generalisability and Reliability*).

Data Collection – a Qualitative Approach

In exploring children's thoughts and experiences of science and scientists, any strictly empirical position advocating measurable and unchanging – 'universal' – meanings, would not sit well with the theoretical framework that is reader response theory and the theory of interpretive communities. Neither would such an approach fit well with the relativist ontology and interpretative epistemology upon which the research is founded.

The research does not set out to test any theories or absolutes; there are no fixed deductions to be made or to be experimented upon, quantified and replicated. It is not a question of whether or not quantitative methods would fully satisfy the research parameters, rather than a necessary recognition that the employment of quantitative methods would prove to be too inadequate a methodology and would not satisfy the research parameters at all.

The development of a 'mixed method' approach, too, wherein both quantitative and qualitative investigative systems might be used in tandem, would not, in this instance, offer a research design that might more fully satisfy the research parameters within the theoretical framework and methodological underpinnings.

Whereas in some mixed method investigations quantitative analysis, its due triangulations and deductions, might be said to back up or enrich qualitative findings, in this research's case, upon exploring children's contextually-complex and fluid realities and their experiences of the making of many meanings therein, there can be no truly quantifiable or truly universal conclusions. The actual writing – and reading – of these very words, for example, has already called into being texts unique to the writer and to the reader; the temporal 'event' (Rosenblatt, 1978, p. 12) that has transpired in this singular moment of writing or reading cannot be lived through again; the writing and the reading cannot be replicated and the experiences and consequences of such texts coming into being are so not quantitatively calculable.

In order for there to be effective theoretical and methodological coherence, wherein the research's parameters (of due exploration and interpretation) are to be met, the use of rigid, positivistic experimental techniques would be not only inadequate but would be entirely inaccurate. In place of universal meanings, there are many perpetually fluid meanings and by the very nature of their being fluid, they cannot be finitely measured.

It is possible, however, that quantitative statements about qualitative findings might be made. These quantifications will arise out of the qualitative data itself – organically, as a result of the qualitative data collection and analysis and not as a result of any specific quantitative system that had been put in place beforehand. It might be mentioned, for example, that two thirds of the children hold one particular belief and the other third of the children believe something else. Such quantitative statements will serve as interesting, incidental, observations that may or may not better or more easily reflect current ideas or beliefs about how today's children are seen to engage with fictional scientists and science; making such statements does not make any findings any more 'true' than if such statements and correlations hadn't been recognised.

The meanings, ideas and realities that the research seeks to explore are not so much dissociated observations of children's ideas about science and scientists that might be garnered, for example, from the myriad 'Draw a Scientist' techniques (Chambers, 1983): how many children drew scientists with white lab-coats, how many with spectacles, how many with crazy hair (Avraamidou, 2013); rather than an intimate exploration of how some children feel about science and scientists together with a yet deeper, more intimate, reconnaissance of why they think they came to feel that way.

Hence, as the research relies, too, on the concept that each child creates her or his own unique reality and so calls into being her or his own contextually relevant meanings, qualitative methods have to be used in order to explore the same.

The research so employs qualitative methods – group story-making and story-telling, group story-reading and unstructured and semi-structured group interviews, for example – as a means to better understand how children feel about the fictional representations of science and scientists and what that means to them.

Data Analysis – an Interpretative Approach

As there are no universal meanings, so can there be no universal interpretations of those meanings. As there are many fluid meanings, so may there be many fluid interpretations of those meanings that, by the very nature of their being fluid and non-universal, cannot become absolutely defined.

Congruent with the research's reader response and interpretive communities framework and the relativist perspective that underlies it, using interpretative techniques closer to the hermeneutic rather than the positivistic tradition is not only an essential choice but would have to be the only choice of method of interpretation around which the research's ideological framework and its qualitative stance could cohere.

The use of an interpretative approach, however, becomes more complicated when we acknowledge that every child unavoidably moves into the autonomic group and interpretive community that is 'adult' – and from both an autonomic group and an interpretive community point of view there can be no going back. That is, whereas, in many instances, a person can move back and forth between groups and communities – being an omnivore, then a vegetarian for a while, then an omnivore again, for example – a child growing into an adult is a uniquely one-way transition.

As an adult, therefore, I am only able to recall my childhood, all its fluid realities and many changing meanings, through the meanings and fluid realities offered by my present-day adult self. Childhood, though, "has its own methods of seeing, thinking and feeling" (Rousseau, 1762/1948, 1948, p. 52) and if this so, Crain (2016) believes, then "measuring children in terms of an adult yardstick is likely to miss what is unique to the child" (p. 109).

Although the children aren't to be measured, as such, it is important to remember that when entering into transactions with any articulated thoughts, feelings, ideas – texts – that the children might present during the research or as a result of the research process, the only tools, the only interpretative approaches, that an adult researcher has at her or his disposal in the examination and analysis of those texts, have to be employed through the sets of interpretive strategies that are already in place in being significant to the 'adult' and 'adult researcher' communities.

As an adult/adult-researcher, one cannot 'step outside' (see *Ontological and Epistemological Position of the Research*, above) of the context that is one's own interpretive community or set of interpretive communities. There exists no position, there are no interpretative approaches, from which an adult researcher can examine any of the children's texts using interpretive techniques from the children's interpretive communities in order to see or feel how the children see or feel or think about something from the children's own point of view.

An adult is not a child and so cannot interpret the world as a child does or re/create a child's meaning. All that is available to the adult researcher, and so to her or his research, is the doubly complex use of fluid hermeneutic techniques from fluid adult perspectives that operate in unison to create fresh fluid meanings that, in turn, might make some 'sense' of the data, the texts, that the children offer.

Despite this complexity, it is anticipated that some commonalities or patterns may emerge from the gathered data. If more obvious themes do not seem immediately evident upon primary examination of the texts, then by examining these commonalities, patterns, motifs, it is likely that less obvious themes can be discerned.

It is the emergence of any such themes, both obvious and non-obvious, that this research looks forward to with respect to investigating children's ideas about science and scientists and so satisfying the research aims. Hence, having initially used interpretative techniques to collate and code the data, the research then employs a specific thematic approach to create fresh meaning in pursuit of the research aims and objectives.

Thematic Analysis

The discourse analysis of qualitative research by any number of trusted methods – conversation analysis, interpretative phenomenological analysis or narrative analysis, for example – can be satisfactorily employed in identifying the emergence of themes from qualitative data. For this research, however, I felt that these approaches to data analysis did not present any fully appropriate methods of choice.

First, the high level of linguistic and dialogic expertise, for an inexperienced practitioner, would prove a stumbling block to the correct dissection and proper interpretation of the data within the singular scope of any such method. Any naïve or amateurish use or misuse of the precise language, for instance, of these methods may serve to detract from both the analysis itself and the report of the analysis.

Second, the somewhat inflexible nature these methods employ in codifying the data does not sit so comfortably with the theory of reader response. In the strictest sense, iterative meanings are fluid and transitory; every time the data is revisited, the data – the text – is created afresh and new meaning is made and so, when thinking about the essence of reader response theory, these meanings cannot and should not be conclusively codified; this research embraces fluid interpretations of what the children say and why they say it, not how they use language or conversation to say it. In order for the research and what it may be telling us to be spoken about and let out into the world, however, the data does have to be analysed in some fashion, a fashion that is more flexible, accessible and resonates more readily with the theory of reader response.

Foundational Thematic Analysis

Hence a more suitable method of qualitative analysis might be the more basic or "foundational" (Braun & Clarke, 2006, p. 78) method of thematic analysis itself; that is, 'thematic analysis' as "a method in its own right" (p. 78).

Thematic analysis in itself is not associated with any particular ontological or epistemological perspective. Nor does it arise, then, from any particular theoretical framework that any study, from its own ontological and epistemological foundation, might adopt. Braun and Clarke instead suggest that thematic analysis is

> essentially independent of theory and epistemology, and can be applied *across* a wide range of theoretical or epistemological approaches ... [it is an] accessible and theoretically flexible approach to analysing qualitative data. (Braun & Clarke, 2006, pp. 77-78)

This theoretical independence and flexibility entirely suits the tricky investigative challenge that reader response theory and its making of fluid meanings promotes.

Braun and Clarke, with respect to thematic analysis, examined the levels at which commonalities, patterns and themes within the data might be identified. They felt that, at a semantic or 'explicit' level, patterns could be identified within the surface meanings of the gathered data (p. 84). A researcher could then try to theorise her or his interpretations of these surface meanings, these explicit semantic patterns, into something broader; that is, into patterns or themes that might hint at wider implications. In going beyond the explicit, surface level of the data, a researcher so may examine the data at a more latent or inherent level and come to "identify or examine the *underlying* ideas, assumptions and conceptualizations – and ideologies – that are theorized as shaping or informing the semantic content of the data" (p. 84). A researcher so not only identifies and interprets the patterns and themes that are there at a face-value semantic level, but also seeks to determine how those patterns and themes themselves developed.

Hence, rather than employing the simply dual approach of interpretation and theorisation, thematic analysis engages, instead, a more complex, intricate and intimate re/examination and theorisation of the data. Although such an approach might re/amplify a researcher's unrealised or unchecked reflexivity and potentially skew what might be 'true' emerging themes, the use of such an approach can be considered a reflection of reader response theory itself, wherein the re/creation of meaning leads to a richer, deeper understanding of whatever potential for meaning the data embody.

An Inductive Approach

Braun and Clarke believe that identifying themes and patterns within the gathered data in such a way, represents an inductive method of analysis that means that the themes identified are

> strongly linked to the data themselves[,] ... may bear little relation to the specific questions that were asked of the participants [and] would not be driven by the researcher's theoretical interest in the area or topic. (Braun & Clarke, 2006, p. 83)

Notwithstanding the idea that meanings created within the framework of reader response theory cannot possibly be conclusively codified (as they are fluid and ever-changing), an inductive thematic analysis could, in effect, be seen as a way of "coding the data without trying to fit it into a pre-existing coding frame, or the researcher's analytic preconceptions" (p. 83). That is, a researcher would forego a preconceived theoretically deductive top-down approach wherein she or he might mine the body of data for specific items of theoretically-relevant interest, to instead allow the data to speak for themselves, bottom-up, and, from these freshly created meanings, not so much reverse engineer the surface meanings, as delve deeper beneath the surface to explore what is hidden.

In the absence of a theoretical mission to mine the data for specifics, and with all due reflexivity in mind, it could be said the patterns and themes identified through an inductive thematic analysis would indeed be more strongly linked with the data than through a theoretical approach as, particularly on account of the recursive nature of the coding process, patterns emerging from the data may shift and change and the whole body of data becomes – or is – an organic entity in itself.

A full description of how the coding and analysis of the data was carried out is presented in *Chapter 5 – Method; Thematic Coding and Analysis*.

Conclusion

In shaping texts or encounters with the world, using interpretive strategies unique to both themselves and their interpretive communities, children create many meanings and subsequent realities.

These meanings and realities, already experientially and socially constructed through the aesthetic or efferent transactions of reader response, undergo deconstruction and reconstruction – re/creation – when a child shapes texts of fiction about science and scientists.

The reading of these fictions, through the power of a child's imagination and the ability of a child's brain to go "beyond itself" (Wolf & Barzillai, 2009, p. 132), not only calls into being the fictions themselves, but transacts fresh fluid meanings and re/creates new ideas about what it may mean to be a scientist in the real world.

These new ideas and meanings will connect, to some degree, to a child's own sense of self – a sense of self that the children (that are, for instance, the age of the children taking part in this study) are indeed able to reflect upon and talk about (Bosaki, 2001; Hay & Nye, 2006).

In order that the research be theoretically and methodologically sound, not only must the methodological approach to the research fit well with the theoretical framework and its ontological and epistemological foundation, but the methods of data collection and of data analysis must be consistent with the same. Hence, using those sets of interpretive strategies significant to, among others, the 'adult' and 'adult researcher' communities, this research so employs qualitative data collection and interpretative analysis; and, more specifically, foundational thematic analysis of the data, in order to see what themes may emerge.

The calling into being of these themes, the interpretation and the making of meaning therein, will hopefully occasion both a greater depth of feeling for children's own attitudes to and perceptions of what it means to be a scientist in the world and, perhaps more importantly, will reveal ideas as to how the children feel from the children's own ontological and phenomenological perspective.

Chapter 5 – Method

Introduction

Having established the ontological and epistemological position of the research, the congruence between these positions and how they correlate and integrate with the research's theoretical framework, and having argued the necessity for a committed qualitative approach and foundational thematic analysis, this chapter describes the method with which these ideas were brought to the undertaking of the research.

The chapter first describes the research participants and, especially as the participants are young children, takes particular care in outlining the research ethics, showing singular attention to the participants' welfare both as children as individuals and as children in groups.

Then the development of the research instrument and the qualitative method of data collection are outlined. Great attention to detail is taken in an explanation of how the deductive and inductive coding and thematic analysis of the collected data was carried out.

The chapter then examines the research's internal and external validity, its generalisability and its reliability.

Conducting the fieldwork with interferences, interruptions and mistakes, is described and, finally, my own position within the research, my reflexivity, is discussed.

The Participants

The research took place in a small, mixed gender, nondenominational Junior, Infant & Nursery School – a Primary, Community School (age group 3-11) – situated in an industrial village in the North of England. Data collection took place during the school years 2010/2011 and 2011/2012.

Although the school's capacity was officially 192, the school regularly enjoyed the company of over two hundred children (208 children in 2010/2011 and 215 children in 2011/2012). The children were from a wide range of socio-economic backgrounds with the number of children known to be eligible for a free school meal having been/remaining at the national average at the time (Ofsted School Inspection Report, 2010, p. 3). Most pupils were of a white British heritage and very few (2 children) spoke English as a second language.

In both school years, 15 of the school's children were categorised as Gifted and Talented and 33 children in 2010/2011 and 32 children in 2011/2012 had a Statement of Special Educational Needs provision.

The Year 5 children of school year 2010/2011 (Cohort 2011) and, for continuity and coherence, that is, in order that all the research participants be at the same stage of their primary school education, the Year 5 children of school year 2011/2012 (Cohort 2012) became the respondents in the research.

Cohort 2011

There were 21 children, 11 girls and 10 boys, in Cohort 2011 and they were between 9 and 10 years of age. The Head of School advised me that the children of this Year 5 were "quite eloquent ... they could teach themselves" and the Year 5 teacher confirmed that these children "would work with you".

Cohort 2012

There were 25 children, 9 girls and 16 boys, in Cohort 2012 and although these children, too, were between the ages of 9 and 10, the Head of School advised that the children were "mainly August birthdays" which meant that a good deal of the children were younger than would be expected, on average, for a Year 5 class. The Year 5 teacher agreed and advised that the class being "mainly younger than usual boys" was "easily distracted". Consequentially, these children's intellectual and emotional responses and their ability or willingness to engage with the research and the research process were expected to differ, perhaps considerably, both between individuals within the same class and from the 2010/2011 cohort as a whole.

Ethics

Because children are often seen as "innocent, fragile and in need of protection" (Sargeant & Harcourt, 2012, p. 7; see also Christensen & James, 2008), conducting research with children can be a particularly sensitive matter.

In accordance with the British Educational Research Association's Ethical Guidelines for Educational Research (2011) and Articles 3 and 12 of the United Nations Convention on the Rights of the Child 1990 (United Nations General Assembly, 1989) referred to therein, I was especially mindful to conduct the research within an ethic of respect for The Person, Knowledge, Democratic Values, The Quality of Educational Research and Academic Freedom (BERA, 2011, p. 4). I sought to take particular care in my Responsibilities to Participants (p. 5) as the majority of the participants in the study were, indeed, children.

Children's Well-Being and Safety

It was always my intention that within both the context and the process of the research, the children were to enjoy themselves and have some fun. At all times, the children were to feel comfortable and entirely at ease. Nor would they ever be exposed to or be allowed to come to any harm. The research, for both cohorts, so took place within the familiar and safe surroundings of their own classrooms at school, in school time. The children had their usual, regular access to refreshments (they were allowed to fill and refill their own water bottles at set times), restrooms and any other school services should the need arise. The school did not have a Nurse's Station but if a child injured themselves or felt unwell they were advised to 'go to the office'. The 'office' was the school's main reception office where sticking plasters were applied, sick bowls (a big yellow bucket) administered and where the children would wait for parents, guardians or carers to come pick them up and take them home if need be.

All the school's normal protocols remained in place. All due respect was paid to the Head of School and to the Year 5 teacher and any requirements they might have had should anything unforeseen have arisen – a fire alarm going off, for example (which it didn't). School assembly times were promptly observed, as were all play-times, lunch breaks and home-times. If children had to leave the research session for a health appointment, special tuition or a private music lesson, for example, then the children were allowed to do so without question. Besides the research being done in the Year 5 classroom, school life went on exactly as normal.

Data collection took place towards the end of June 2011 and the beginning of July 2012 respectively when the school's curricula work was nearing completion or had been completed, Standard Assessment Tests were finished and the school was winding down towards the end of the Summer Term. So, although the Year 5 cohorts were at the end of a school year that might have felt too long or too stressful for them, when the research took place the children were free from the pressures of schoolwork and homework and were anticipating their summer break.

Important to the ethical considerations of the research and the development of the research instrument was the consideration that every child in the school had either met me before or knew who I was. This was because in 2007, upon securing grant funding, I had started setting up a school library. In order to do this, I had visited every class in the school to ask the children what their favourite books were or, if they had no favourites, what sort of stories they enjoyed or thought they might enjoy reading so that I could buy these books and types of stories for the new library. Children gave me advice both formally as in each class in itself, where their teachers, in class-time, had encouraged the children to make lists of the books or types of stories they enjoyed; and informally, where children themselves approached me as individuals, or in pairs or groups of friends, to talk to me about books or stories they liked (or didn't like), and would make suggestions about the sorts of books or stories they thought the new library might need.

Using web-based library management software – Junior Librarian 3 from Micro Librarian Systems (MLS) (2016) – to catalogue and categorise approximately 2,000 books, a small library was so established within the main body of the school. Every week at a designated time, each class, Year 1 through to Year 6, was formally invited to visit the library during class-time. Throughout the school year, any children who wanted to be so, were trained to be Librarians and, as such, would staff the Library every lunchtime so that children could visit the library more informally during their lunch break, as well.

In the school's Reception Class and Early Years Unit, too, during their own separate 'library time' within the Unit itself (the Unit being somewhat set apart from the rest of the school), the children and I, each week, re-assembled/built our own library (by carefully spreading grant-bought books upon two specially cleared tables). I ensured that every Reception Class and Early Years' child took time to choose an age-appropriate library book to take home for a week. When the children returned their books a week later, they were invited to choose a replacement.

Hence, I had effectively come to know – that is, I had taken book and story advice from, given book and story advice to and placed books into the hands of – every single child in the school. The children's parents, guardians and carers, too, in the main, knew who I was: the Reception Class and Early Years' parents speaking to me directly/face to face as the children were picked up after library time from inside the Early Years Unit, and the Year 1 through to Year 6's parents speaking to me, albeit more in passing, as I gradually built and then supervised the open plan library at the heart of the school.

I so was not a stranger to the children nor to many of their parents, guardians and carers. However, despite reassurance from the Head of School that all of the children's parents, guardians or carers, when first enrolling their children at the school, had already signed a standard form allowing photographs to be taken and audio- and video-recordings of their children to be made, I felt that in order to pursue a properly robust method in duly working within an ethic of respect for the children and any knowledge that might be created during the research process and thereafter, I should ask for permission specific to this doctoral study. Accordingly, before commencing any doctoral engagement with the children and in accordance with the BERA guidelines, I sought the collaboration and approval of those who act in guardianship of the children (p. 7) and wrote to each of the children's parents, guardians and carers (see *Appendix; Letter of Parent/Guardian Consent*).

Parent, Guardian or Carer Consent

In the Letter of Consent, I explicitly asked permission from parents, guardians and carers to work with their children. I explicitly asked for the children's own permission, too. I explained what the research was about and what the research process and the research instrument entailed. I especially highlighted the fact that, in order for me to properly examine what the children said and did during the study, it was my intention to audio- and video- record the children.

I made assurances that all the children's contributions would remain entirely confidential and would never be shared or passed on to any third party, and that the children's names would be made anonymous and so would never appear in the publication of any research results.

I advised the children's parents, guardians and carers that I had already secured the permission of the Head of School and the Year 5 teacher to work with the children and that, as I had already been working with the children in the setting up and supervision of the school library, I had (in April 2010) already secured an Enhanced CRB Disclosure Certificate. All due formal integrity was in place and I assured the parents, guardians and carers that it would be maintained.

The Head of School advised that it was highly unlikely that any parent, guardian or carer would respond in writing (or otherwise) to my request for permission to work with their children. Hence, in the Letter of Consent, the parents, guardians, carers and the children were given the opportunity to 'opt out' of joining in with the research. I asked that if any parent, guardian or carer had any objections to my undertaking the research with their children, then they should feel free to let me know, and other in-school arrangements could be made for the opted out child whilst the study was taking place. I made myself available by providing my home and mobile telephone numbers and advising when I would be on school premises if any parent, guardian, carer or child wished to speak with me face to face.

As each bout of data collection was to take place over 2 days, it was likely that the children might go home and speak about their experiences of the study. In the Letter of Consent, I so also asked the parents, guardians and carers that if, initially, they had had no objections to their children taking part in the study but during the study objections arose then, again, they should feel free to raise those objections with me and remove their children from the research environment; children removed from the study would be invited to work elsewhere within the school whilst the remainder of study was being carried out and, if necessary, any contributions their child had made up to that point would be removed from the body of data collected.

Deception and Subterfuge

BERA's Openness and Disclosure guidelines advise that the securing of participants' voluntary informed consent before the research begins should be the norm for the conduct of research (p. 6). BERA further advises that researchers must "avoid deception or subterfuge" (p. 6) to secure that consent unless their research design specifically requires doing so in order to ensure appropriate data collection. At the heart of this doctoral study, however, lies an aim to try to find out and understand how children feel about science and scientists in literature and the research instrument was designed in such a way that, when data collection commenced and I began to speak to the children about stories, the children would not be aware that that I was specifically interested in how they felt about the science and/or the scientists in those stories. In the Letter of Consent, then, a small degree of 'deception or subterfuge' arose in that I made no mention whatsoever about the 'actual' subject matter. I referred to 'stories' and the 'characters' and 'personalities of the characters' in those stories; I did not mention stories or characters about science or scientists; indeed, the words 'science' or 'scientist' were, purposefully, not mentioned at all.

Before, during and after the doctoral study, no parent, guardian or carer ever raised any objection to my carrying out the research or my examining the data collected.

Children's Consent

Notwithstanding the Letter of Consent and my asking the children's permission to work with them therein, I felt that the contents of the letter, having being addressed to the children's parents, guardians and carers, might not have been disclosed to the children. I felt that it was very important that the children themselves should really want to be involved with the research. So, in the field, at the beginning of the first of each cohort's research day, just before the research began, I explained to the children exactly what had been outlined in the Letter of Consent to their parents, guardians and carers and asked the children if they were happy to begin doing the research with me. Thereafter, at several points during the research process – at the beginning, during and at the end of each research day – I asked the children, as a class, whether they were happy to continue. I intimated that if they didn't wish to take part, other activities could be arranged for them; they could do some reading, drawing or colouring in the library, for example. I also advised that if they didn't want to opt out right then and there in front of the class, then, if they came to speak to me personally during their play-times or lunch break, I could make alternative arrangements for them if they so wished.

Before, during and after the doctoral study no child ever opted out or raised any objection to my carrying out the research and any of its on-the-spot modifications, or my examining the data collected.

Mindfulness

After the data collection had taken place, I again wrote to the children's parents, guardians and carers to thank them for allowing their children to take part in the research. I confirmed that the children seemed to have enjoyed themselves, as had I, and I revealed that I had actually been interested in how the children felt about science and scientists in stories. I advised that many months of transcription and data analysis lay ahead but if anyone wished to speak to me about any aspect at all of the research then they should feel entirely free to do so.

I again made myself available by again providing my home and mobile telephone numbers and advising when I would be on school premises if any parent, guardian, carer or child wished to speak with me face to face (see *Appendix; Letter of Thanks to Parent/Guardian*).

Never once, not before, during or in the years since the research took place, has any party ever raised any objection to my having carried out the research. One parent alone, soon after the 2011/2012 field work had been completed, asked me what the research had revealed. I explained to her that, with respect to this doctoral study, many months of transcription and analysis lay ahead and it would be some time before any themes emerged. I went on, however, to share with her the results of the research I had previously undertaken with the previous three cohorts of Year 6 children in connection with the similar sort of subject matter, that is, how the children felt about embarking upon a career in science. She found the results interesting and was very supportive of my endeavours.

It was with all due mindfulness, then, that in accordance with BERA's (2011) ethical guidelines and the United Nations Convention on the Rights of the Child 1990 (1989) Articles 3 and 12 that, despite a slight but necessary degree of 'deception or subterfuge', I conducted the research within an ethic of respect for the children, their parents, guardians and carers, the school, the teachers and particularly the Head of School and the Year 5 teacher whose help and advice I very much appreciated.

Data Collection

The argument for effective theoretical and methodological coherence, wherein the research's criteria for exploration, interpretation and analysis are to be met, has been made (see *Chapter 4 – Methodology; Methodological Coherence*), and qualitative data collection expected to be the most methodologically sound approach.

As the research concerns the engagement of children with fiction, the reading, creation and discussion of fiction plays a large part in the research design.

The reading of and engagement with fiction is very often a private and personal event; it is a special transaction between an individual person and the text. So, too, could the discussion of fiction, one-to-one, be a very private and personal event. However, although a great deal of data could be garnered from such an interaction, I felt that my speaking with children one-to-one about what they have read or are reading, how they feel about it, and what meanings they feel might have arisen for them, particularly about science and scientists in stories, would not be as beneficial as listening to the children speak to and interact with each other about the same.

Discussing their thoughts and feelings with an adult researcher, on their own, face to face, might feel uncomfortable or embarrassing for a child and so could generate too daunting an atmosphere for her or him to feel at ease enough to fully share or explore her or his ideas. Hence, such an insular and restricted interaction may not garner as rich a seam of ideas as might a child talking to another child or to other children when sharing or exploring their ideas with their friends, classmates and peers.

Nor, too, would such an individual arrangement speak to the first of my ethical intentions for the study that 'within both the context and the process of the research, the children were to enjoy themselves and have some fun' (see *Ethics*, above).

From the perspective of the theories of reader response and interpretive communities, as well, a one-to-one arrangement could be seen as methodologically weak in as much as, as an adult and a researcher, in the research moment, I can only make meaning by accessing interpretive strategies pertinent to the interpretive communities that are adult, researcher and adult-researcher. I am not a member of the children's child or child-participant interpretive communities and so cannot use any of those interpretive strategies. When trying to generate data from children about children's own ideas, there so might be a dissonance or incongruity of interpretive communities if only a child/child-participant community where to interact with an adult/adult-researcher community. Far more 'truthful' data might be generated through many, more congruous, child/child-participant to child/child-participant interactions.

That is, I am not a child and I cannot think or pretend to think like a child. I can only engage with children as an adult. In trying to understand how children feel about science and scientists in fiction and in so trying to generate lots of data about the same, an advantage might lie in having the children talk to one another about the science and scientists in fiction and share their ideas and, as an adult-researcher, simply guide the group conversation and 'listen in'.

The most appropriate and methodologically robust arrangement, therefore, would be for the children to speak to me from within the comfort and familiarity of the interpretive community that is their friends and classmates community rather than be singled out for one-to-one questioning. The 'researcher effect', too, in one-to-one encounters where, for example, a child, perhaps feeling ill at ease or 'put on the spot', might tell me what she or he thinks I want to hear, would prove to be preclusive and detrimental. Therefore, in order to gather the children's more natural collective perspectives, it was necessary to use both unstructured and semi-structured group interviews.

Unstructured and Semi-Structured Group Interviews

Tying in with the positioning of the researcher, on account of her or his own interpretive communities, as a person either unavoidably or necessarily set apart from the participants, Taber (2007) believes the advantages of carrying out unstructured group interviews include the ideas that

> the comments of one student [would] act as stimulus for another, perhaps eliciting information that would otherwise not have been revealed [and] the closer match in levels of knowledge and language (compared with that of the researcher) may help the flow of the interview. (Taber, 2007, p. 156)

This speaks directly to the idea that more 'truthful' data might be generated through child/child-participant to child/child-participant interactions, in the children's own terms using the children's own language. This idea extends very well to the use of semi-structured group interviews, too.

In an unstructured group interview one might ask a single question, *'What did you like about the story?'*, for example, in order to start the discussion off. From pursuant answers, and by asking follow up questions in the research moment, a researcher might follow – or create – an undetermined path toward an in-depth or at least fuller understanding of how the children actually did feel about the story and not just whether they 'liked' it or not.

When setting out to explore, particularly, more than one research objective or aim, however, it is important that discussions be more closely monitored and that more specific questions be asked in order to achieve each objective and aim. In this instance, a schedule of questions can be arranged around which discussions about individual objectives or aims can be based. There would still be scope for a lot of varied and interesting digression as this type of schedule is not a strictly set list of questions, each of which must be asked and answered, rather, this type of schedule could be thought of as a guide, an aide-mémoire, wherein, should discussions stray too far from a particular objective or aim then participants could be encouraged back toward more relevant discussion by the researcher referring back to the scheduled questions. Often, in research, time is of the essence, and the degree to which participants can be encouraged or 'allowed' to digress from exploration of specific research aims, might lie with the time restrictions; digressions might reveal rich seams of data, but if the data is not relevant to resolution of the research aims then answers to the research question(s) are less likely to be found.

Despite the advantage that the children might prefer to be interviewed with their friends, classmates or peers rather than speaking alone with a researcher, there existed the possibility that some children might feel reticent or uncomfortable about speaking up in front of the class. It was important that no child be disadvantaged or even feel disadvantaged in any way, and so each pre-printed interview schedule was given to every child with space enough to write down anything they wanted to say next to each question. In this way, any child who felt reticent or uncomfortable about speaking up didn't have to do so, but if the same child wished to share their thoughts or ideas they could still do so by way of writing down whatever it was they wished to say.

It was anticipated that the verbal exchange of thoughts and ideas between the children and myself would generate a lot of data; data that could not all be easily made note of by being written down in the research moment. Attempts to physically take notes would serve to not only frustrate the flow of the questioning and answering but would frustrate the children, too, as they would have to wait as the notes were taken. For ease of transcription, therefore, the class interactions during the unstructured and semi-structured group interviews and the group story presentations were video-recorded and, for 'back-up' purposes, were audio-recorded, as well.

Development of the Research Instrument

In researching the scientist in fiction and how children engage with fictional representations of science and scientists, the research aims had become to consider

- *i)* *how children feel about science and scientists*
- *ii)* *whether children have any insight into why they feel this way and*
- *iii)* *how children engage with positive images of science and scientists through writing, reading and discussion of fictions about the same.*

In pursuit of these aims, it was important to find out whether or not the children were engaged with fiction itself, in the first instance. Then, if the children were or had been so engaged, whether or not scientists or science had ever been part of the encountered fiction or had ever played a part in the children's engagement with the same. In order to consider to what extent children might engage with positive representations of science and scientists in fiction, it was also important to find out whether or not the children felt that fiction had ever had an emotional impact upon them. Besides the research aims, then, three initial objectives were defined:

- *A.* *to examine how engaged children are with fiction (of any nature)*
- *B.* *to investigate whether children are familiar with science or scientists in fiction*
- *C.* *to explore whether children think they are influenced or inspired by fiction.*

In order to explore these objectives together with the research aims in a thorough and methodologically sound fashion, I felt it necessary to break the fieldwork into four distinct parts; the first part seeking to explore each of the three objectives and the second, third and fourth parts seeking to explore, respectively, the first, second and third of the three research aims.

Doing so raised concerns about both the well-being of the children and the sustaining of their interest and again spoke to the ethical intention that the children were to enjoy themselves and have some fun, as well as, ideally, both practising their creative writing, and learning about real and fictional science and scientists. It was important that, in the face of lots of questions about what they think and about how they feel about science and scientists, the children did not become frustrated or bored or get too tired. For each cohort, then, the fieldwork was carried out over two days instead of one day only (four days in all).

THE FIRST DAY

PART ONE – an exploration of the children's engagement with fiction and scientists and science in fiction.

The questions for the first semi-structured group interview were drawn up in order to pursue the three initial objectives. Throughout the first semi-structured group interview, it was necessary to take great care to make no mention whatsoever of scientists or science unless the children themselves raised the subjects.

Hence, after being re/introduced to the children by the Year 5 teacher, I asked the children if they were all happy to work with me that day. I said that if they didn't wish to work with me they were entirely free to go and do something else; they could go to the library and read or draw, for example. All the children wanted to stay. I told the children that we were going to talk about stories, children's stories in particular; I asked if that was all right with them. It was. I so progressed to the first semi-structured group interview in pursuit of the three objectives:

Interview Schedule for Semi-Structured Group Interview No. 1:

Objective A – to examine how engaged children are with fiction (of any nature)

1. *What's your favourite type of story?*
2. *What's your favourite type of character?*
3. *Do you have any actual favourite stories or favourite characters in stories?*

4. *Why are these your favourites?*

Objective B – to investigate whether children are familiar with science or scientists in fiction

5. *If you were to make up a story of your own, what type of story would it be?*
6. *Who would be in it?*
7. *Do these characters have anything in common; that is, are your characters the same in any way?*
8. *How are they different?*

Objective C – to explore whether children think they are influenced or inspired by fiction

9. *Do you think that any stories or any characters in stories have made you feel different about anything?*
10. *In what ways do you feel different?*
11. *Why do you think you feel different?*

Having established an extent to which the children were or were not engaged with fiction and scientists and science therein, the pursuit of the first research aim, *to examine how children feel about science and scientists*, progressed.

PART TWO – the children's group story-construction and group story-telling.

Drawing upon the Year 5 teacher's familiarity with the children, the class was divided into three groups that were, without the children's knowledge, as equally matched as possible with respect to age, gender and ability.

The children were invited to, within their groups, make up a story. Later on, the children were asked to present, in their groups, the story they had made up to the rest of the class.

I suggested that the story could be any sort of story at all; any genre, any subject, any length. There was only one rule: although the children could have as many characters as they liked in the story, there had to be, at least, the four basic characters I had in mind. These were the characters of: a woman, a child, a scientist and a man.

Before starting the story, with respect to these four assigned characters, the children were asked to further define them by means of pre-printed 'Personality Sheets' (see *Appendix; Example of 'Personality Sheet': Scientist – Front of Sheet*; *Scientist – Back of Sheet*). That is, each child was given four sheets of A4 paper upon one side of each was printed, each sheet respectively, the titles: *What sort of person is the WOMAN?*, *What sort of person is the CHILD?*, *What sort of person is the SCIENTIST?* and *What sort of person is the MAN?* Beneath each title, besides there being a space to allocate a gender (to the Child and to the Scientist) and an age, there was printed a list of personality traits:

kind/caring or *unkind/uncaring*

clever or *not so clever*

calm or *nervous*

bossy or *not so bossy*

cheerful or *grumpy*

follows rules or *breaks rules*

shy or *not really shy*

sensitive/feelings easily hurt or *tough/feelings not usually hurt*

trusts people or *doesn't really trust people*

has a lot of imagination or *doesn't have much imagination*

friendly or *not so friendly*

honest or *dishonest*

doesn't worry much or *worries a lot*

likes things to stay the same or *likes to change things*

likes to work in a team or *likes to work alone*

tidy or *untidy*

patient or *impatient*

These seventeen personality traits were based upon the 16 Personality Factors – or *primary factors* or *source traits* – derived by Raymond Cattell (1973; Cattell & Mead, 2008) in defining the basis for those surface behaviours that define personality.

Each child was asked to circle each of the attributes they thought were most appropriate for their characters. The children were also given the opportunity to add any personality attributes or characteristics of their own as, upon the back of each personality sheet questions were printed, on each sheet respectively: *What else could you say about the WOMAN?*, *What else could you say about the CHILD?*, *What else could you say about the SCIENTIST?*, *What else could you say about the MAN?* – together with a further invitation to draw the characters if they wished to.

As the children were allowed complete freedom to create whatever story they desired, albeit within the bounds of having, at least, the four pre-assigned characters, it was anticipated that the children's assumptions, presumptions, biases and/or prejudices about the nature of stories and the characters within those stories would, or would not, become apparent to varying degrees; it was anticipated, also, that which was missing from the children's written work about the characters would be just as important as that which was present.

After twenty minutes or so, each team was invited to present their story to the class.

Unstructured Group Interview No. 1

After all three stories had been presented to the class, an unstructured group interview was carried out wherein the whole class was invited to discuss their initial reactions to each others' stories. Questions were prepared to start the discussions off:

1. *What did you like about each story?*
2. *What did you like about the characters in the stories?*
3. *Is there anything you didn't like?*

After all three stories had been discussed in general terms, the pursuit of the first research aim progressed.

Interview Schedule for Semi-Structured Group Interview No. 2:

In pursuit of the first research aim, *to examine how children feel about science and scientists*, there were six questions:

1. *When you knew that one of the characters in your story had to be a scientist, how did that make you feel?*
2. *Do the scientists in your stories have anything in common; that is, are your scientists the same in any way?*
3. *How are the scientists in your stories different from one another?*
4. *The scientists in your stories were... the way they were... – is that how you expected them to be?*
5. *Why do you think the scientists in your stories did such good or bad things?*
6. *Do you think any other sort of person would do the things the scientists in your stories did?*

Having explored how the children felt about the scientists and the science in their stories, the pursuit of the second research aim, *to investigate whether children have any insight into why they feel this way*, progressed.

PART THREE – exploration of whether or not the children have any insight into why they feel the way they do about science and scientists.

Interview Schedule for Semi-Structured Group Interview No. 3:

In pursuit of the second research aim there were ten questions:

1. *Do you think any Real Life Scientists would do the things the Scientists in your stories did?*
2. *Why would/wouldn't Real Scientists do those things?*
3. *How do you know that?*
4. *Have you seen or heard any Real Scientists behaving that way?*
5. *How do you think Real Scientists behave?*
6. *Where do you think you get your ideas about Real Scientists from?*
7. *Can you name any Real or Fictional Scientists?*
8. *Do you think that the way you feel about Real Scientists had anything to do with how you made up the Scientists in your stories?*

9. *Do you think if you saw or heard (any/more) Real Scientists it would change how you feel about Scientists/Science?*
10. *What sort of person becomes a scientist? (The children write this down).*

All the class discussions were video- and audio-recorded.

THE SECOND DAY

PART FOUR – how the children engage with positive images of science and scientists through reading and discussion of fictions about the same.

Having examined how the children felt about science and scientists and whether they had any insight as to why they felt that way, part four sought to further address the third research aim, *to explore how children engage with positive images of science and scientists through writing, reading and discussion of fictions in connection with the same*.

The Drafting and Standard of the Literature

So that no child could be rendered dis/advantaged or biased in any way by having already read or heard about any particular story (that the other children hadn't read or heard about), I felt it necessary to draft an original science fact/fantasy adventure story depicting science and young scientists in a positive light. The story was duly drafted and in order to be assured that the material was of an adequate standard, it was submitted as part of a book proposal to a Literary Agent who was the children's fiction rights representative at Bloomsbury Publishing Plc. After due review and revision, the material was accepted by the agent (for potential publication) and the Head of School and the Year 5 teacher were so assured that the literature was up to industry standard for literature (fiction) for 8-12 year olds. An extract of the story, *Audacious, Endeavour and the God Particle Chronicles*, is presented in the Appendix.

The whole of the Year 5 cohort engaged in a shared reading of the story wherein I read the story to the children as they followed along with their own printed copy.

Unstructured Group Interview No. 2

After the shared reading had taken place, an unstructured group interview took place wherein the whole class was invited to discuss their initial reactions. Questions were prepared to start the discussions off:

1. *Did you like the story?*
2. *What didn't you like about it?*
3. *Which characters did you like best?*

The children's responses were video- and audio-recorded. After the shared reading had been discussed, the pursuit of the third research aim progressed.

Interview Schedule for Semi-Structured Group Interview No. 4:

In pursuit of the third research aim there were nine questions. The first six questions were:

1. *Could you imagine yourselves as the young scientists in the story?*
2. *Why is that?*
3. *Could you imagine any of your friends/family/classmates as the young scientists in the story?*
4. *Why them?*
5. *Do you think stories like this (with Scientists as heroines/heroes) could affect the way you feel about Scientists and Science?*
6. *What makes you say that?*

After these questions were discussed, I then revealed that all the science in the story was real science: real cosmology and real particle physics, at the cutting edge of current knowledge. The cosmological phenomena – primordial black holes, Hawking radiation, the possibility/probability of the existence of alterative dimensions, time dilation – all actually existed and the sub-atomic particle that the protagonists' father was dangerously hunting down was a real particle, the Higgs boson, which at the time the research was carried out in 2011 had been eluding the world's physicists since the 1960s, and was finally observed on July 4th 2012, just one week before the 2012 research took place.

The interview schedule for semi-structured group interview no. 4 continued:

7. *Now, do you think stories like this (with scientists as heroines/heroes) could affect the way you feel about scientists and science?*
8. *Why do you feel that way?*
9. *What sort of person becomes a scientist? (The children write this down).*

The children's responses were video- and audio-recorded.

When my time with the children came to an end, I thanked the children for helping me with my research and told them how much I had enjoyed their wonderful stories and thoughts and ideas. I advised them that if they wanted to talk to me about any aspect of the research at all, or if they wished to speak to me more about writing, reading and sharing stories of any nature, I would be more than happy to speak with them whenever they wished.

Here the fieldwork ended.

Thematic Coding and Analysis

Having transcribed verbatim the data gathered by use of the video- and audio-recordings of Unstructured Group Interview Nos. 1 and 2, Semi-Structured Group Interview Nos. 1, 2, 3, and 4, and the six group story presentations, the data were coded and then analysed using foundational thematic analysis.

The Coding and Analysis of the Data

In its execution, the thematic analysis of qualitative data requires the iterative sifting through and coding of the data, and the finding of correlative thoughts, ideas and/or patterns therein in order to think more deeply about the same, recognise emerging themes and, in doing so, create meaning with which to fulfil the research aims.

Initially, I carried out this sifting and coding using the qualitative data analysis software NVivo (QSR International, 2012). However, in bottom-up coding, the act of drawing ideas from a body of data, a text, coding those ideas and setting them down within any sort of software system with a view to grouping (or splitting) these codes into themes, in effect creates an entirely new body of data, a new text.

As the exercise progressed I came to feel that not only was this new text entirely too different in nature from the original transcription text but, as it expanded with the addition of each code/node (adding new free nodes, attaching branches to tree nodes, or creating new case nodes, for example), this new text became further and further estranged from the original text.

In trying to shape my own meaning from the original text, I felt I was destroying it; I was tearing it apart; I was not generating a fresh shape of text, an adaptation or rearrangement into some form of sympathetic sister text that better revealed the original's patterns and themes; I felt I was tearing bits of the text away in order to create something else, something entirely different. Not only that, I realised that upon intending to look to this new and different text to find meaning from the original, I must also intend to abandon that original.

Although any such new texts, formed from words, phrases, sentences or parts of sentences from an original text set side by side one another or set in some form of hierarchy, might render a 'thematic'-text or 'hierarchy of themes'-text wholly adequate for research founded upon other theoretical frameworks, it was this very same fragmentation and reorganisation, this tearing of words and phrases from their delicate context within something already fully formed and 'perfect', in order to assemble some sort of alternative artificial construct, that I felt was becoming more and more anathema to the fabric and the essence of the reader response framework within which the research was embedded.

Reader response theory argues that a text is called into being by the reader; and the reader, calling into being this unique and irreplicable entity, creates meaning from this transaction.

In order to satisfy the research aims, it was my intention to call the transcription text into being and thereupon create some sort of meaning. I found, however, that through the process of NVivo coding, I was calling into being – as an author – this entirely new text and was transacting with this new text as a way of making meaning from the original.

This new constructed text, although representative of something in itself (a collection of ideas; a progressive/ranked organisation of patterns), felt like an artefact; it was *of* the original, but not the original. It was a by-product of the original and it represented my re/constructed role as 'author/reader' instead of just 'reader'.

As both author and reader of the new text, I began to question whether, when looking to that new text for the making of meaning, I had a right to claim the making of meaning from the original text.

Respecting the Text

Although I have to, of course, become 'author' in that I have to write down my findings and formed opinions – in this very paragraph, for instance – in order to relay my research to others, when looking to fulfil the objectives and aims of the research, I felt that I had to listen more directly to what the children had to say; I needed to make meaning from what the children actually said within the context in which they said it. That is, I felt I had to stay true to the children as being the authors of their texts and me as being, only, the reader.

These three issues: the creation of an artefact, my re/constructed role as author of that artefact, and the abandonment of the original text, I came to feel presented a phenomenon that could not claim any position within the way of thinking or way of being that is reader response theory – and especially reader response theory within the further context of this particular piece of research: that is, this research does not use the 'lens' of reader response theory to think about how the children feel about science and scientists and what the children have to say about the same; rather, this research is founded upon reader response theory and regards the looking upon of any text as a unique transaction in the temporal creation of the text itself and in the temporal creation of meaning. The creation of any new text is an entirely different entity in and of itself and, thinking about those fundamental convictions of reader response theory, such an artefact cannot represent the text from which was compiled. Therefore, I decided to put NVivo to one side and begin again.

The research methodology and design had incorporated Braun and Clark's "foundational" (2006, p. 78) method of thematic analysis and their inductive approach toward the identification or discovery of themes. They suggested that although themes and patterns could be identified at a semantic surface level, it was upon looking beneath these surface patterns, that one might come to see the themes that shape the semantic content (p. 84).

Their inductive approach advocated looking at the data from a bottom up point of view, in as much as one might let the data speak for itself as, in iterative transactions with the data and coding of the same, themes might gradually be revealed. This is as opposed to a top down approach wherein a researcher might approach the data with a theory or question in mind and actively seek out data that appealed to the theory or that 'answered' the question.

Having eschewed NVivo's (bottom up) artefact, however, I decided to do both, that is, both an inductive bottom up and a deductive top down coding and analysis of the data – which is entirely in keeping with the flexibility that thematic analysis, as a method of thematic analysis in itself, allows.

Deductive (Theory-Driven) Top Down Analysis

Braun and Clark (2006) offer a step-by-step guide to 'doing thematic analysis' (pp. 86-93). They divide the process into six phases

Phase 1: Familiarising yourself with your data
Phase 2: Generating initial codes
Phase 3: Searching for themes
Phase 4: Reviewing the themes
Phase 5: Defining and naming themes
Phase 6: Producing the report

which, in order that the data be examined with all due thoroughness and rigour, I adapted for use within my own study.

Familiarisation with the Texts (Braun & Clark's 'Phase 1', p. 87)

Having, over many months, transcribed the data verbatim from video- and audio-recordings and from the children's written work, and having already created an NVivo artefact, I was very familiar with the data. In being so, some ideas or ideas for themes had naturally occurred and I had made a list including, for example, the idea that, at first, the children hadn't seemed to speak about literary stories connected to science and scientists at all; and, when asked to share their ideas about real or fictional scientists, the children had tended to talk mainly about real scientists and not fictional.

Generating Initial Codes (Braun & Clark's 'Phase 2', p. 88)

In order to achieve the research aims, however, the research objectives had to be met. The text had to be approached in a logical and thorough fashion and, this time, I employed a theory-driven approach: I approached the data with a view to 'answering' the questions that, to begin with, each of the objectives asked. I felt this was representative of 'top down' analysis as, when I approached the data, I held 'an objective' in my mind as I searched the data for what the children had had to say about the same.

The research design had evolved specific questions that the children were to be asked in order to satisfy each one of the objectives, and each of these questions, in approaching the data, effectively represented an 'objective' in itself.

For example, Objective A was

> *to examine how engaged children are with fiction (of any nature)*

and the questions used in Semi-Structured Interview No. 1 to first explore this objective were

1. *What's your favourite type of story?*
2. *What's your favourite type of character?*
3. *Do you have any actual favourite stories or favourite characters in stories?*
4. *Why are these your favourites?*

With the first question in mind, that is, *What's your favourite type of story?*, I re-approached the original transcriptions (from both Cohort 2011 and Cohort 2012) and read and reread them many times. I read them while listening to the audio recordings of the same, and I re/watched the video recordings of the same, many times, listening closely to what the children were saying, within the often shifting contexts in which those things were being said.

Looking through each transcript, for "the most basic segment, or element, of the raw data or information ... regarding the phenomenon" (Boyatzis, 1998, p. 63), I then began to physically highlight, with pen and paper, what the children had said in response to the first question. I went through each of the transcripts in their entirety, that is, I did not just look at Semi-Structured Group Interview No. 1 and the questions and answers therein, as, very often, the children would spontaneously answer questions that I had previously asked and moved on from, even, for example, remembering questions, thoughts or ideas from Day One of the research and suddenly speaking about them to me on Day Two. I appropriately coded these answers at the side of the page, and when I felt the search for 'answers' had been exhaustive, I moved on to the next question. Question 2, still with respect to Objective A, was approached in the same fashion; a different colour of highlighter was used and appropriate codes laid at the side of the page.

However, as the generation of initial codes progressed, I realised that the transcripts and my making physical (paper) copies of them as I sought to keep each objective, research aim and other themes and their codes separate from each other, would create an unwieldy amount of paper that would become increasingly difficult to manage, difficult to swiftly refer to and difficult to store; nor would the generation of many, many copies of the already hefty transcriptions be environmentally friendly.

Hence, using the codes I had already assumed, I created an electronic folder, the name of which became a parent code: 'Objective A'. Within this folder, I created subfolders and the names of these folders, too, relating to the questions that had been asked in connection with Objective A, became codes in themselves: 'Objective A/Q1 – Favourite Type of Story'; Objective A/Q2 – Favourite Type of Character', for example.

I electronically copied the transcription texts into the subfolders and it was these texts that I re-highlighted, and re-coded, exactly as I had done with the paper copies.

The idea of electronically highlighting and coding had many advantages. Besides being very environmentally friendly, the data, its highlighting and its coding was far easier to manage. The file names of the transcription files within the sub-folders themselves represented parent-child codes. Most advantageous was the idea that the expanding and collapsing of the folders and subfolders could more easily reveal gaps – either in the data or in the coding. For instance, with respect to Questions 1 and 2 of Objective A, Figure 3, below, shows how the expanded sub-folders follow a logical pattern in and of themselves. If any one of the transcription (.docx) files were not present, one might more easily see so and hence refer back to the data to see why: was the data not there (because I had not asked the question or the children had not answered the question), or had the data been accidentally passed over (not coded), or coded incorrectly.

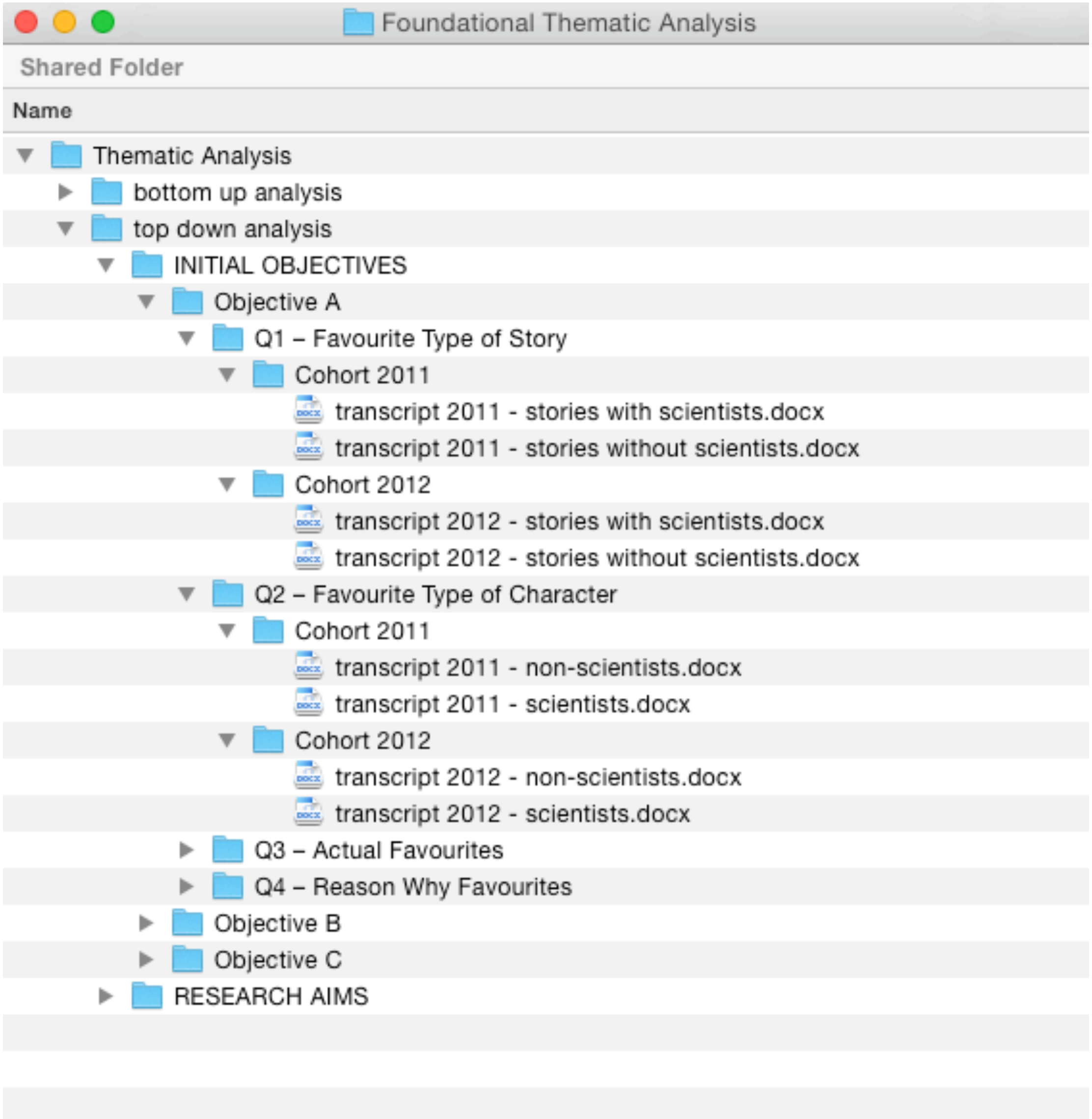

Figure 3: Expanded Folders and Subfolders for Objective A – Questions 1 & 2

It could be argued that the expanded folders and sub-folders bear similarities (parent-child/tree-branch codes/nodes) to an NVivo presentation of the same. I would argue, however, that at the end of each of my branches there lies the actual transcription text in its entirety; although it is an electronic copy of the original text that has been highlighted, it still more fully represents the original text and it has only been highlighted, not torn apart and reassembled.

Searching for Themes (Braun & Clark's 'Phase 3', p. 89)

With respect to Question 1 of Objective A, that is, what the children's favourite stories were, I had coded for, for example: 'detective', 'funny' and 'adventure' stories.

I already had in mind, from my initial familiarisations with the texts, the idea that the children hadn't spoken about literary stories about science and scientists very much. On collating the codes into scientist and non-scientist groups for example, a theme did begin to emerge: *although the children were very familiar with all sorts of literary fictional stories, they were not familiar with science and scientists in literary fiction.*

With respect to Question 2 of Objective A, that is, what the children's favourite story characters were, I had coded for, for example: 'comedy', 'crazy' and 'underdog' characters. When these codes, too, were collated into scientist and non-scientist groups, a similar theme began to emerge: *although the children had lots of different favourite story characters (some connected with their favourite stories, some not), none of these characters were scientists.*

Reviewing Themes (Braun & Clark's 'Phase 4', p. 91)

Braun and Clark suggested two levels of "reviewing and refining the themes" (p. 91). Level 1: "reviewing at the level of the coded data extracts" and Level 2: "consider[ing] the validity of individual themes in relation to the data set" (p. 91).

Level 1: With respect to, for example, Question 1 of Objective A, I reread all the coded/collated data extracts in connection with the theme *although the children were very familiar with all sorts of literary fictional stories, they were not familiar with science and scientists in literary fiction* to make sure they formed a coherent pattern – that pattern being that the children did not, at that time, recall or speak about any stories connected to science or scientists. I believed that the extracts did form a coherent pattern.

Level 2: I re-read the entire data set (of all collated codes/extracts – the entire transcripts, in fact) to check that the theme "'work[ed]' in relation to the data set" (p. 91) – which it did.

With respect to Question 2 of Objective A and the theme, *although the children had lots of different favourite story characters (some connected with their favourite stories, some not), none of these characters were scientists*, I carried out the same Level 1 and Level 2 reviews. I believed that these extracts, too, formed a coherent pattern and the theme did 'work' in relation to the entire data set.

Besides this, I compared both themes to one another. The extracts and codes for both themes seemed to corroborate one another; together they were, coherent, congruous and compatible – and together, in their mutual corroboration, they felt 'stronger'. I so merged the themes (and their data-sets) and together they became the single idea that *although the children were very familiar with all sorts of fictional stories and fictional characters, they were not familiar, in the first instance, with fictional stories or fictional characters connected to science or scientists*.

Defining and Naming Themes (Braun & Clark's 'Phase 5', p. 92)

Braun and Clark felt that in defining and naming the themes, one must look to "refine ... the overall story the analysis tells, generating clear definitions and names for each theme" (p. 87).

As the themes that Questions 1 and 2 of Objective A generated were coherent and seemed congruous enough to be combined, I decided that for clarity and concision, the 'story' that the analysis of these themes should tell should be:

> *The children were not familiar with science or scientists in literary fiction.*

Producing the Report (Braun & Clark's 'Phase 6', p. 93)

This single theme and other themes arising out of the rest of the objectives and the research aims are presented in *Chapter 6 – Results*.

In looking to explore the research objectives and aims in this top-down/'theory-driven' way, however, other themes began to emerge. These themes were not 'attached' to any particular research objective or aim, but seemed to arise naturally both from the data and from the themes that the theory-driven analysis had derived. They are best described as being derived through an inductive, data-driven, bottom up analysis.

Inductive (Data-Driven) Bottom Up Analysis

I went back to the data to code for other themes. Again I carefully sifted through each transcript looking for "the most basic segment, or element, of the raw data or information ... regarding the phenomenon" (Boyatzis, 1998, p. 63). This time, however, I was not looking for data in connection with the 'phenomenon' that was any one of the research objectives or aims, rather, I was looking for data in connection with 'any' phenomenon.

In order that the data be examined with all due rigour, I again adapted Braun and Clark's step-by-step guide for thematic analysis and proceeded in accordance with how I had proceeded for the theory-driven coding and analysis. That is, being already familiar with the data (Phase 1), I generated initial codes (Phase 2) and began to search for themes (Phase 3).

With respect to Phase 3's searching for themes, however, it was hard to tell whether or not I already held in mind, subconsciously, 'an idea' – much as I had done, consciously, with the idea I had held in mind (*'that the children hadn't spoken about literary stories about science and scientists very much'*, for example) during the theory-driven coding for Questions 1 and 2 of Objective A. It is the nature of reader response theory and interpretive communities' interpretive strategies, however, that I bring myself, in the particular mood and in the particular moment, to the making of meaning throughout the research process. Hence, when I highlighted extracts and coded for, for example, the children's thoughts about science being *'boring and complicated' (Joseph)* or being *'studying more than talking' (Moira)* or that scientists were *'good at maths' (Andrew)* or *'basically crazy' (Philip)*, I cannot be sure that I did not already hold in my mind the idea that *the children felt that there was a difference between the 'idea of doing science' and 'the idea of being a scientist'*.

One might believe that 'doing science' is the same as 'being a scientist' – as 'being a scientist' means that one has to 'do science'. When coming to group the codes, however, although I could have grouped these codes together under the umbrella idea about *how the children felt about doing science/being a scientist*, I instead felt that the codes were better grouped separately, each representing a theme in itself:

> *The idea of doing science: 'boring and complicated' (Joseph), 'studying more than talking' (Moira).*

> *The idea of being a scientist: 'good at maths' (Andrew), 'basically crazy' (Philip).*

Hence, for Phase 4, reviewing the themes, I took great care at Level 1, to reread the coded/collated data extracts connected to each of the themes in order to be certain that the extracts did form coherent patterns – the patterns being that the children did have very different ideas about the nature of 'doing science' and the nature of 'being a scientist'. I believed that the coded extracts did form coherent patterns.

At Level 2, I re-read the entire data set (of collated codes/extracts – the entire manuscripts) to check that the themes "'work[ed]' in relation to the data set" (p. 91) – which they did.

In reviewing the themes, I had compared them to one another many times. In this case, though, although the codes for each theme were internally (within each theme) coherent, congruous and compatible *within* each theme, I felt they were not externally (when compared to one another) coherent, congruous and compatible and so each did warrant being a theme in itself. I did not combine these themes and for Phase 5, defining and naming the themes, I felt that *'the children's idea of doing of science in the real world*' and *'the children's idea of being a scientist in the real world*' were themes in and of themselves.

These themes and others arising out of the data-driven analysis are presented (Phase 6) in *Chapter 6 – Results*.

Validity, Generalisability and Reliability

In qualitative research, "[v]alidity", Leung (2015) argues "means 'appropriateness' of the tools, processes, and data" (p. 325). This appropriateness extends to every aspect of the research and its design:

> Whether the research question is valid for the desired outcome, the choice of methodology is appropriate for answering the research question, the design is valid for the methodology, the sampling and data analysis is appropriate, and finally the results and conclusions are valid for the sample and context. (Leung, 2015, p. 325)

Having shaped the research question, aims and objectives with a view to shaping interventions with which to better engage children with the idea of taking on a career in science, it is appropriate, therefore, in carrying out the research, to first secure the help of a sample children of appropriate age and socioeconomic group.

When thinking about how these children might think and feel about science and scientists, this research recognises and embraces the multiple or fluid realities that each of the children taking part has already created in life and will create in the research moment; it embraces too, the idea that these realities are to the larger degree unknowable to anyone outside of them and so are not measurable in any positivistic way. Hence, positivistic paradigms that perceive of one objective reality, that see the world as somehow singularly knowable and measurable as such are, in fact, entirely anathema to this research.

As it is not possible to control all the multiple, fluid variables that the research encourages and embraces, it would be highly inappropriate to use empirical mechanisms of positivistic data collection and analysis – repeatable experiments, statistical techniques and surveys, for example – as these are entirely incompatible with my intention to shape creative means with which to better engage children with science and scientists. Positivistic techniques would, at best, provide thin data with which to approach the research aims; thoroughly exploring how children think and feel and share ideas about fictional and real science and scientists requires, instead, rich data collection through imaginative and creative means.

Appropriate to most qualitative studies would be the use of hermeneutic tools and processes in the gathering and the analysis of the data, but for this study, particularly, a study founded upon the theories of reader response theory and interpretive communities, it is *only* by the use of hermeneutic techniques to collect, code and analyse the qualitative data and make some sense of the same, that theoretical and methodological coherence can be claimed, the research aims can be met and the research question can be answered.

It is necessary, therefore, to reject any positivistic concept of there being only an objectively constituted and measurable one reality in favour of a relativist and interpretivist perspective and approach. This research so celebrates the essential individuality and validity of other people's views, experiences and ideas and in particular the views, experiences and ideas of the children who took part.

The 'appropriate qualitative tools' with which to carry out this exploration, that is, asking the children to write, read, share and discuss their own and others' stories about science and scientists, for example – and the hermeneutic analysis of the data thus gathered – fit well with the research question. These tools are far more likely to encourage the generation of deep, rich data rather than, for example, asking the children to fill in a Likert scale questionnaire. A Likert Scale questionnaire, often used to quantify qualitative data – and useful in many respects, for other studies – would, in this research instance, put words and ideas (about science and scientists, for instance) into the minds of the children as the children worked their way through the questionnaire. Far better to have the children shape their own fresh ideas and reflections about science and scientists through group story writing, group presentation of those stories and both group and individual interactions both with myself and with one another when sharing and discussing those stories within the research environment.

Hence, with respect to this study's internal validity, although the sample of children with which I was privileged to work was an opportunistic/convenience sample, I believe the children were of the correct age and socioeconomic background with which to carry out the research, and the qualitative methodology and method I sought to employ, would precipitate interpretations and findings that could be deeply descriptive, rich and emotive. For this study, in trying to shape interventions, especially in connection with imaginative worlds, it is this richness and emotive connection, that might better shape those interventions with which to better engage and better persuade children toward thinking about science and scientists in different, more creative, more emotive and enjoyable ways. With respect to the study's external validity and generalisability, however, because the sample of children was opportunistic, the research findings cannot be entirely satisfactorily extrapolated into the wider world. Other studies, with other samples – these samples, too, being opportunistic in as much as one cannot pick and choose exactly which children should and should not be in any Year 5 class in any similar UK primary school – should be carried out in order to paint a broader or more generalisable picture.

With respect to the research's reliability, a qualitative study of this nature is not reliable/replicable in a quantitative sense: it is not a repeatable experiment where by using the same method, one might achieve the same precise results and same conclusion. Again, it is the very nature of this qualitative study particularly, that is, its foundation within a reader response and interpretive communities framework, that unique meaning is made, both by the children and myself in the research moment, and by myself in coming to interpret the data gathered therein. Leung (2015) believes the "the essence of reliability for qualitative research lies with consistency" (p. 326) and, provided "the methodological and epistemological logistics consistently yield data that are ontologically similar" (p. 326) then some degree of variability is tolerated. This study's epistemology informs its methodology – and vice versa. From a reader response perspective, the way the research's results – its knowledge, my knowledge, the children's knowledge – come into being, the way that knowledge is made and is made fluid, thoroughly informs the qualitative and hermeneutic nature of the research's methodology; the methodology and method, the bringing into being of fictions, fluid meanings and interpretations, informs its epistemology. Hence, in this respect, the research's methodological and epistemological foundation is consistent – and its internal reliability sound.

With respect to the 'variability' that arises in ontologically similar data: all the data are similar in that their being called into being and their 'being' in the research has been occasioned by sound epistemological and methodological congruence; variability occurs, I believe, in the moment of interpretation. I bring who I am, in the mood and the moment, to the data's analysis and interpretation and what might one day have been rich, thick, interpretation can another day be interpretation that is thin and poor. The iterative nature of thematic analysis, however, the detailed coding and the corroborations and re-corroborations both within and between data-sets, these checks and balances, ensure that interpretations are valid and consistent – for me. If someone else were to undertake the analysis and interpretation of the same data, different interpretations might be made – different interpretations, however, that would not necessarily contradict and/or invalidate my own interpretations.

In this regard, although internally sound and consistent, this study and similar qualitative studies with small samples and particularly interpretative foci, might not be expected to be generalisable or transferrable into the population at large. However, I would argue that the age and socioeconomic range, for example, of the sample is to some degree representative of 'similar' samples throughout England and I would so expect that the experiences and ways of being in the world that the children described during the research process are to some degree externally generalisable and transferrable. The interventions that were shaped by the research could therefore be staged within the general population.

Conducting the Fieldwork

The fieldwork was conducted in the children's own classroom which was a comfortable, bright and happy environment with which the children were, of course, very familiar, and throughout the research, the children did seem to enjoy themselves. When, for example, the children were asked to, in groups, create their story and story characters, I took the opportunity to move from table to table answering any queries the children had. Looking at the face of each child, it seemed that most children were happy to set about their creative writing; those children that seemed reticent at first, took to filling in their character personality sheets, and no child from either cohort declined to contribute to or help act out the stories the groups had created.

The Research Instrument

Upon carrying out the research in the field, however, I felt that the research instrument was too long; it contained too many questions, and there was 'too much to do' in the time I had been allocated. Had there not been so many interruptions during the school day, I think the instrument would have worked very well, but I did not factor in the amount of disturbance and interference that would occur throughout the entire school day. As a result, when lots of children had their hands raised in wanting to answer a question, I found myself speaking with one child and hurriedly moving on to the next child and the next. Ideally, I should have taken more time with each child, asking follow up questions and probing deeper. Had I done so, of course, then other children with their hands up would probably have put their hands down as I continued to engage with just the few. I gradually learned to slow down, however, and when working with Cohort 2012 especially, when time was running out, I chose the scheduled questions more carefully.

Mistake/Alternative Dynamic

Despite meticulous preparation, I also made a rather large mistake – which turned out to be fortuitous. On the first day of research with Cohort 2011, the first thing I did was give the children the story personality sheets. The sheets were explained and the children were asked to, in groups, create their own story, the only criteria for which being that each story contained at least four characters, one of whom had to be a scientist. This was not in absolute accordance with the final research design wherein the children were to undertake Semi-Structured Group Interview No. 1, discussion about the children's thoughts and ideas about the nature of stories *in general*, before discussing the writing of their own stories. That is, for Cohort 2011, on the first research day, Part Two of the research instrument happened before Part One. Cohort 2011, therefore, had already written and shared their stories containing scientists before they started talking about stories in general.

However, in order to properly pursue objective B, *to investigate whether children are familiar with science or scientists in fiction*, it was necessary to do so without mentioning scientists or science at all beforehand. Hence, at the start of the first research day with the children of Cohort 2012, in more accord with the final research design, Part One happened before Part Two; that is, the children of Cohort 2012 were neither given the story personality sheets, nor did they know that they were going to be asked to write stories that contained scientists. Science and scientists were so not mentioned or referred to in any way whatsoever before the discussions about stories in general took place.

Hence, although both cohorts of children were encouraged in exactly the same way to share their thoughts and feelings about what sort of things might be important in *any* sort of story, Cohort 2011 shared their thoughts *after* they'd written and shared their stories that featured a scientist, and Cohort 2012 *before* they were given the story personality sheets and the nature of the pending writing and sharing a story that featured a scientist exercise was revealed. For clarity, the Research Instrument, as it actually happened, is described in Figure 4 below.

The Research Instrument (as it happened)	
Cohort 2011	Cohort 2012
THE FIRST DAY	
Part Two – the children's group story-construction and group story-telling *Unstructured Group Interview No. 1* *Semi-Structured Group Interview No. 2*	***Part One*** – exploration of the children's engagement with fiction and scientists and science in fiction *Semi-Structured Group Interview No. 1*
Part One – exploration of the children's engagement with fiction and scientists and science in fiction *Semi-Structured Group Interview No. 1*	***Part Two*** – the children's group story-construction and group story-telling *Unstructured Group Interview No. 1* *Semi-Structured Group Interview No. 2*
Part Three – exploration of whether or not the children have any insight into why they feel the way they do about science and scientists *Semi-Structured Group Interview No. 3*	***Part Three*** – exploration of whether or not the children have any insight into why they feel the way they do about science and scientists *Semi-Structured Group Interview No. 3*
THE SECOND DAY	
Part Four – how the children engage with positive images of science and scientists through reading and discussion of fictions about the same *Unstructured Group Interview No. 2* *Semi-Structured Group Interview No. 4*	***Part Four*** – how the children engage with positive images of science and scientists through reading and discussion of fictions about the same *Unstructured Group Interview No. 2* *Semi-Structured Group Interview No. 4*
End of fieldwork with Cohort 2011	End of fieldwork with Cohort 2012

Figure 4: The Research Instrument (as it happened)

This turned out to be fortuitous because the children of both cohorts, when asked to think and talk about stories in general, never once referenced any stories that contained a scientist or scientific content of any nature – and this was despite the 'alternative dynamic' that had been applied to the start of the first day session with Cohort 2011 wherein Cohort 2011 actually had the stories they'd written about scientists in their minds when sharing their ideas about stories in general but still did not reference any science or scientist stories. This so served to make such an absence of reference to science and scientists in stories even more striking.

Interruption

Some interruptions were entirely unforeseen. Whilst talking with Cohort 2011, for example, the entire school had to suddenly stop what they were doing and form a 'Walking School Bus' wherein all classes were accompanied out of school to walk down into the local village and then back to school again. The Year 5 Teacher had no idea this was about to happen, so neither of us were prepared. Also, although I was well informed about break times and dinner times for the school and the class, it was customary for the school to have assembly at different and unpredictable times during the week. For both cohorts, our discussions were interrupted when the entire school had to go to assembly and from then, straight to break or lunch. It is likely that the children's trains of thought, thus interrupted, never returned to the same track.

Besides natural absences on account of illness, for example, where a child would be present for one research day but not for both research days, children were also regularly, during both days, taken from the classroom for private music lessons or extra reading, writing or sports tuition. Some of these children, on returning to the classroom, were able to 'dive back in' but others, unfortunately, were not. The degree of discontinuity to both the former and the latter children's thoughts, was not determinable.

Interference

Immediately after the children's stories were acted out, using the school's 'Two Stars and a Wish' technique, which was prevalent practise throughout the school at the time (for both cohorts), the teacher asked the children which two things ('two stars') they had liked most about the stories and the story-making process, and what they had liked least or would like to change ('a wish'). The Two Stars and a

Wish device was not part of the research design, and although it did tie in with Unstructured Group Interview No. 1 wherein the questions served to encourage the children to begin thinking about how they felt about their own and others' stories, it pre-empted and disrupted my asking of the scheduled questions.

Mis/Leading the children

On occasion, in trying to help a child out, I found myself putting ideas – in this instance, an actual scientist (or two) – into a child's mind:

Andrew:	*Erm, I can't remember his name but, erm, by the 18th, 17th century there was this person and he worked out loads of things, like … that the earth was round … no, that the earth turned and the sun didn't. I can't remember his name…*
ED:	*Copernicus?*
Andrew:	*Yeah, Copernicus.*
ED:	*Nicolaus Copernicus. Yeah. Heliocentricity – the earth revolves around the sun…*
Andrew:	*And, and he worked out loads of things that they didn't work out for another 100 or 200 years – and the reason he didn't tell anybody was because he would've been sent to jail or something or, or burned at the stake because, erm, there wasn't, because they believed in so much religion that it was, sort of, against the law.*
ED:	*That'd be Galileo…*
Andrew:	*Galileo, yeah…*

The Year 5 Teacher, too, in trying to help a child out, might be seen to have put ideas into a child's mind. When sharing ideas about putting scientists into stories, for example, one child thought it might be hard to put a scientist into a story:

Joe:	*Because it's, it might be because it's harder to <u>use</u> scientists…*
ED:	*In what way is it harder to use a scientist in a story?*
Joe:	*Because, erm, it's not like a normal person. It's like, it's, it is like a normal person that's like…*
Teacher:	*D'you think they have to use big words? Be a bit cleverer?*
Joe:	*Yeah…*
Teacher:	*Is that what puts you off?*

Joe: *Yeah…*

Teacher: *That's what he's trying to tell you…*

In both these instances, one might construe the mis/leading as 'justified' in as much as it is hard to watch a child struggle for words and, for the comfort of the child and the rest of the children – bringing to bear both personal ethics and the research ethics – I felt it better to assist rather than deny assistance in the name of research. Doing as much, I believe, in these instances, did not invalidate the research. In the above examples, the first child was trying to remember the scientist who discovered heliocentricity – and nobody had led him to that; the second child was trying to explain why he didn't like the idea of putting a scientist into a story and although the teacher might have 'put words in his mouth', this did not detract from the fact that the child did indeed not like the idea of putting a scientist into a story.

Reflexivity

When developing and engaging with a study founded in the theories of reader response and interpretive communities, one is continuously and *purposefully* aware of one's place in and one's influence upon every aspect of the research: from thinking about the research's theoretical and methodological frameworks, to the research's design and execution.

In every fresh reading or thinking about the frameworks, the design and the data gathered, I have re/shaped meaning – a fluid meaning that, through coding and thematically analysis of the data, I have come to make some 'steady' sense of.

Still, however, by using the interpretive strategies I possess by my being within my own interpretive communities, my iterative transactions with the data will have shaped, or favoured, the presence of some themes over others. The themes I have presented in the research findings are those that seemed to offer a more robust, reliable or deeper presence within the texts.

In previous chapters, I have sought to explain my position within the research, especially as an adult/adult researcher engaging with children. I have explained, too, that although it was not my intention to do so, I have made mistakes; I have, for example, perhaps mis/lead a child in trying to 'help him out'. There could be other instances of mis/leading or mis/direction that I am not aware of – but I do not believe these to be commonplace.

I am sure, however, that "there is no outside-text" (Derrida, 1967/1997, 1997 p. 158). There is no way for me to step outside of the research, its context, its data analysis and presentation, to look upon the research and see, for sure, that I have been truly robust. I have been in the midst of it; I *am* in the midst of it, whilst writing these words. From within my own public and personal interpretive communities, I have no option, no other way of coming to the research, than by employing my own interpretive strategies to shape the research into meaning that not only means something to me, but that I can present to the world with scholarly confidence.

An awareness of reader response theory is in itself reflexive. I bring all that I am to every encounter with all aspects of the research, including my "personality traits, memories of past events, present needs and preoccupations, [my] particular mood of the moment, and [my] particular physical condition" (Rosenblatt, 1970, pp. 30-31). Nonetheless, in order to ensure proper validity and reliability I have tried to remove 'myself' from the many research texts, and let the data, the themes and the research findings speak for themselves.

Moreover, in doing so, I am acutely aware that just as I have 're/written' the research texts many, many times, so have the research texts re/written me.

Conclusion

Having established a congruent theoretical and methodological framework, it was important to design a method that fitted the framework well and to execute that method in an ethical and robustly academic fashion – all the while paying special care and attention to the research's young participants.

The methods of data collection, the use of unstructured and semi-structured group interviews – and the creative writing of, reading of or listening to stories in connection with science and scientists – fitted very well with and were consistent with the research's necessarily qualitative approach. These methods of data collection allowed the generation of layer upon layer of rich data.

Despite the interferences, interruptions and mistakes that happened when conducting the fieldwork, the research's validity, reliability and possible generalisability still proved to be sound, and with all due reflexivity in mind, the data was thematically analysed enabling the emergence of themes which are presented in *Chapter 6 – Results*.

Chapter 6 – Results

Introduction

The primary aim of the research was to consider how – or whether – children's engagement with fictional representations of science and scientists shaped their perceptions of real science and real scientists. In this regard, the research aims were to determine

1. *how children feel about science and scientists*
2. *whether children have any insight into why they feel this way and*
3. *how children engage with representations of science and scientists through writing, reading and discussion of fictions about the same.*

In order to answer these questions, I needed to first find out whether the children in the research groups engaged with fictions in general, that is, I needed to establish whether or not fiction of any nature was actually a part of their lives, and I then needed to establish whether they had any experience of fictions connected to science and scientists. These were important preliminary considerations as my interpretation of the research findings and my intention to shape interventions, using stories, to encourage positive impressions of a life in science, did need to take into account the extent of the children's past and present exposure to and engagement with both stories in general and stories involving science and scientists. For these reasons, three initial objectives were defined

A. *to examine how engaged children are with fiction (of any nature)*
B. *to investigate whether children are familiar with science or scientists in fiction*
C. *to explore whether children think they are influenced or inspired by fiction.*

Theory-driven thematic analysis of the data gathered in connection with these research aims and objectives revealed several themes

1: The children are without conscious awareness of science or scientists in literary fiction

2: The children are very much aware of science and scientists in film and television fiction

3: The children are without conscious awareness of the effect of fictions

4: The children believe that real scientists are good people who are motivated to do good in the world

5: Young dynamic scientists in a story would not make the children think about being a scientist – but real science in a story might do so.

Inductive, data-driven thematic analysis of the data also revealed

6: The fictional scientist has a place in the real world

7: The children subconsciously differentiate between 'doing science' and 'being a scientist'
7a: The idea of 'doing science' in the real world
7b: The idea of 'being a scientist' in the real world

8: In the children's minds there exists a real/fictional hybrid scientist.

Before the themes are presented in full, however, the children's own group-written stories that were, at the children's request, performed as small plays in front of the class (instead of being read aloud), are described here. These stories/playlets, six in all, are recounted here in full rather than being attached as an appendix because they embody all that the research aimed toward. They are stories, stories with science and scientists in, made up, in the moment, by children interacting/ transacting with one another from within their own interpretive communities. The children brought to the creation of these stories all that they had learned, accomplished and made meaning of, so far, in life, not least about science and scientists. As such, these stories represent the children's past and present engagement with fictional representations of science and scientists; they represent the research itself.

Also, when sharing and discussing their own, each others' and other stories, the children often spoke about the heroes and villains in the same. In this respect, as it proved difficult to draw the children into speaking more specifically about the similarities and/or differences between the natures of fictional and real heroes, fictional and real villains, and fictional and real scientists, an additional analysis was carried out upon the language – the words and/or phrases – the children used to describe the personalities, desires and actions of four identity types: Fictional Heroes, Fictional Villains, Fictional Scientists and Real Scientists. Respectively, four graphical hierarchies are also presented here and are colour-coded in order to more easily see where the personalities, desires and actions of the four identity types diverge and overlap.

How the children felt about putting scientists into their stories is then examined, and the scientists the children created in those stories are more fully explored.

I thought it important to describe these ideas – that is, the children's ideas about Heroes, Villains and Scientists; about how the children felt about putting scientists into their stories; and about how the scientists in the children's stories turned out – because these ideas do form a background to and do have some bearing upon the themes that arose from the rest of the data.

Part One: The Children's Stories

Cohort 2011's Stories

The children of Cohort 2011 were immediately delighted at the idea of writing a story in their groups but, unexpectedly, during the story planning time, one group of children asked if, rather than reading their story out loud to the class, it would be possible for them to act their story out in front of the class, instead. The rest of the class immediately and whole-heartedly agreed, and the class teacher, too, said she was very happy for the children to do this.

As this seemed to be a very interesting and exciting idea, and as one of the most important ethical aspects of the research was that the children should feel entirely comfortable at all times and should not have to do anything they didn't want to do or had not already agreed to do, a class vote was taken. It was so agreed, by majority show of hands, that the stories be acted out as small plays, instead of being read aloud. The children were asked if there was anyone who didn't like the idea of acting out their stories. Nobody raised any objection. In the event that any child might have been unsure or reluctant to put up their hand to complain or disagree with the class, the children were assured that if anybody did feel uncomfortable about acting in front of the class, then they didn't have to take part. The children were advised that it was important for everyone to feel at ease and to have some fun, and simply joining in making up the story was the most important aspect.

Cohort 2011's three groups of children eagerly wrote and then enthusiastically enacted each of their stories in a freshly prepared space at the front of the class. All the children seemed to very much enjoy writing and/or acting out and then talking about their stories.

Story 1 (2011): The Evil Scientist

> *"…we had a bad guy and a hero" (Cassie)*
> *"…the hero actually died. The hero died and the bad guy won" (Matthew)*

A Narrator [Cassie] stands to one side as she tells the tale: *"One hot blazing day, Andy trekked across the Sahara Desert with the sun blazing down on his head*. [Andy, a boy, wearily trudges along wiping his sweaty brow]. *He was off to find the Evil Grandpa Scientist*. [Frankie, the Evil Grandpa Scientist, laughs wickedly, 'Mwahh, ha, ha, ha!]. *Then suddenly out popped a ninja.* [Ninja Helen pops out]. *And another.* [Ninja Annie pops out]. *And another.* [Ninja Jonah pops out]. *He pulled out his sword* [Andy pulls out a sword (a ruler)] *and tried to kill them.* [Andy fights with the three ninjas]. *He succeeded with only two* [Ninja Annie and Ninja Jonah die] *but the other ran away safely* [Ninja Helen runs away].

He carried on walking to find the Grandpa. [Andy trudges along]. *He then found him in a cave.* [Andy comes across Evil Grandpa Scientist Frankie, sat like a king upon a throne (a chair)]. *The other two ninjas came alive again* [Ninja Annie and Ninja Jonah jump back to life] – *but he didn't know that they were behind him. He pulled out his sword once again* [Andy pulls out his sword] – *but one ninja tried to stop him* [Ninja Helen attacks Andy] *and chopped off his arm* [Ninja Helen chops off Andy's arm, and dies; Andy feigns agony, 'Arggh! My arm!']. *And then another ninja tried – and died* [Ninja Jonah fights Andy and dies]. *And another – and died* [Ninja Annie fights Andy and dies].

Then he did what he was able [Andy tries to run Frankie through with his sword] – *but he didn't succeed* [Evil Grandpa Scientist Frankie pulls out an imaginary gun and shoots Andy] – *and he died* [Andy dies. Evil Grandpa Scientist Frankie laughs maniacally, 'Mwahh, ha, ha!' – then begins to choke; he chokes, chokes… and dies]. *And the Grandpa died of old age. The End."*

Story 2 (2011): The Good Scientist

> *"…[this] was an adventure [story]" (Mary-Ann)*
> *"…the scientist was basically the hero … there wasn't really a bad guy – in fact, there wasn't a bad guy" (Finn)*

Flynn both narrates the story and acts out the story as part of the group; sometimes he pauses in his acting to narrate, other times he narrates while acting at the same time.

Flynn, the 'Guinea Pig Man', a scientist, is piloting a plane carrying his four friends, Callum (a boy) and Rachel, Lorna and Sharon (three girls) and his two guinea pigs, Kyle and Joe (two boys), over Peru to Argentina to get to an award ceremony for his 'great award' for his Laser-Phaser 3000, a device that can turn anything into a guinea pig. Suddenly, the engines fail and the plane crashes into the Peruvian rain forest; the friends and guinea pigs dramatically panic and crash to the forest floor.

Flynn the Guinea Pig Man quickly orders his friends and the guinea pigs out of the plane and hurriedly ushers everyone to safety before leaving the plane himself. Then he tells his friends he has a confession to make: because he expected the journey to Peru to be a short one, he didn't pack any food.

Sharon is outraged – but when Callum suggests that they eat 'those darn guinea pigs … they're doing my head in', she and the guinea pigs protest vehemently. Rachel makes a grab for guinea pig Joe, but Flynn leaps to both guinea pigs' defence and wraps his arms around them to protect them. Sharon rounds upon Rachel and demands that she keep away from the guinea pigs – those guinea pigs are not to be touched!

Flynn so orders Sharon and Callum to go and find 'bugs' to eat. They do so and when the two return they offer the imaginary bugs to Flynn. Flynn stabs their 'big haul' of bugs onto a pencil and offers the haul/pencil to Rachel, then Lorna (each friend taking a single imaginary bite of the pencil). He takes a bite himself and offers the haul/pencil to Sharon, then Callum (who each take an imaginary bite).

He then offers the rest of the bugs to his guinea pigs, 'You can just eat the rest, okay?' Guinea pig Kyle and guinea pig Joe each pick a bug from the pencil – but Lorna swipes the rest of the bugs and gobbles them down, sharing them with Rachel. Flynn is extremely annoyed, 'You've eaten all of them?! Aw, c'mon!' He slams the pencil down, 'This could be a problem…'

Flynn then suggests that everybody follow him into the rain forest to find better shelter. Everybody, friends and guinea pigs alike, does so. As he leads them along, he mutters to Lorna and Rachel, 'I still can't believe you ate all my bugs…'

Suddenly, Flynn spies a river – and then a kayak floating toward them. 'Look! Look! A boat! Let's go!' The friends quickly dive into the boat and take their seats, all as Flynn kindly coaxes and guides the crawling guinea pigs into the boat before him. Taking his seat at the front of the boat, Flynn rows (by himself), 'Heave! Heave!' for over two hours, until, 'Look! A village! That means food! Shelter! And probably a way home! Quickly! Row harder!' At last, his friends start to row.

When they reach the village, Flynn dives out of the boat first, 'C'mon! Quickly! Look!' Sharon, Callum and Lorna dive out of the boat after him; guinea pig Joe crawls off the boat and Rachel gently ushers guinea pig Kyle after them. Flynn points ahead, 'What's that?! It looks like a road! With cars! And there's a hospital! Quickly!' The friends all race toward the road/hospital leaving Flynn to gently guide the guinea pigs after them.

At the hospital, Flynn narrates, they were rescued. They managed to get to Argentina for his award ceremony where he won first prize for his Laser-Phaser 3000. It was, he concludes, 'a pretty dramatic experience'.

Story 3 (2011): The Bit of a Bonkers Bad Guy Scientist

> *"Ours was kind of, erm, like a horror [story]" (Mary-Ann)*
> *"…we had a bit of a bonkers bad guy, but we didn't have a hero" (Nate)*

A (girl) Scientist, Helen, studies her imaginary tablet device with interest. The (boy) Scientist, Nate, asks her what she's doing. Helen shows him her tablet and says, 'I'm looking for some new things. D'you know anything?' Nate says, *'I've heard 'Minions' are quite good. Can you get anything on them?'. Helen duly orders the Minions via her tablet and plops her tablet down.*

Mary-Ann, a Delivery Person, presses an imaginary doorbell upon an imaginary door, 'Ding, dong!' Helen opens up the door and Mary-Ann presents four Minions – Liam, Maisie, Andy and Anne. With delight, Helen takes the large stick (blackboard pointer) that Mary-Ann is carrying, 'Oooh, a beating stick, I guess!' she declares. The Minions shuffle through the door on their knees. Nate takes the stick from Helen, 'Wow. That's a good quality beating stick,' he says admiring the stick.

Helen puts a tip in Mary-Ann's hand and wraps Mary-Ann's fingers around it, 'Here's your tip,' she says, 'Keep it for other things'. Mary-Ann exits, looking at her palm with disgust and trying to shake off whatever imaginary horrid sticky thing has been put there.

Nate points the beating stick at the Minions now kneeling before him. 'Right!', he demands, '<u>You</u> will behave. There are some rules around here. You are not to cry, eat or sleep. Oh, and no annoying sounds. Got that?' The Minions nod. 'Got it,' Minion Liam says, in a faux tiny voice.

'Now,' Nate lords it over the subservient Minions, 'I need you to go to 'Death by Acid'. It's a store on the West Side. Springfield Avenue. I need you to get me some Anti-Gravity Syndrome, okay? And whatever you do, don't <u>drink</u> it. Go!'

As the Minions shuffle away to the store, Mary-Ann reappears. 'Where are the minions?' she asks. 'I sent them out to the shop to buy something,' Nate answers.

In the background, at the store 'Death by Acid', the Minions have obtained the Anti-Gravity Syndrome – and begin to drink it.

Helen, to one side, suddenly realises, 'There wasn't enough minions as I thought. What am I going to do, now?' Mary-Ann replies, 'Well, I could get you another one…' Nate intercedes, 'I'll write to the company…'

Behind Nate's back Helen declares, 'Aah! I have a better idea…' Helen takes Mary-Ann by the shoulders and pushes her to her knees, 'Minion-ify…' she menaces. Mary-Ann becomes a Minion. 'Run along with the others…' Helen orders.

Mary-Ann shuffles off toward the other Minions – but the other Minions, having drunk the Anti-Gravity Syndrome, are now starting to float about in slow motion; they float out of the store.

Nate is reading the tablet, 'The company email said the minion had a tragic, tragic death…' Helen responds with an innocent, 'Ooh…'

All five Minions, humming to the tune of Strauss' Blue Danube[1]*, then float in slow motion toward Helen and Nate. The Minions surround Helen and Nate and oust them from the laboratory – whereupon Helen and Nate, exiting through the imaginary front door, go and hide under a table, Nate waving goodbye.*

Cohort 2012's Stories

The children of Cohort 2012 were also delighted at the idea of writing a story in their groups, and when it was explained to them that the children of Cohort 2011 had asked to act their stories out instead of reading their stories aloud, they too agreed that this seemed to be an interesting and exciting idea.

By majority show of hands, it was agreed that the stories could be acted out as small plays, instead of being read aloud. Again, the children were asked if there was anyone who didn't like the idea of acting out their stories. Again, nobody raised any objection and in the event that any child might have been unsure or reluctant to put up their hand to complain or disagree with the class, the children were assured that if anybody did feel uncomfortable about acting in front of the class, then they didn't have to take part at all. The children were advised that it was important for everyone to feel at ease and to have some fun, and simply joining in making up the story was what mattered most.

Cohort 2012's three groups of children energetically wrote their stories and then they, too, had a great deal of fun and laughter acting each of their stories out in a prepared space at the front of the class.

[1] Strauss II, J. (1866). An der schönen blauen Donau (By the beautiful blue Danube/The blue Danube). Originally performed by the Vienna Men's Choral Association. Dianabadsaal, Vienna. [15 February, 1867].

Story 1 (2012): The Good Scientist

> *"He was kind…" (Joe)*
> *"I think he was benign … but he had a few screws loose" (Jonah)*

A father enters his home and is greeted by his two sons and their (boy) Pet Duck. Son #1 purposefully trips his father up. The Father falls to the floor clutching his knee in (imaginary) agony – declaring that he thinks he's broken his knee.

His wife mutters, "Not again…"

The (boy) Scientist and three daughters gather round in concern – until the Scientist steps forward, brandishes a pencil and in a strange, maniacal voice, asks whether they need his help. The father says, "Yes, please, Sir…" and the Scientist, with sound effects, zaps/Tasers his knee with the pencil.

Everybody present, except the father, says "One, two, three…" and the Scientist zaps the father's knee three more times – whereupon the Scientist declares that the father should be fine, gives him the thumbs up and high fives him.

The father looks to his two sons – and grounds them. They complain, Son #2 saying that it's not fair. The father demands that they go to their room – and they duly skulk off to their room with their Pet Duck following behind them.

In their room, the sons decide to put oil on the stairs. Then do so. Their duck quacks his approval.

Their father, busy chopping vegetables in the kitchen, calls up the stairs wondering what they're doing up there – and when he marches up to investigate, he slips on the oil and falls all the way back down the stairs, badly hurting his back.

His wife mutters, "Not again…"

The Scientist, appearing, helps him into a chair and asks him if he needs his help again. The wife asks the Scientist whether he can "make it five times so it, so he's, he's more stronger?" – but the Scientist says no, readies his pencil and zaps/Tasers the father's back as normal – three times. The Scientist then thinks that he *actually might give the father an extra shot "for fun". The father agrees, so the Scientist pokes him with his pencil – but the father says that it hurt.*

Daughter #1 suggests that the father might've had enough treatment for today – but the wife says, "No." The Scientist thinks about it and agrees.

The father points to the oil on the stairs wanting to know who put it there. The sons lie and blame the wife who says she didn't do it as she was in the kitchen with the father. They blame Daughter #2 instead – then look to blame the Scientist with, "Why are you here, Mad Scientist?" – but the Scientist says that he helped the father – why would he want to hurt him?

The wife blames the cat. The father grounds Daughter #2 – and sends the wife to her room.

Sons #1 and #2 fling their arms around each other's shoulders and start singing 'We are the champions!' [2]. They walk off – their Pet Duck following after them, quacking – but their father grounds them again for breaking his knee.

The wife signals a delighted 'Yes!' with her fist and Sons #1 and #2 fling their arms around each other's shoulders again – and, singing 'We are the losers!' (to the tune of 'We are the Champions' [2]) they exit, their Pet Duck quacking after them.

Story 2 (2012): The Evil Scientist

> *"…[the scientist] was a bit evil" (Jonah)*

Two boys lead Hamster #1 into the (girl) Scientist's laboratory and ask her, "What potion are you doing, today?" She declares that she won't tell them – and hits one of them on the chest with a rolled up piece of paper – whereupon they both fall to the floor and get turned into Hamsters #2 and #3.

Two more boys enter and chase Hamsters #2 and #3 around before rounding them up and shoving them out of the lab.

---

[2] Mercury, F. (1977). We are the champions. On *News of the World* [LP]. London, United Kingdom: EMI & Elektra.

The Scientist then takes the two hamsters off the two boys' hands (by paying them), puts them back in the lab where, when she gives them something to eat, Hamsters #2 and #3 transform back into human beings – to which Hamster #1 yells, "Arrgh! They were giant hamsters! Now they're human! I'm crazy." Hamster #1 then faints. The Scientist and a (boy) assistant drag him to a corner of the lab and leave him there – where he begins to snore loudly.

Story 3 (2012): The Mad Scientist

"Just mad!" (Allen)

A mum and her little boy are playing in their house, next door to which live a (boy) Scientist and his two (boy) assistants. The mum and little boy look to the activity 'next door'...

The Scientist – with a classic evil laugh – declares that he is going to make a potion and decides that the first thing he needs is a tooth.

Assistant #1, flapping his hands/stamping about like a confused minion, gets a tooth and brings it back to the Scientist who slams it into his imaginary handheld vial as Assistant #2 leans against a table pretending to continually drink/be drunk.

The Scientist thinks about what he needs next. Assistant #1 suggests "armadillo bogies" – and the Scientist agrees, shoves his finger up an imaginary armadillo's nostril, gets the bogies out and puts them in his vial.

The Scientist then declares that he needs frogspawn – which he duly gathers and puts in his vial. Then he wonders whether he needs "a cow or something" – and asks Assistant #1's advice. Assistant #1 suggests, "Cow manure!" The Scientist agrees, gathers the cow manure and puts it in the vial.

The Scientist then decides that he needs "The North wind!" – and orders still drinking/drunk Assistant #2 to turn around – whereupon Assistant #2 heaves himself off the table, turns around and pretends to break wind – with sound effects – into the vial the Scientist holds out, positioned for just that purpose. The Scientist thanks Assistant #2 who gets back to drinking/being drunk.

The Scientist wonders what's next for the potion. Assistant #1 suggests "monkey breath?" The Scientist agrees and so asks him to breathe into the vial. Assistant #1 does so.

The Scientist thanks him and decides that he needs one last thing – carbon dioxide. Assistant #2 heaves off the table again, looks to his imaginary drink, shakes his head, shrugs affably and hands his drink over to Assistant #1 who takes a swig – then hands the drink to the Scientist – who carefully, with great concentration, mixes it into his vial.

Meanwhile, next door, the mum and little boy are still playing – when the Scientist yells, "KABOOM!!" – and he and his assistants explode/stagger about – then stumble toward the mum and little boy.

The Scientist approaches the mum with, "Sorry! Erm, I'm the scientist who lives next door. We, erm, we blew up our house. Is it alright if we stay here…?"

The mum says okay – and the Scientist thanks her, says that she's a "life-saver" and hugs her dramatically – but the mum then says that he can stay only if he stops hugging her every time she says something to him. To which the Scientist agrees – and dramatically hugs her again.

Then, the Scientist decides "We'll start concocting that potion again…!" – and says to his assistants, "Evil laughs, people! Evil laughs…" The assistants – and the Scientist – duly laugh evilly, their laughs degenerating, purposefully, into choking coughs – at which the Scientist demands, "Cough drops! Cough drops!"

Heroes and Villains – and Scientists

The children seemed to very much enjoy acting out/sharing their stories and talking about what they liked about each others' stories – especially the funny parts and the endings. It was important, though, to try to further define how the children felt about the characters in their stories and, particularly, the scientists they had created. When asked to think, specifically, about story characters, answers included

> *"There's usually the, sort of, the hero or two heroes or whatever, and they defeat the bad guy" (Mary-Ann)*

"There's always a bad guy" (Nate)

The children recognised that they had a mixture of heroes and villains in their stories and when asked *'What are your heroes or villains like?'* they often mentioned whom the villains and heroes had been (that is, which girl or boy had played which part in their stories/playlets), what they had done, and what had happened to them in the end. It proved difficult to re/frame the question in such a way as to better encourage the children to share how they felt about the *natures* (personalities: kind, evil or crazy, for instance) of the heroes and villains in their stories. Upon one reframing, for example, where the children were asked about the differences between their heroes and villains: *"[H]eroes or villains … so how about differences. How were they different?"* answers referred back to the actual stories again, rather than the characters in them

"Ours was kind of, erm, like a horror, and theirs was adventure" (Mary-Ann)

"There's different startin' and different conclusions" (Liam)

"…everybody thought of different ideas?" (Anne)

The question, or its delivery, might have been too clumsy or not clear enough – or could have been too sophisticated, in the research moment, in as much as suddenly being asked to assign or compare and contrast multiple characters' traits might have felt far too abstract an enterprise for the children. Still, when encouraged further *"[H]eroes and villains … how are they different from one another?"*, answers referred, for example, only to the physical attributes of the characters

"…well, I think our hero and villain were very different because, erm, ours, one of our, erm, there was a grandpa and then a, sort of, 15 year old boy, y'know, so they had about seventy, eighty years of difference" (Matthew)

Upon an alternative reframing, however: *'Were the heroes and villains similar in any way?'* one boy responded

"Erm, the heroes [and villains] … the similarities are that they're both scientists because their bad guy was a scientist and our good guy was a scientist" (Kyle)

Here, although the scientist was mentioned in the context of being a 'bad guy' or a 'good guy', still, what type of person that scientist was, even in recent light of all the personality traits in the characters' personality sheets that the children had worked with, was not spoken about.

In the first instance, then, when speaking about heroes and villains, both the scientist and the non-scientist heroes and villains were labelled, simply, hero or villain; good guy or bad guy. I felt it important to note, however, with respect to the scientists particularly, that just as the non-scientist villain was, simply, 'a bad guy', so too was the scientist villain, simply, 'a bad guy'; the scientist, as a bad guy, was not 'an evil/bad scientist' or 'a mad scientist' but an ordinary generic bad guy… who happened to be a scientist. That is, the scientist was a bad guy by virtue of she or he being a bad person not by virtue of she or he being a scientist.

The children did go on to discuss the nature of the heroes and villains in their own and in other stories in greater depth, together with the nature of heroes or villains in general. When talking about villains in general, the children felt that both scientist and non-scientist bad guys, wanted the same things: power, control, wealth, etcetera. For some of the children, the bad guys' traits seemed comparatively benign

> *"...quite bossy and demanding" (Liam)*

> *"They want to be in charge" (Annie)*

but for other children, the bad guys were more villainous

> *"They also like committing crimes" (Maisie)*

> *"…it's like just something went wrong in their mind when they were a baby, like they banged their head really hard and all they think is crime, crime, crime, murder, murder, robbery, robbery, take over something" (Nate)*

> *Cassie: …all baddies [are], like, mean and evil.*
> *ED: How are they baddies?*
> *Cassie: They try to kill someone or stop someone from doing something…*

> *"They want to try to take over the world and rule" (Jonah)*

Although scientist villains and non-scientist villains wanted the same things and might go about getting those things in similar sorts of ways (by exercising control or coercion of some nature upon vulnerable or unsuspecting people, for example), it felt important to further explore where the children thought 'the scientist' – both villainous and non-villainous; both fictional and real – might stand on the scale/range between 'good' and 'evil' and so, although it was not part of the original research design, the specific words the children used when talking about different types of heroic, villainous and scientist characters, were re-coded and re-analysed.

Cohort 2011 had written and acted out their scientist stories before they shared their ideas about fictional heroes and villains, and fictional and real scientists. Cohort 2012 had not. Cohort 2012 had begun talking about heroes and villains in existing stories before writing or acting out their scientist stories and, as the representation of the scientist in fiction turned out to be scarce, the children did not mention fictional scientists as either heroes or villains. In order that there be no bias against or toward non-scientist villains, then, only Cohort 2011's words were re-coded and re-analysed.

The words and phrases the children used when speaking about the personalities, the desires and the actions of *fictional heroes* and *fictional villains* were first collated.

Figure 5 below, *The Features of Fictional Heroes*, details the features of the heroine or hero characters that the children had spoken about: they have adventurous personalities, no desires of their own (in this instance) but do go out and save both human and animal lives.

Figure 6, *The Features of Fictional Villains*, similarly describes the features of (non-scientist) fictional villains: they have, for example, mean and evil personalities; amongst other things, they want to take over the world and they do go out and commit crimes.

The words and phrases the children used when speaking about the personalities, the desires and the actions of *fictional scientists* and *real scientists* were next collated.

Figure 7, *The Features of Fictional Scientists*, details what the children had to say about the fictional scientists they had, so far, come across: although these scientists could, like the fictional villains, be evil and demanding, they could also be creative and clever; and although they, too, might like to take over the world, they also were capable of wanting to create things, and their actions could be both destructive and creative.

Figure 8, *The Features of Real Scientists*, by far the largest diagram, details all the traits the children used when speaking about real scientists: real scientists could have unadventurous personalities and could be unsocial and grumpy, but they were clever, too, and could be reserved and dedicated. Real scientists wanted to make the world a better place, for example, and could be inventive or creative in trying to protect people and the planet.

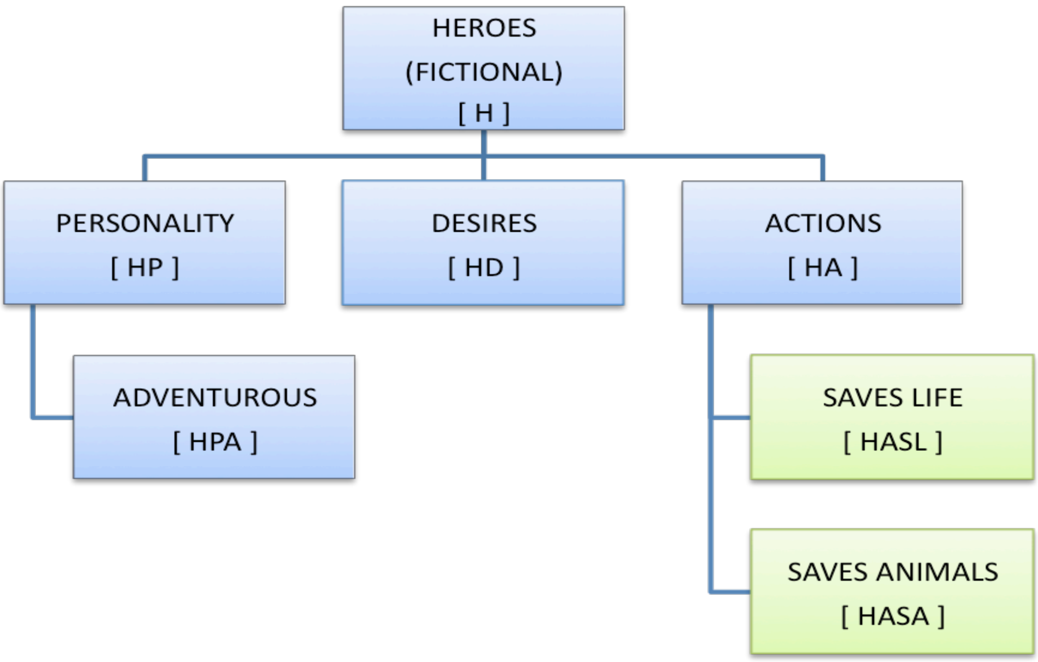

Figure 5: The Features of Fictional Heroes. ***[GREEN colour represents traits Fictional Heroes have in common with Real Scientists]***

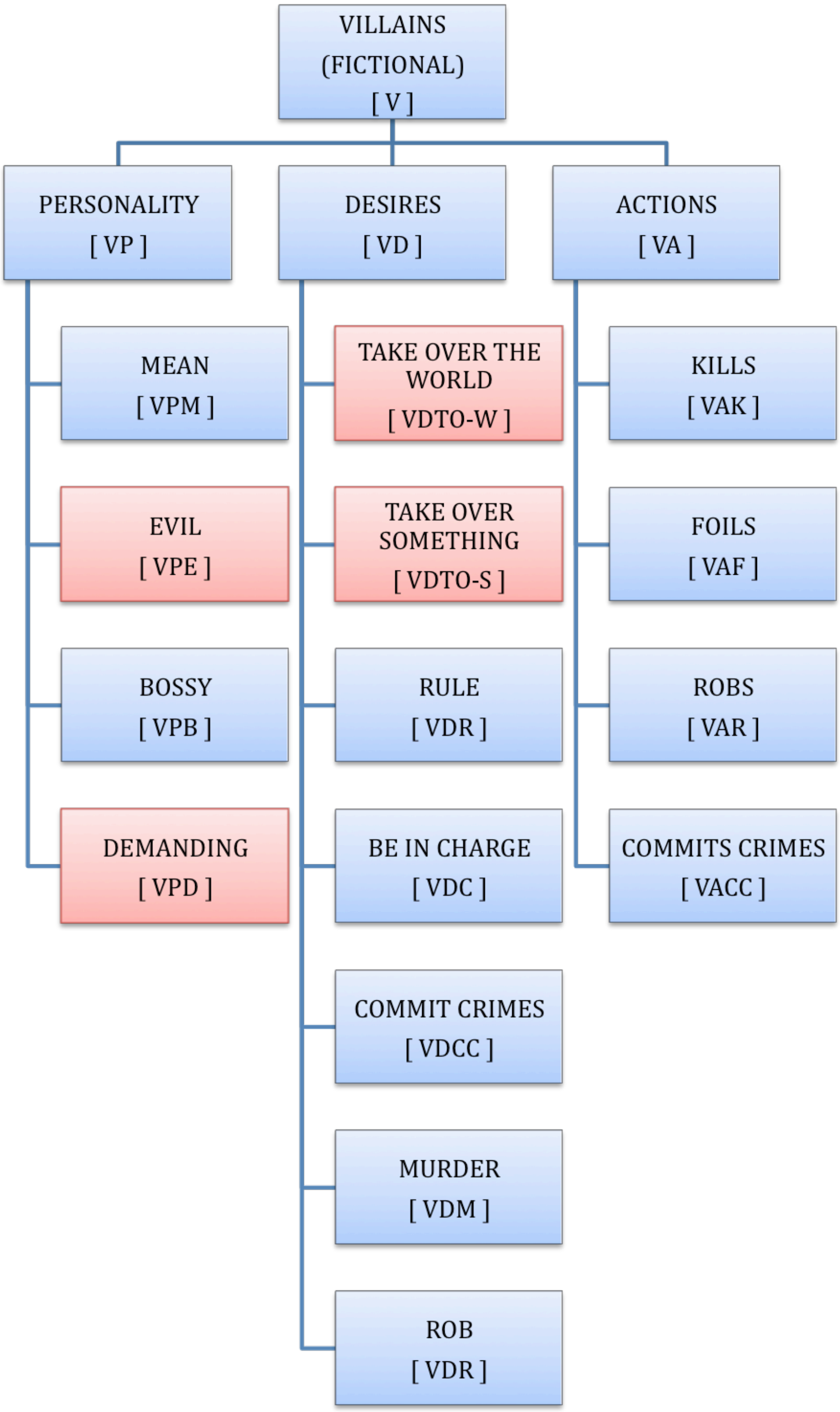

Figure 6: The Features of Fictional Villains. ***[RED colour represents traits Fictional Villains have in common with Fictional Scientists]***

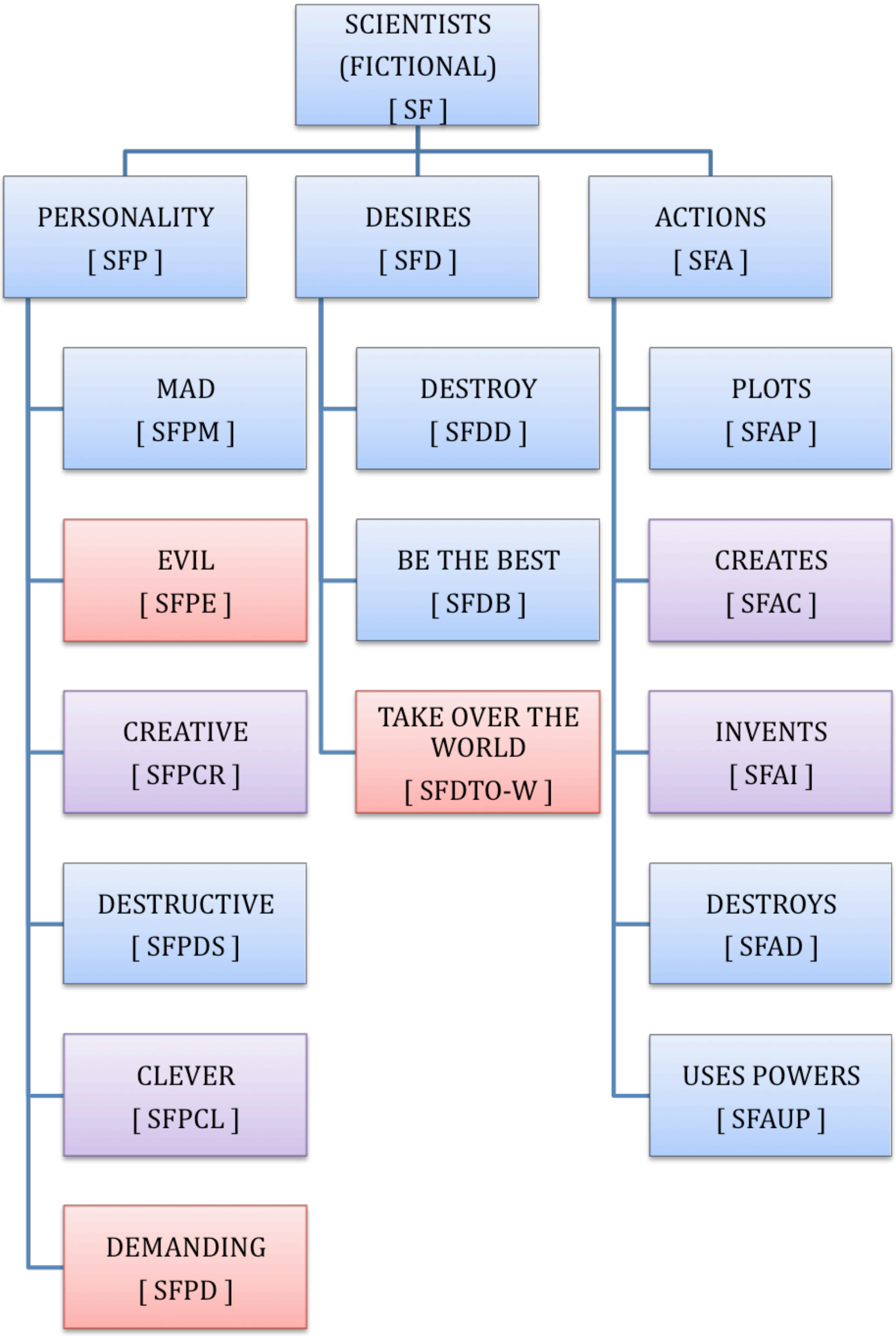

Figure 7: The Features of Fictional Scientists. ***[RED colour represents traits Fictional Scientists have in common with Fictional Villains; PURPLE colour represents traits Fictional Scientists have in common with Real Scientists]***

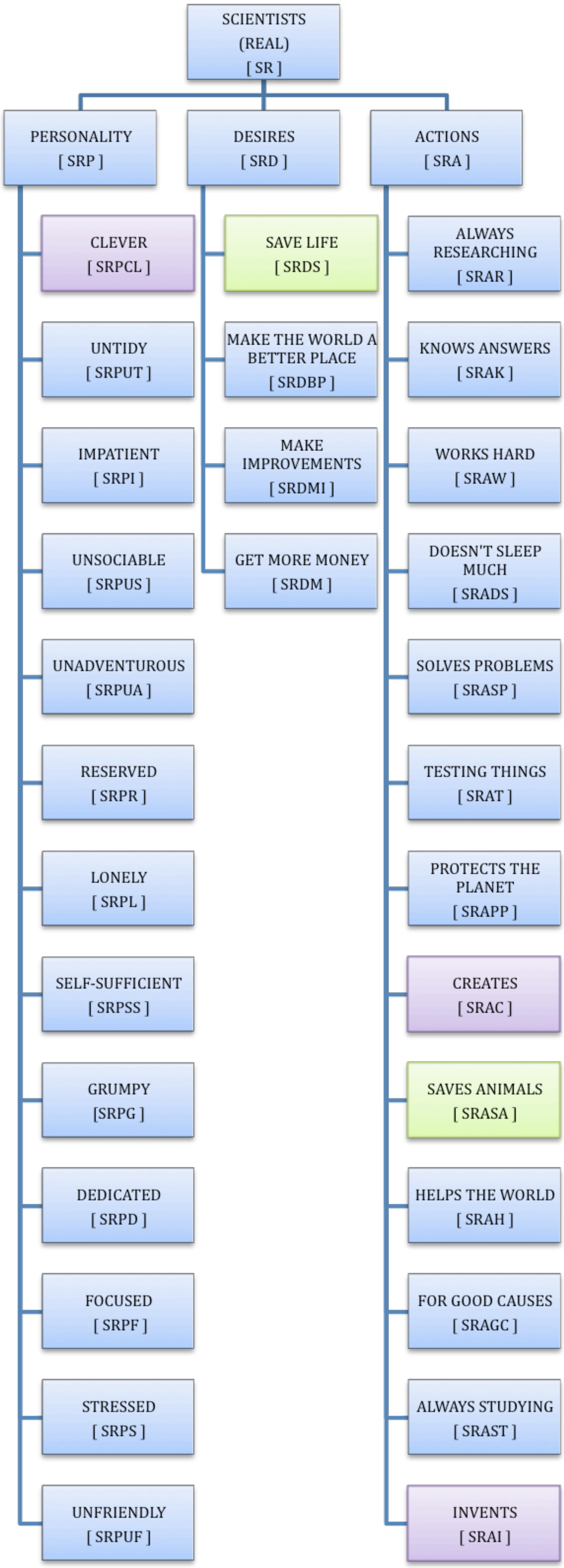

Figure 8: The Features of Real Scientists. ***[GREEN colour represents traits Real Scientists have in common with Fictional Heroes; PURPLE colour represents traits Real Scientists have in common with Fictional Scientists]***

Comparisons of all four character types were then made wherein some similarities and differences became more evident, viz:

Fictional Villains vs Fictional Scientists: In Figures 6 and 7, the words or phrases in the personality, desire and action boxes coloured red represent the exact same characteristics that the children used to describe both fictional villains and fictional scientists: fictional villains and fictional scientists can both have personalities that are 'evil' and 'demanding' and they both might wish to 'take over the world', but that is as far as the commonalities go. Whereas a fictional villain 'kills', 'robs' and 'commits crimes', a fictional scientist, although she or he might like to 'plot' or 'destroy', still might also 'create' or 'invent'.

Fictional Scientists vs Real Scientists: In Figures 7 and 8, words in the boxes coloured purple represent the characteristics that fictional scientists and real scientists have in common: they are both 'clever' types of people who like to 'create' or 'invent'.

Fictional Heroes vs Real Scientists: In Figures 5 and 8, words or phrases in the boxes coloured green represent the characteristics that fictional heroes and real scientists have in common: they both like to save human lives and animal lives.

Fictional Villains vs Fictional Heroes & Fictional Villains vs Real Scientists: there are no coloured boxes representing any characteristics shared by villains and heroes (Figures 5 & 6), or villains and real scientists (Figures 6 & 8): that is, just as fictional villains and heroes have nothing in common, so too do villains have nothing in common with real scientists.

These various comparisons seem to show that the children feel that fictional scientists, who have to be mad, bad or dangerous to know – as it is their being so that makes for an interesting story (see *Theme 6: The fictional scientist has a place in the real world*, below) – still do not murder, rob or commit crimes like non-scientist villains do. Fictional scientists, the children believe, like real scientists, can be clever, creative and inventive people, and real scientists, having nothing in common with fictional villains, are better associated with fictional heroes (saving human and animal lives).

Hence, when thinking about the scientist in fiction, although she or he is likely to be evil, mad or villainous in order to make for that interesting or exciting story, she or he is only usually just that: villainous rather than murderous; and for the children of Cohort 2011, the bad guy scientist, unlike the bad guy non-scientist, was never explicitly described as a murderer, a thief or a criminal. Hence, it seemed that in comparison to the non-scientist villain, the scientist villain was still a relatively 'benign' sort of person.

The Idea of Putting Scientists into Stories

The children's recall of film and television series stories about science and scientists, and their enthusiastic recounting of some of their favourite science fiction film, television or cartoon story scenes, did suggest that the children were very familiar with and excited by science and scientists in fiction (see *Theme 2: The children are very much aware of science and scientists in film and television fiction; Fictional Scientists*, below).

Despite enjoying science and scientist fictions, however, when I asked *'When you knew that one of the characters in your story had to be a scientist, how did that make you feel?'* the overwhelming majority of the children agreed that the idea of putting a scientist into one of their own written stories would not have occurred to them. In Cohort 2011, for example, one child felt

> *"Erm, like, with the scientist, erm, we would've never thought of it if we didn't get to do the [personality] sheet and we didn't know there was a scientist and we would've never have had it in a story" (Lynne)*

By majority show of hands, the children of Cohort 2011 agreed that they would never have thought of putting a scientist into a story. It is likely, however, that the children might never have thought of putting any number of other professions into a story, either – an artist or an electrician, for example – and when asked, *"Okay, so, who would have thought of putting a scientist in a story?"* only three children (all boys) raised their hands.

For the children of Cohort 2012, when presented with the idea that one of the characters in their story had to be a scientist, feelings were mixed. When asked *'When you found out you were going to have to have a scientist in your story, how did that make you feel?'* the children wrote down how they felt:

"…quite excited; happier; exsited; a bit nervous; a little nerverse and also a little crazy and bonkse; a littel bit confused; xsiting; quiet happy; challenged; very intreaged; excited; a mixture of lots of imotions; unhappy because I don't like scientists; [it would be] funny; emazingly happy; amazing; happy; happy; happy; [it would be] funny; okay; happy; happy; happy" (24/25 Children of Cohort 2012)

These feelings collated to

Negative Feelings		
(unhappy; nervous; confused)	=	*4*
Neutral Feelings		
*(okay; challenged; intrigued)**	=	*4*
Positive Feelings		
(intrigued; amazing; funny; excited; happy)	=	*16*

* 'mixture of lots of imotions' allocated here

Despite counting feelings like 'okay', 'challenged' and 'intrigued' as non-happy feelings, still two thirds of the children felt happy to incorporate a scientist into their stories. Only 4 out of 24 (17%) of the children had negative feelings.

Hence most of the children had few or no qualms about weaving a scientist into their stories. When invited to share why they felt the way they did about putting a scientist into their story, Jacob, for example, explained

"What intrigued me with what we were going to do [was] when you said the woman and child, I thought: Okay, now that's just like a normal story – but when you said the scientist that made me more like: 'Oh, that's going to be even more fun…'" (Jacob)

Some children felt that

"…with scientists you can basically do anything with them" (Flynn)

Bobby: I thought it'd be a lot funnier

ED:	*Be a lot funnier? Why's that?*
Bobby:	*Erm, because some scientists are usually a bit crazy and, like, they have big [demonstrates] pointy-up hair.*

and others felt that having a scientist in their story would make for

"…a clever story" (Jaike)

Kate:	*Er, a bit more cheery [story]…*
ED:	*Cheery?*
Kate:	*'Cos scientists cheer up the place…*
ED:	*How do scientists cheer up the place?*
Kate:	*They'll all crazy and everywhere and thinking of different things.*

Only one child (from both cohorts), Joe, offered an explanation as to why he was reluctant to put a scientist into his story; his explanation was, with the best of intentions, interrupted by the teacher who then, perhaps, led Joe away from what he was originally going to say. Joe's explanation and the teacher's interaction are included here in full because Joe's remarks are pertinent and the teacher's remarks could be seen to reflect how an adult might perceive a child's reluctance to put a scientist into a story:

Joe:	*It made it a bit harder.*
ED:	*It made it a bit harder. Now, why, why is that?*
Joe:	*Because if the, 'cos you don't really <u>use</u> scientists in stories.*
ED:	*You don't really <u>use</u> scientists in stories. No? Why d'you think that is?*
Joe:	*Because it's, it might be because it's harder to <u>use</u> scientists…*
ED:	*In what way is it harder to use a scientist in a story?*
Joe:	*Because, erm, it's not like a normal person. It's like, it's, it is like a normal person that's like…*
Teacher:	*D'you think they have to use big words? Be a bit cleverer?*
Joe:	*Yeah…*
Teacher:	*Is that what puts you off?*
Joe:	*Yeah…*
Teacher:	*That's what he's trying to tell you…*

Although it could be argued that the teacher knew Joe better than I did and believed that he was worried about having to use 'big words' when putting a scientist into a story, the contributions that Joe had already made that day had been both confident and eloquent. Joe had, for example, made the suggestion that stories might need 'a moral'; he had also happily contributed to and acted out an entertaining group story with a scientist in it, and indeed Joe was the only child willing to offer an explanation for his reluctance to put a scientist into a story. The teacher's remarks are interesting in as much as they could be seen to imply that the (adult) world regards scientists as 'cleverer' than 'normal' people – and/or that perhaps the writers of stories with scientists in them, children and adults alike, might so have to be 'cleverer' than 'normal', too.

The Scientists in the Children's Stories

When I admitted to the children of Cohort 2012 that *'I was actually interested in <u>one</u> character … in each of the stories. Can you guess which character I was really, really interested in?'*, only one child responded

> *"Was it the scientist?" (Jonny)*

When I asked who else thought that it might be the scientist that I was interested in, out of the remaining 24 children (the 25 children comprising 9 girls and 16 boys), 7 children raised their hands: 3 girls and 4 boys.

Cohort 2012's stories were, of course, very different from those of Cohort 2011. However, the range of scientists in the stories of both cohorts seemed to be similar in that

> *"…one's kind of evil, one of them's just barking mad and the other one's quite kind" (Bobby – Cohort 2012)*

> *"…we had a bit of a bonkers bad guy … then there was an evil one and a nice one" (Nate – Cohort 2011)*

The children of Cohort 2012 were so asked to think about the scientists in their stories. They were asked to think about *'…the way they were; they were kind, or they were evil, or they were plain mad…'* and then the children were asked *'Is that how you expected them to be?'*

Initially, the children gave answers that implied that the scientists in their stories were a reflection of real life scientists

Allen: *Yes, [they are all different] because … all the scientists in the world are different.*

ED: *All the scientists in the world are different. Why? What makes you say that?*

Allen: *Everything, everyone has something that, everyone has something different about them that someone else doesn't.*

"Most scientists are different because there's different types of scientists…" (Cathryn)

Lucy: *Well, every scientist is different because they've got, like, different brains – and they've got more knowledge in their brains and stuff like that.*

ED: *Right. Yeah. So … why d'you think that is?*

Lucy: *Because they're all different. Because I don't look like you – and they won't look like anyone else.*

Some answers, however, within the context of what we had been discussing and what had already been said, seemed to seamlessly confuse – or fuse – the idea of a fictional scientist with the idea of a real life scientist. Jonny, for example, began speaking about (fictional) scientists in stories and then, I felt, seemed to glide into thinking/speaking about real life scientists, thus:

ED: *…any more answers about the scientists in your stories? [Were they] how you expected them to be?*

Jonny: *Kind of, yeah … because, erm, scientists [in stories] are normally mad … or evil.*

ED: *Why … d'you think scientists are always mad or evil?*

Jonny: *Because they, they might've been born like that.*

ED: *They might've been born like that – that's a good answer, yeah. Any other reason, you think?*

Jonny: *They, they might just want to be different from other people.*

ED: *They want to be different to other people, that's interesting, yeah. Why would they want to be different, d'you think?*

Jonny: *Because the, the world needs different kind of things.*

This thinking/speaking about fictional scientists (*'scientists [in stories] are normally mad … or evil'*) apparently effortlessly transforming into thoughts/words about real scientists (*'[scientists] might just want to be different from other people … because … the world needs different kind of things'*) occurred often, and is more fully explored in Theme 8: *In the children's minds there exists a real/fictional hybrid scientist*.

Other answers, however, appeared to refer to the notion of purely fictional scientists

> *"…no – because I expected all of them to be, like, evil or mad" (Alfie)*

> *"…you don't really expect it because when you think scientist you imagine them in an evil lair or something, making things happen, so you don't really expect a kind one…" (Amie)*

With Cohort 2011, however, perhaps it was because the children had discussed the nature of heroes and villains before talking about the scientists in their stories that, when I asked the same question *'Is that [mix of scientists – evil, mad and good] what you would expect?'*, the role – or story convention – of 'villain' was immediately mentioned, and the (fictional) scientists spoken about in this vein remained purely fictional

> *"Well, I do expect them all to be villains because, erm, scientists, if you think you've got a scientist in the story it's normally going to be a mad scientist or a, y'know, evil guy who's working up evil plans to destroy the world. That sort of thing…" (Andrew)*

> *Nate: Erm, basically, when I think of scientists I think mad, evil. Creates things and destroys things and then…*
> *ED: Why do you think that?*
> *Nate: Erm, because they're so clever, they can just invent anything and then destroy it up front.*

Some of the children of Cohort 2011, however, also confused/fused the idea of fictional scientists with the idea of real scientists and, again, within the context of what was being discussed, the line between fictional and real scientists seemed to be blurred

> *"…if you, like, put a [mad] scientist … in one of the stories then it's probably likely that it's gonna, that he's gonna, like – or she – is going to become famous because of his inventions and stuff … I think it was, like, Marie Curie or something…" (Mary-Ann)*

Because of the blurring between what was real and what was not real, it often became important to re-establish exactly which type of scientist, that is, real or fictional, we were talking about. Hence questions organically arose as to the nature of real scientists in the real world, what those real scientists do in the real world and why they do those things. How the children felt about real scientists is explored below in Theme 4: *The children believe that real scientists are good people who are motivated to do good in the world* – wherein we can see how the children's good and mad-benign story scientists' actions and motivations reflect as much.

Part One: The Children's Stories – Conclusion

Although for most of the children the idea of putting a scientist into a story they were making up would not have occurred to them, when required to do so, the majority of children felt positive and happy about it.

Some children thought that putting a scientist into a story would be, for example, *'even more fun'* than making up *'a normal story' (Jacob)*. Only one child from both cohorts volunteered his reluctance to put a scientist into a story, feeling that doing so made the making up of the story *'a bit harder … 'cos you don't really <u>use</u> scientists in stories' (Joe)*.

The scientists in the children's stories presented a quite even mix between good, bad and mad/crazy. The scientists in Cohort 2012's stories comprised one good scientist (a boy), one evil scientist (a girl) and one crazy but benign scientist (a boy). The scientists in Cohort 2011's stories comprised one good scientist (a boy), one evil scientist (a boy) and a pair of scientists (a girl and a boy) who, although only one of the team was termed *'a bit of a bonkers bad guy' (Nate)*, were both thought of as being crazy and were deemed mad-malign as opposed to mad-benign.

Re-coding and re-analysis of the words and phrases the children of Cohort 2011 used to describe the characteristics of four identity types – Fictional Heroes, Fictional Villains, Fictional Scientists and Real Scientists – revealed that real scientists, having nothing in common with fictional villains, were better associated with fictional heroes – both real scientists and fictional heroes liking to save lives; and, like fictional scientists, real scientists were clever, creative and inventive people.

The children's scientists: reflection, part reflection, and no reflection of real scientists

When the children were asked whether the scientists in their own and each others' stories turned out how they expected them to be, the children gave a variety of answers. Some answers suggested that the children thought their scientists were a reflection of real life scientists; some answers suggested their scientists were a fictional/real scientist hybrid; and other answers suggested their scientists were not at all a reflection of real life scientists in as much as their being deemed 'evil' or 'mad-malign' suggested they were thoroughly fictional.

This noticeable confusion – or fusion – of the idea of the fictional scientist with the idea of the real scientist arose often and sometimes to such an extent that moments had to be taken to clarify whether the children were thinking and talking about real scientists or fictional scientists. The idea that for a lot of the children there did exist a 'hybrid' real/fictional scientist is explored below in Theme 8*: In the children's minds there exists a real/fictional hybrid scientist*.

Part Two: The Themes

Theme 1: The children are without conscious awareness of science or scientists in literary fiction

After Cohort 2011's own stories had been written and shared, the children were encouraged to share their thoughts and feelings about what sort of things they felt were important in *any* story.

The structure of stories was discussed, in that stories have a beginning, a middle and an end; a story's inciting incident, its first, second and third act, its climax and its ending were spoken about. I was hoping that the children would begin to talk about the characters in (their own, the others' or other) stories without my specifically asking (which I, eventually, had to do: see *Heroes, Villains – and Scientists*, above), yet, despite having just interacted with character personality sheets and written, self-directed and acted out their own stories some minutes earlier, even when asked *'…when you're thinking about stories … what other things do stories have?'* story characters were overlooked and some children, perhaps because they had recently, that academic term, been concentrating hard upon their Literacy lessons, suggested things like adjectives, adverbs, connectives and the use of the correct punctuation as being important.

It is likely that the question was not being asked in a clear enough way as, when more specifically encouraged to share their ideas about the nature and the content of stories, *'What else is it that stories have…?'*, though the children still did not speak about the presence of any characters, they had many ideas about what a story needs, for example

> *"Comedy…" (Pip)*

> *"Adventure…" (Matthew)*

together with more abstract necessities like

> *Frankie: …they might, sometimes, might need you to not know what's going to happen next.*
> *ED: That's right: suspense. Yes.*

> *"Tension…" (Andy)*

> *"Maybe, it [needs] a moral…" (Joe)*

Cohort 2012, talking before any mention of science or scientists in stories was made, shared their thoughts about a great variety of stories, plots, themes – and characters. When asked *'What's your favourite type of story? Has anyone got any favourite stories?'*, the children named some of their favourite books

> *"Diary of a Wimpy Kid"* [3] *(Brady)*

---

[3] Kinney, J. (2007). *Diary of a wimpy kid (Diary of a wimpy kid series: Book 1).* New York: Amulet Books.

"Hetty Feather" [4] *(Cathryn)*

Some children remembered a story but couldn't recall the name of it

"Er, there's a book, there's two books, erm, a book I've read and it's called, erm, The Slug, The Purple Sluggy Slug or something…" (Joey)

"Oh. Oh, yeah, in, in World War Two, I was, there was, there's someone that wrote a book but I've forgot the name… (Archie)

Some children named the author of the story alongside the story's title

"Michael Morpurgo, Born to Run" [5] *(Amie)*

"The Guard Dog by Dick King Smith" [6] *(Lorna)*

Others named the author alongside her or his associated books series, without reference to any specific book in the series

"Erm, J. K. Rowling and the Harry Potter series" [7] *(Finn)*

"Erm, there's a set, there's a set of books, erm, by someone called Pseudonymous Bosch and they come from America. And it, it's, erm, The Secret Series" [8] *(Jaike)*

Some children naming the author alongside the book series also wanted me to know – or were absolutely determined to tell me – exactly what the books in the series were all about

---

[4] Wilson, J. (2009). *Hetty Feather (Hetty Feather series: Book 1).* London: Random House.

[5] Morpurgo, M. (2007). *Born to run*. London: HarperCollins Children's books.

[6] King-Smith, D. (1991). *The guard dog*. London: Young Corgi.

[7] Rowling, J. (1997-2007). *Harry Potter. (Book series – 7 books).* London: Bloomsbury & New York: Scholastic.

[8] Simon, R. (as Pseudonymous Bosch). (2007-2011). *The secret series. (Book series – 5 books).* New York: Little, Brown Books.

Philip: *"…there's this set of books by someone called Joseph Delaney … it's teenage fiction and it's set in, I think, it's Stuart times … some English counties [are] mashed together, kind of, and it's about someone who goes around ridding the county of things that go bump in the night and he takes on an apprentice, and the apprentice is writing in first person, erm, but it's in past tense and he's, erm, writing it from, erm, the notebooks he's kept and where they have to destroy this big, erm, enemy but they have to destroy lots of other, erm, creatures of the dark beforehand…*

ED: *Is that The Spook's Apprentice?* [9]

Philip: *Yeah, yeah. And there's quite a lot to it…*

Then, perhaps on account of the way semi-structured group interviews with children naturally progress, when one child named just an author

"Roald Dahl" (Laura)

so, too, did other children begin to name just the authors

"Anne Fine" (Joe)

"Anthony Horowitz" (Jacob, Donnie)

"The writer who wrote the Captain Underpants…" [10] *(Alfie)*

The children then began to name authors as a question; that is, the children seemed to be trying to call authors to mind, rather than trying to recall their favourite stories

"Jeremy Strong?" (Allen)

"Jacqueline Wilson?" (Alfie)

---

[9] Delaney, J. (2004). *The spook's apprentice (The Wardstone chronicles series: Book 1)*. London: The Bodley Head.

[10] Pilkey, D. (1997-2015). *Captain Underpants. (Book series – 12 books)*. New York: Blue Sky & Scholastic.

The children of Cohort 2012 also gave lots of answers that very much tied in with Cohort 2011's genre-oriented and genre-specific ideas about what a story needs. The children of both cohorts enjoyed, for example

> *"comedy…" or "funny stories…" (Donnie, Brady, Katie, Jack, Cooper, Allen, Julie, Brody)*
>
> *"crazy … unusual … mad stories…" (Joe)*
>
> *"mystery stories…" (Dane, Cathryn)*
>
> *"scary…" or "horror stories…" (Donnie, Cooper)*
>
> *"adventure stories…" (Jacob, Laura)*
>
> *"gripping stories…" (Finn)*
>
> *"…fantasy…" (Terry)*

together with non-fictional stories, like

> *"…football magazines…" (Jacob)*
>
> *"Horrible Histories…" [11] (Lynne)*

When asked more specifically *'How about your favourite type of character. Is there any particular character that you like?'*, the children's ideas seemed to be consistent with their preferred genre-type, for example

Comedy characters

> *"funny…" (Donnie, Katie, Alfie, Cooper, Jacob, Julie)*
>
> *"a comedian…" (Allen)*
>
> *"funny and silly…" (Brody)*

---

[11] Deary, T., Hepplewhite, P., & Tonge, N. (1993-2013). *Horrible Histories. (Book series/franchise – 60+ books)*. London: Scholastic.

Crazy characters

"crazy…" (Jaime)

"crazy and mischievous…" (Joe)

Amie: *Crazy characters.*
ED: *…what sort of crazy characters?*
Amie: *Erm, ones that make you laugh…*

Detective and mystery characters

"I like mystery characters, like detectives, sort of people…" (David)

"mystery…" (Cathryn)

"…when they're all mysterious and stuff…" (Lorna)

Scary characters

"scary…" (Cooper)

"spooky…" (Terry)

Real people

"Wayne Rooney, Danny Welbeck…" (Jacob)

Some children identified more abstract character preferences: complex characters, for instance

"A character that doesn't really make sense" (Flynn)

"I like characters that aren't so complicated that you can't, erm, figure out what they're actually doing … but … they're quite complicated" (Andy)

and especially underdog or lonely characters who were always mentioned by name (and who were all animals)

"I like the Guard Dog[6], erm, because he's small and everyone thinks he's a hamster that's in the wrong pen in the pet shop…" (Amie)

Jennie: *I like Badger from Wind in the Willows.[12]*
ED: *Why d'you like him?*
Jennie: *I like him because he's all alone, and he's just in the woods, trying to survive.*

"I like Joey off War Horse – the horse…" [13] (David)

Not many other characters were mentioned by name

Brody: *Erm, I think, Diary of the Killer Cat.[14] Erm, the cat, Toffee…"*
Class: *Tuffy!!*
Brody: *(Laughs) Tuffy!*

"Horrid Henry" [15] (Jonny)

– although Horrid Henry (and Hetty Feather[4] and Harry Potter[7], mentioned under favourite stories) are eponymous characters; that is, whether the children were speaking about the character itself or a specific book the character was the protagonist/title character of, is unclear.

Theme 1: Conclusion

The children of both cohorts seemed very much engaged with both the mechanics (the grammar, structure and punctuation) of writing stories and with the substance (the nature and content) of stories. They seemed willing and happy to talk about what sort of things they felt were important in any story. They shared their ideas about the story genres they enjoyed (comedy, mystery, adventure, fantasy, for example), their favourite type of story characters (funny, scary, crazy, underdog, for instance) and their favourite writers (J.K. Rowling, Anthony Horowitz, Anne Fine, amongst others).

---

[12] Grahame, K. (1908). *The wind in the willows.* London: Methuen.

[13] Morpurgo, M. (1982). *War horse.* London: Kaye & Ward.

[14] Fine, A. (1994). *Diary of a killer cat.* London: Hamish Hamilton.

[15] Simon, F. (1994-2015). *Horrid Henry. (Book series – 24 books)*. London: Orion Books.

The children of both cohorts, however, never once referenced any stories that contained a scientist or scientific content of any nature. That is, they did not reference any science oriented stories ('stories about space', 'stories set in the future', for example) or any genre-specific stories ('Science Fiction' stories, for instance); nor did they speak about any scientist-type characters they may have brought to mind, favourite or otherwise – and this was despite the 'alternative dynamic' that had been applied to the start of the first day session with Cohort 2011, wherein Cohort 2011 shared their ideas about stories in general *after* they'd written and shared their own science and scientist stories (Cohort 2012 having shared their thoughts about stories in general *before* scientist stories were ever mentioned; see *Chapter 5 – Method; Conducting the Fieldwork; Mistake/Alternative Dynamic*). That is, having just created science and scientist fictions of their own – having thought up fictional scientists' personalities, written about them, acted out and shared their ideas about their own and each others' science and scientist fictions – the children, when called upon to think about stories and story characters in general, did not once mention science or scientists in fiction.

It appeared that although the children were very much engaged with literary fiction, they were unfamiliar with literary fiction that embraced science or scientists – or were unfamiliar with or subconsciously unwilling to engage with such fictions; or had not seen science or scientists as categories of definition – to such an extent that these sorts of stories were not brought to mind and/or volunteered in the research moment and so were not discussed alongside the rest of the stories.

I did not think that the children were unwilling to engage, however. I felt sure that had the children been knowledgeable about stories about science and scientists and these sorts of stories had come to mind in the research moment, the children would have had no hesitation in bringing them up and including them in some of our discussions – and this idea is endorsed when the children were specifically asked to speak about science and scientist fictions, wherein they did so with great enthusiasm (see *Theme 2: The children are very much aware of science and scientists in film and television fiction*, below).

Hence it seemed that the children lacked a conscious awareness of science or scientists in literary fiction. It could also be that Cohort 2011 did not 'forget' their own science and scientist fictions but when coming to think about literary stories in general and/or about writing their own (general) stories, the thought of writing about fictional science or fictional scientists didn't cross their minds – as *The Idea of Putting Scientists into Stories*, above, attests.

The finding of this lack of awareness went far toward achieving objective A, *to examine how engaged children are with fiction (of any nature)*: the children were very well and very enthusiastically engaged with general fictions of many genres, but not with science or scientist oriented fictions.

It was important, therefore, to clarify whether or not, or to what extent, the children did possess an awareness of science and scientists in existing stories.

Theme 2: The children are very much aware of science and scientists in film and television fiction

The first two questions the children were asked in pursuit of objective B, yielded very similar answers to the first two questions the children were asked in pursuit of objective A, viz:

Objective A Schedule

> *What's your favourite type of story?*
>
> *"scary…" or "horror stories…" (Donnie, Cooper)*

Objective B Schedule

> *If you were to make up a story of your own, what type of story would it be?*
>
> *"…it'd be, like, scary…" (Donnie)*

Objective A Schedule

> *What's your favourite type of character?*
>
> *"…crazy…" (Julie)*

Objective B Schedule

> *Who would be in [that story you'd like to make up]?*
>
> *"…someone who was a bit mad and crazy…" (Amie)*

It seemed obvious, after the event, that these questions, although different, would yield the same or similar answers. That's not to say that 'favourite' stories are the same or same type of stories that children would 'like to make up'; a child might enjoy reading complex detective or mystery stories, for instance, but when making up or writing their own stories might prefer creating less complex, or differently complex, slapstick or funny stories. However, in looking to find evidence of the presence of science and scientists in the children's thoughts about stories that, in the first instance, they were aware of and that, in the second instance, they might like to create, the children's answers served to reinforce objective A's findings that, although the children were very much engaged with fiction, they did not seem familiar with the presence, or potential presence, of science or scientists in the same.

One question in Interview Schedule for Semi-Structured Group Interview No. 3 (in pursuit of the second research aim), however, yielded data well suited to the pursuit of objective B: *'Can you name any real or fictional scientists?'* spoke directly to the pursuit of objective B as asking for the names of fictional scientists was an explicit request to determine whether or not the children were familiar with science and scientists in fiction, albeit alongside a request to think about real science and scientists, as well.

Despite being asked to give examples of real or fictional scientists, however, the children of both cohorts, at first, only gave examples of real scientists. Fictional scientists were not mentioned at all. Whether this was again on account of the way semi-structured group interviews with children might naturally progress, whereby one child, first to speak, named a real scientist and the others simply followed suit, is unclear.

Real Scientists

The children's ideas about real scientists were usually framed within a question

> *"Was Einstein a Scientist?" (Joe)*

> *"Was Neil Armstrong a sort of Scientist?" (Damian)*

> *"Was Leonardo Da Vinci a Scientist?" (Matthew)*

"Er ... Thomas Edison?" (Mary-Ann)

"I'm not sure about this one but was Ben Franklin a scientist?" (Missy)

"Isn't Stephen Hawking a scientist?" (Alfie-Jack)

"Are N.A.S.A. scientists?" (Jonny)

Flynn: Ooo! Erm, Albert Newton?
ED: Yes. Newton. Isaac. Isaac Newton.

"I've forgotten his name … he's a Greek philosopher; could philosophers be scientists?" (Finn)

and were rarely stated as fact

"Charles Darwin" (John)

In some instances, the children were aware of the science but couldn't recall the scientist

Jonny: Who was the person that the apple moved?
ED: Newton…

Whereas other children knew the name of the scientist but were unsure of the relative science

"Was it Alexander Bell who did the telephone?" (David)

"Erm, did Charles Darwin go out on a ship and [find] loads of species?" (Pip)

Laura: Erm, you know Brian Cox?
ED: Oh, yes…
Laura: What kind of science does he do?
ED: He's a cosmologist. A physicist.

The question was raised as to whether or not mathematics was considered a science

Flynn: *Erm, I've forgotten the name of it but there's an equation and it's something like ABC and I've forgotten the actual name of it…*

ED: *Pythagoras' theorem?*

Teacher: *Is that Pythagoras?*

Flynn: *Yeah, Pythagoras' theorem.*

ED: *'A' squared…*

Teacher: *That's maths.*

ED: *…plus 'B' squared equals 'C' squared?*

Flynn: *Is that mathematicianal?*

ED: *Yes – but I think a mathematician might be a scientist, don't you think?*

Teacher: *Yes.*

Some examples of scientists were connected with subjects that the children had studied in school, most often with the stories they had heard and studied in their History lessons

"…the Egyptians they, erm, figured out, they, they figured out <u>part</u> of the universe 'cos they, the pyramids lined up to a star that the pharaoh was, or something like that, was buried under and it all, and it all had to do with astronomy and would most of the pyramid builders or pyramid designers, architects be, like, scientists?" (Pip)

Alfie: *I'm not sure of his first name but he was a man in World War Two. His last name was Browning and he invented the Browning machine gun … and I think he was a scientist.*

ED: *John Browning, yes…*

Frankie: *We did that one who sat in the bath once and how the water went up.*

ED: *Archimedes. Yes. Eureka!*

Joe: *That's the one I was going to say…*

Other examples of real scientists, although not explicitly studied in school, were also given, together with the real stories behind these real people

Finn:	*I'm not exactly sure who did it but in World War Two – the invention of the nuclear bomb, how they, the race to make the nuclear bomb between German and American scientists…*
ED:	*Oppenheimer … the Manhattan Project.*
Finn:	*Yeah…*

– albeit some of the stories were chronologically and/or factually incorrect

Andrew:	*Erm, I can't remember his name but, erm, by the 18th, 17th century there was this person and he worked out loads of things, like … that the earth was round … no, that the earth turned and the sun didn't. I can't remember his name…*
ED:	*Copernicus?*
Andrew:	*Yeah, Copernicus.*
ED:	*Nicolaus Copernicus. Yeah. Heliocentricity – the earth revolves around the sun…*
Andrew:	*And, and he worked out loads of things that they didn't work out for another 100 or 200 years – and the reason he didn't tell anybody was because he would've been sent to jail or something or, or burned at the stake because, erm, there wasn't, because they believed in so much religion that it was, sort of, against the law.*
ED:	*That'd be Galileo…*
Andrew:	*Galileo, yeah…*

Then there was the question of whether 'an inventor' was a scientist

"Was Alexander Bell an inventor ... or a, or was he a scientist?" (Andy)

Brady:	*Erm, this may be an inventor again but the person who invented the first steam train that moved by itself, erm, something…*
ED:	*Stephenson…?*
Brady:	*Something Stephenson…?*
ED:	*Stephenson's Rocket?*
Brady:	*Stephenson's Rocket!*

Or whether an 'explorer' or an 'adventurer' was a scientist

> *"Erm, wasn't there also [someone] that tried to sail off the edge of the earth ... because he was told it was flat? Was he a scientist?" (Frankie)*

The children also mentioned real scientists they had seen within non-fictional televisual and digital programming. For example, on television

Brainiac: Science Abuse (Tickle & Rowntree, 2003 – 2008). Rated 12.

> *"There's this show called Brainiac Science Abuse … and they figure out stuff that's never been done before, like, they've walked on custard..." (Andy)*

> *Jacob:* *…is Richard Hammond kind of a scientist 'cos he does, like, 'cos he does, like, all those, erm, science things on TV and stuff?*
>
> *ED:* *I don't think he is a scientist himself … he's a presenter, isn't he, of the programme? But I'm sure all the people he works with are real scientists – because you actually see them doing real science experiments, don't you?*
>
> *Jacob:* *(Nods…)*

and via other digital media, like YouTube

> *"On YouTube there's like this thing called World's Best Discovery*[16] *and there's loads of scientists get, get, like, they're cornering, cornering the beach off and there's like a, like a, like a black shape in the water moving about, and they eventually get it out but it's just a whale" (Brody)*

As the children had made no mention of any fictional scientists – they may have misheard or misunderstood the question, or the question might not have been asked in a clear enough way – the children were again asked, this time specifically, for examples of fictional scientists.

Fictional Scientists

The children's ideas about fictional scientists appeared to come more from made-for-cinema films, quite a few of which were made a generation or so before the

---

[16] 'World's Best Discovery' does not currently exist, *per se*, on YouTube: there are however, many YouTube works connected to a great variety of the 'World's' diverse 'Discoveries'.

children were born and some of which were age inappropriate in as much as these films were British Board of Film Classification (BBFC) and the Motion Picture Association of America (MPAA) rated above the children's 9-10 year old age range.

The children enjoyed, particularly, recalling and relating in great detail some of their favourite story moments. From, for example, live action films like

Flash Gordon (Hodges, 1980). Genre: Action, Adventure, Sci-Fi. Rated PG (US), PG (UK)

> *"…there's a film called Flash Gordon and, erm, there's this crazy scientist who's got a few screws loose who makes this, erm, rocket ship … and … it's got this pedal in it and you just have to put your foot down and when, when it takes off you just put your foot down and then, erm, and it's all going to be fine, you're just going to go upwards because of the gravity and you won't if you've got your seat belt on – but I don't think you can do that – and Flash Gordon, erm, then dies in this gas chamber thing and then they bring him back to life with this, erm, with a gun" (Jaime)*

E.T. the Extra Terrestrial (Spielberg, 1982). Genre: Family, Sci-Fi. Rated PG (US), PG (UK)

> *Bobby: …the film E.T. … because when E.T., like, gets poorly, these, like, science people get involved – and they're all people in white suits and then they have to take him through this tunnel thing and then, and then they experiment on him whilst he's, like, getting worse and stuff…*
>
> *ED: Yes, I remember that.*
>
> *Bobby: And, and they've got the special, the special, special plant that shows if you're dead or not – because when he's alive, the plant's, like, up, like that [demonstrates], but when, when he's getting poorly, it goes, it starts to go down.*

Back to the Future (Zemeckis, 1985), *Back to the Future Part II* (Zemeckis, 1989), *Back to the Future Part III* (Zemeckis, 1990). Genre: Adventure, Comedy, Sci-Fi. All rated PG (US), PG (UK)

> *"The person from Back to the Future?" (Mitch)*

Julie: *In Back to the Future … there's this scientist called Doc and, erm, I think he gets shot in the first one…*

ED: *Yeah, Doc Brown.*

Julie: *And Marty gets his time machine and goes back to old Doc and he tells him that, erm, he needs to get this book thing, I think, yeah, and, and in Back to the Future II, erm – it's always creepy because they always go in this café that's different all the time.*

The Fly (Cronenberg, 1986). Genre: Drama, Horror, Sci-Fi. Rated R (restricted) (US), 18 (UK)

Aiden: *Oh, oh, I watched this film called Fly and he made this, I think it was a time travelling machine, and, erm, when he went inside to time travel to somewhere else, there was a fly inside the time machine…*

ED: *…he made a teleportation device…*

Aiden: *Yeah, and … he started growing antennae. And he did it with a monkey and when it came back out it was all squished and stuff…*

ED: *Ewww – yuk… (Laughs).*

Class: *(Laughter) Cool…*

There were some examples from much older live action films like

Chitty Chitty Bang Bang (Hughes, 1968). Genre: Adventure, Family, Fantasy. Rated G (US), U (UK)

> *"In … the old film Chitty Chitty Bang Bang … there's this … bit where … the Grandpa, he's made this … I can't remember what it was – but he's got – I think it's a hot air balloon but I can't remember – and he's gone off … and there's a flying car which would be make, erm, which would, it's a science thing, but it wouldn't actually be real, but then there's a, a bit, this weird song … and it's got loads of stuff about scientists in it" (Jimmy)*

and from more modern films such as live action

Spider-Man 2 (Raimi, 2004). Genre: Action, Adventure, Fantasy. Rated PG-13 (US), 12 (UK)

Frankie: There's also a dude on Spiderman with tons of electric arms.
ED: A dude on Spiderman, er, Doc Ock – is that Doctor Octopus?
Frankie: Yeah, he was an alien scientist.

Burke and Hare (Landis, 2010). Genre: Comedy, Thriller. Rated R (restricted) (US), 15 (UK)

Alfie: I can't remember what his name is but, he used to, like, erm, erm, they used to give him, like, dead bodies and he used to cut them up and put them in jars. Investigating bodies…
ED: Y'mean like, erm, doing post mortems and things?
Alfie: I don't know what that means. I seen it in the holidays and … the people … gave the body to this man and he used to cut it up and investigate all the things like…
Bobby: In the battlefields?
Alfie: No – it were on the roads.
ED: Was it Burke and Hare, who used to steal bodies?
Class: Yeah! Yeah!

Super 8 (Abrams, 2011). Genre: Mystery, Sci-Fi, Thriller. Rated PG-13 (US), 12 (UK)

Jamie: I watched a film, erm, called Super 8 and there was these scientists in it and this alien had crash-landed and they catched it and they were trying to feed it…
ED: That was really scary … that film (laughs).
Jamie: …and, erm, well, he's trying to feed it and the monster grabs him, and then they, erm, I think they put it to sleep and then they tried to, erm, erm, they find these weird cube things or metal balls, I think, and then they try to find out how to make the ship…
ED: Yes, to send him back home, I think – is that right?
Jamie: Yeah…

and animated films such as

9 (Acker, 2009). Genre: Animation, Action, Adventure. Rated PG-13 (US), 12 (UK)

"…there's a film called 9 and there's a scientist and he, and erm, there's a World War going on, and he makes, like, robots to kill the Germans and, erm, instead, they kill the Germans first but then they attack the humans then and then, erm, the scientist, like, makes, like, little voodoo dolls that come to life … and, erm, he dies from unknown voodoo" (Lorna)

Monsters vs. Aliens (Letterman & Vernon, 2009). Genre: Animation, Action, Adventure. Rated PG (US), PG (UK)

David: Erm, I watched this film called Monsters versus Aliens and there's this, erm, person called Dr Cockroach and he became a cockroach, because, erm, he was a, er, a very famous scientist and he invented like this, erm, machine, and when he went inside it he switched it on and when he came out he was a, he was a cockroach in a lab coat.

ED: Oh, yes – there's a woman in it [who] becomes a giant?

Class: Yeah!

David: There's one called, erm, Bob, there's one called Bob and he's a, he's a gloop and he used to be a tomato and these scientists, erm, he used to – there was this guy called Bob and he used to be a tomato this scientist was testing on him and he put this liquid inside him and he turned him into this, like, blue goop then he grew eyes and a mouth and he became a monster.

Up (Docter & Peterson, 2009). Genre: Animation, Adventure, Comedy. Rated PG (US), U (UK)

John: Erm, I watched this, erm, film called Up and it's got this famous explorer in it called Charles Muntz. Is he real?

ED: No … he's a story scientist – and he turns out to be wicked, doesn't he, in the end, as well?

John: Is he real, though?

ED: No, he isn't real. He's a fictional scientist.

To a lesser extent, the children gave examples of fictional scientists from both animated and live action television series. Animated series like *Family Guy* (MacFarlane & Zuckerman, 1998 – to date); Animation, Comedy; Rated TV-14 (US), 15 (UK) and *The Simpsons* (Groening, Brooks & Simon, 1989 – to date); Animation, Comedy; Rated TV-14 (US), PG (UK) – though two of *The Simpsons* examples were in specific relation to the live action film *The Fly* (above) that had just been spoken about.

The live action television series were situation comedies like

The Big Bang Theory (Lorre & Prady, 2007 – to date). Genre: Comedy, Romance. Rated TV-14 (US), PG and 12 (UK)

> *Bobby:* *Erm, there's this, d'y'know the, the TV show The Big Bang Theory?*
> *ED:* *Yep.*
> *Bobby:* *Did that, like, come from Stephen Hawking?*
> *ED:* *No, I don't think it did. Stephen Hawking has been on the programme [though] and Sheldon is a theoretical physicist like Stephen Hawking. I think that's why he faints when he meets him (laughs)…*
> *Bobby:* *(Laughs) Yeah, 'cos, some, some, sometimes he doesn't, doesn't, like, stop talking about Stephen Hawking. Also his friends are, like, sort of scientist people…*

The children did not cite any examples of literary representations of fictional scientists and were so asked, more specifically, for examples of the same.

Literary Fictional Scientists

When asked to recall any fictional scientists they had come across in books they had read or were aware of, the children could recall two examples. The first was

> *"…Uncle Quentin, erm, and he's a scientist and he's very frumpy-ish and he's, he's not very sociable and he's, y'know, he's always very harsh" (Andrew)*

Uncle Quentin was first introduced in *Five on a Treasure Island* (1942), the first book of Enid Blyton's series *The Famous Five* (Blyton, 1942-1962).

The second example of a literary fictional scientist was

> *"…Uncle Monty – he, he gets killed by Count Olaf and he's, in a way, a scientist because he studies snakes" (Flynn)*

Uncle Monty was both introduced and then killed off in *The Reptile Room* (1999) the second book of Daniel Handler/Lemony Snicket's series of children's novels *A Series of Unfortunate Events* (Handler/Snicket, 1999-2006).

Despite gentle reminders of the question and being allowed lots of thinking time, these were the only two examples of scientists in novels that both cohorts could call to mind at the time. Both examples came from Cohort 2011.

It seemed that, despite the children's substantial knowledge about fictional science and scientists in both live action and animated television series and in made-for-cinema films, the children's knowledge of literary fictional science and scientists was limited.

Theme 2: Conclusion

When asked if they could name any scientists, real or fictional, the children mentioned only real scientists, at first, and gave many examples of both real scientists and real science. Whether this was because they had misheard the question or because the first child to volunteer an answer mentioned a real scientist and other children followed suit is unclear.

What was noticeable, however, was that most of these real scientists that the children recalled were presented as a question, *'Was Einstein a scientist?' (Joe)*, for instance. Whether this was also because the first child to volunteer a real scientist, did so in question form and other children simply followed suit is unclear.

No such questioning or uncertainty occurred, however, when the children were asked to specifically recall fictional scientists. The children's ideas about fictional representations of science and scientists were first and foremost garnered from live action and animated television series and live action and animated cinematic films. After much time and thought, Cohort 2011 recalled only two examples of literary scientists. The children of Cohort 2012 could not recall any.

The finding that the children were very much aware of science and scientists in film and television went far toward achieving objective B, *to investigate whether children are familiar with science and scientists in fiction*: the children were very familiar with science and scientists in fiction – but mainly television and film fiction rather than literary fiction.

Theme 3: The children are without conscious awareness of the effect of fictions

The children were asked how they felt about the influence of stories in general. When asked *'Do you think stories have an effect on you?'*, most answers were definitively negative:

> *"No, they do not…" (Allen)*
>
> *"No, because no stories have never had an effect on me…" (Terry)*
>
> *"No…" (Brody, Joe, Jimmy, Brady)*
>
> *"Not really because they are just stories…" (Julie)*
>
> *"Not really. I think no book has made me feel different…" (Katie)*
>
> *Laura: Not really.*
> *ED: Not really. Why's that?*
> *Laura: Because… I don't know.*

Other answers were qualified

> *"No – but it depends on what kind of book I read" (Alfie)*
>
> *"Maybe … if it was about something I really want to be … [a journalist]…" (Cathryn)*

Some children raised the idea that whether the story was true or not might make a difference as to whether or not they might be influenced by it. Some children felt that a story being 'real' or 'true' might make a difference

> *"Yes and no – because if it's real it might but if it's not real it won't change [me]…" (Jacob)*

but one child felt that 'true' stories wouldn't make any difference at all

> *"No! Because it's just a story even if it's true or not…" (Cooper)*

No child categorically affirmed that they felt influenced or changed in any way by any story they had come across. It seemed that despite the children's intellectual and emotional engagement with and enthusiasm toward both their own and others' reading and story-telling, most of the children felt that they had never been influenced by a story.

Worries that the initial question might have been too difficult or epistemologically challenging for the children to understand, however, were dispelled when the children answered a similar but more specific question: In view of the positive spirit with which most of the children had embraced the idea of putting scientists into their stories (see *The Children's Stories; The Idea of Putting Scientists into Stories*, above), coupled with our concurrent lively discussions about the same, the children of Cohort 2011 were asked *'Do you think that [stories about fictional] scientists have affected the way you feel about real scientists?'*. Thoughtful responses included

> *"…not really, no, because they're not, like, proper real… (Pip)*

> *"Erm, not really, because they're not actually <u>real</u> – so you can't, like, relate to them because they're just, like, in a story which isn't the same as real life…" (Frankie)*

Not only did most of the children feel this way – in that they felt that they could not relate to fictional scientists because fictional scientists simply weren't real – but the children also felt that fictional scientists did not relate to real scientists either

> *"…scientists [that are] fictional – they don't really, like, relate to the real scientists…" (Callum)*

The idea that story scientists do not relate to real scientists, or only superficially relate in as much as they 'do experiments' and 'invent things', is further explored below in Theme 6: *The fictional scientist has a place in the real world*, wherein the children suggest that fictional scientists have to be the way are in order to make for an exciting or funny story.

Upon reframing the question, the children of Cohort 2012 were asked, *'Do you get any ideas about how you feel about [real] scientists from story books?'*, answers included

"Oh, no – because in story books they might only tell you what they wear…" (Sara)

"No – because [if] a story book mentions a scientist, it's probably just like 'and here's my old friend, he's called Billy, he's a scientist' – and it's not going to, like, say what he <u>does</u>…" (Liam)

Answers like these, specific to stories that contained science and scientists, revealed that the children felt that the ideas they held about science and scientists had, too, been unaffected by the books they had read or the stories they had been told.

This being the case, I felt that even though the children believed that they had, so far in life, remained unaffected by any of the stories they had encountered, they still might have some thoughts as to whether or not there did (or could) exist a type of story that they thought might have an effect on them. Did they feel, for example, that some type of story could be written about something or in such a way that might have an effect upon how they felt or how they thought about that something.

Although not within any of the semi-structured group interview schedules, and with respect to stories in general, I asked the children *'[Is there] any sort of story that you think might have an effect on you?'*. Typical responses included

"No and yes – because if it's, like, got some real information [in it] It might affect [me] – but some stories [like that] are just, like… boring" (Jonah)

Following on from this, and again in particular pursuit of their thoughts about science and scientists in stories, the children were asked *'Do you think, in your hearts and minds, there is any type of story that could be written that would change the way you feel about science and scientists?'*. One child's answer was typical of the children's feelings

"I don't know if there is a [fictional] story book – but about all the facts … that's actually <u>real</u> about scientists, like, all the bits that are being told in the story … are actually true…" (Allen)

For both stories in general and stories that had science and scientists in them, the children seemed to feel that to be influenced by the same, these fictional stories had to have something 'real' or 'true' about them.

With this in mind, the children were asked *'Do you think that [true stories you've heard about] real scientists have affected the way you feel about scientists?'*. Again one child seemed to sum up the children's thoughts

> *"…yeah, because it shows … [real scientists] … they're not bad and mean people, they're, like, they can be right nice people if you, like, get to know them and stuff" (Cassie)*

Cassie's words hence offered an alternative view of the children's general belief that they felt they had never been influenced by stories in general or stories that contained science and scientists.

Theme 3: Conclusion

The majority of the children did not feel that they had ever been influenced or changed in any way by any stories that they had encountered so far. Some children brought up the idea that whether a story was true or not might make a difference as to whether they might or might not be influenced by the same. One child, for example, feeling that it would make some sort of (positive or negative) difference, albeit another child feeling that, true or not, a story was *'just a story even if it's true or not…' (Cooper)* and so would not make any difference at all.

The children of Cohort 2011 were asked more specifically – and organically, in as much as the question did not appear in any of the semi-structured group interview schedules – about whether or not they felt that any fictional stories they had heard about science and scientists had had any effect upon how they felt about the same. The children were again of the opinion that the way they felt about science and scientists had not been at all influenced by fictional stories containing science and scientists they had come across so far because, not only could the children not relate to the science and scientists in these stories as *'they're not actually <u>real</u> … they're just, like, in a story' (Frankie)*, but also *'scientists [that are] fictional – they don't really, like, relate to the real scientists' (Callum)*, that is, the children felt that the fictional scientists in such stories do not relate to real life scientists, either.

Hence, the way the children felt about the influence of stories that, specifically, contained science and scientists, corroborated the children's feelings that they felt unaffected by fiction in general.

When the idea about being influenced by any stories they had heard about science and scientists was approached from a different angle and the children of Cohort 2012 were asked whether any of the feelings and ideas they already held about science and scientists had been garnered from story books, the children who offered a response again said no. These responses not only corroborated the children of Cohort 2012's belief that they felt unaffected by fiction in general, but corroborated, as well, the children of Cohort 2011's belief that they, too, felt unaffected by fiction specific to science and scientists.

Every text a person encounters, calls into being, shapes and makes meaning from, of course, has to have an effect upon a person. These complex fluid act/s of calling into being and shaping texts, together with the re/creation of meaning will re/create the self, albeit in most instances imperceptibly.

The children, naturally, are likely to be unaware of and were not told about the theories of reader response and interpretive communities and how texts of any nature might affect them. However, despite believing that they had so far remained unchanged by any fiction they had encountered, the children did concede that the possibility of being changed by a story might exist: When asked whether or not they could imagine being influenced by any sort of story at all – a story type, perhaps, that they had not yet encountered – some of the children revealed that if a story had something 'true' or 'real' about it, *'if it's, like, got real information [in it]' (Jacob)*, then maybe that story might have an effect upon them.

Furthermore, when asked whether or not there existed a type of story, specific to science and scientists, that might influence them, the children responded in the same vein: *'if there is a [fictional] story book – but about all the facts … that's actually <u>real</u> about scientists, like, all the bits that are being told in the story … are actually true' (Allen)*, then, yes, the majority of the children felt that they could be influenced by the same.

This idea of being affected by 'true' facts in fictional science and scientist stories, corroborated the children's feelings about the idea of being affected by general fiction stories that contained 'true' or 'real' information.

With this in mind, when the children were asked whether they thought any 'true' stories they might have heard about real scientists had changed how they felt about real scientists, the children's thoughts were summed up in one child's words that offered an alternative view – a view that could be interpreted as a reversal – of the children's general belief that they had never felt influenced by either general stories or stories that contained science and scientists. True stories about scientists might change how the children felt about real scientists *'…because it shows … they're not bad and mean people … they can be right nice people if you … get to know them and stuff' (Cassie)*.

The finding that the children were without an awareness of the effect of fictions or that they believed they were unaffected by fictions, went far toward achieving objective C, *to explore whether children think they are influenced or inspired by fiction*: the children did not believe that they had been affected by fiction. This of course does not mean that the children were not or are not affected. From a reader response perspective, the children are, of course, very much affected by fiction; the children not only call into being the fictions that affect them but, by doing so, create unique meaning which must, to lesser or greater degrees, re/create the child.

Despite the children's belief that they had not been affected by stories, however, the children did concede that fictions, both those connected to science and scientists and those not connected, that contained 'something true' or 'something real' did have the potential to influence and/or change how they felt.

Theme 4: The children believe that real scientists are good people who are motivated to do good in the world

When sharing their thoughts and ideas about their own and others' story scientists, the children naturally came to compare their fictional scientists with real life scientists.

The Motivations of Real Scientists

When asked *'Why d'you think real scientists … do the things they do?'*, besides 'ordinary' human impulses like

"I think … a real scientist would do what he does to get more money … to buy more things" (Liam)

typical answers included

"I think, normally, a scientist does the things he does because … he thinks he can make the world a better place and … he can make improvements and he can make a step forward so that we can do things much easier and because if we [were] the same all the time and we never took steps forward … everything would always stay the same … because if we hadn't had people like scientists we might still be doing what the Tudors did" (Andy)

"[scientists] helped medicine and people with cancer and stuff – and … helped them to have medicine" (Mary-Ann).

"…all the scientists in the world – well, most of them anyway – are good guys because they help in the world" (Alfie-Jack)

The children seemed to believe that real life scientists are good people who not only want to make the world a better place but who do, in fact, strive to do so. I found no evidence to suggest the children felt that real scientists were even a little bit villainous (see also *The Children's Stories; Heroes and Villains – and Scientists*) and one child summed up real scientists' *raisons d'etre*

"If, if we didn't have scientists we wouldn't have the things we've got now…" (Pip)

The Motivations of Fictional Scientists

When the children were asked *'Why did the … fictional scientists [in your stories] do the … things they did?'*, the children shared ideas about their fictional scientists' motivations that were as reasoned and as sincere as the motivations given for real life scientists. That is, the children did not take their fictional scientists' motivations, especially the good fictional scientists' and the mad-benign fictional scientist's motivations, lightly.

Ideas about the actions of their good fictional scientists (one saving his friends and experimental guinea pigs from an aircraft disaster in the jungle; the other using a

Taser-like device to heal), for instance, reinforced the observation that this type of scientist in the children's stories appeared to be a reflection of real life scientists (real life scientists being, the children believed, good people)

> *"I think he did what he did because he knew all about the power, his power … and I think he knew that he'd reached a point in his life where he can't go any further so he wanted to protect the other people" (Flynn)*

> *"…because he saved all his friends from basically certain death and if he didn't do that then he probably, probably wouldn't be able to live with himself and that's what basically made him good in the story and plus, how he helped everyone" (Pip)*

> *"Because he wanted to help people and he didn't, like, want to hurt them or anything" (Allen)*

> *"Erm, he was kind because he didn't want to leave the person in pain" (Gabe)*

When asked about the mad-benign (comically mixing strange, funny or gross materials to make a potion that accidentally exploded) fictional scientist's motivation, *'Why d'you think your [mad-benign] scientist did the things he did?'*, one child felt that the scientist was actually kind at heart and might not actually 'want to be mad' at all

> *"He was used to, like, [being] kind to people, and … he might not've wanted to be mad" (Jacob)*

The mad-malign and the evil scientists' motivations, however, seemed less clear – or seemed blended with other ideas – in as much as, although the children were asked about the specific mad-malign or the specific evil scientist(s) in their stories, the few answers given seemed to reflect the children's general ideas about generic mad/evil scientists' motivations (see *The Children's Stories; Heroes and Villains – and Scientists*, above) and not the mad/evil scientists in their own stories. For example, with respect to the mad-malign scientists (ordering minions off the internet, sending them to the shop 'Death by Acid' for Anti-Gravity Syndrome, then minion-ifying the delivery person), one child felt

"…probably they just thought we can invent anything, let's just invent something and steal something and destroy something – because we can invent anything" (Naz)

which, to a large degree, did not reflect the story we were talking about.

With respect to one of the evil fictional scientists' actions (changing unsuspecting people into hamsters and back again), too, motivations also seemed less clear

Katie: *[He doesn't] … let anybody know what he's doing and so no one … was being nice to him.*
ED: *D'you think no one was nice to him and so he became evil? Or perhaps he was already evil and that's why people aren't nice to him?*
Katie: *'Cos he was already evil.*
ED: *He was already evil. … [W]hat made him already evil? How did he become evil?*
Katie: *Don't know…*

"I think ours did what he did because he's done it in the past and, like, he always gets things right … because he's a scientist" (Marian)

Worthy of note, too, with respect to the latter two conversations was that the scientist was played by a girl – Katie, herself, in fact – yet was spoken about as being male.

The suggestion of the presence of inherent evil or past evil was recognised as not being 'normal', however, and supported the idea that evil fictional scientists' motivations do not reflect real scientists' motivations. Some answers, for example, directly compared evil fictional scientists' actions with real scientist/real world actions

Amie: *Erm, he wasn't really, erm, the same as normal [scientists] … a real scientist wouldn't, erm, go and order little minions off the internet to go and buy stuff from the supermarket.*
ED: *(Laughs) What would a real scientist do?*
Amie: *Erm, just, just be testing things and being creative.*

People Other than Scientists, Doing Fictional Science

Whether other people, that is, people other than scientists, would do the things the children's story scientists did garnered different ideas.

When the children of Cohort 2011 answered the question *'D'you think there's any other sort of person that would do the things that the scientists [in your stories] did?'* their answers were particularly specific to the different types of scientists in their stories. For instance, with respect to the good scientist (saving his friends and guinea pigs from an aircraft disaster in the jungle):

> *"I think someone, like, similar to Superman or someone like that could've only done it because he had it in his heart … and he knew he had to do it, it was his duty to save those people" (Frankie)*

With respect to the evil scientist (evil grandpa scientist shooting the young pretender):

> *"Erm, in ours, I think it could've been, y'know, it probably would've happened, y'know, someone who really believes in religion or really believes in their country and it was, sort of, in the rules of their country and if, so, y'know, very, very strong Muslim or, y'know, someone a bit like Hitler who really thought, y'know, the enemy is good. So, that sort of person" (Matthew)*

And with respect to the mad-malign scientists (buying minions off the internet, sending them to the shop, minion-ifying a person):

> *"I think, in ours, erm, a rich person could do the same thing the scientist did, 'cos it's, like, erm, y'know, usually rich people just think they can do anything, buy anything – like, they can buy minions and try and get them to do what they want" (Mary-Anne)*

Real Scientists Doing Fictional Science

When the children were asked, however, *'Do you think any real life scientists would do any of the things the scientists in your stories did?'*, answers were varied.

With respect to the latter mad-malign scientists' story and their (mis)use of minions, whereas some children felt that real scientists would not use minions of any nature

> *"Real scientists like them, they wouldn't have minions … they wouldn't create, like, a robot or something; they'd probably go and get all the things they need themselves because … if they need this thing they just go and get it for their experiment…" (Flynn)*

other children felt that real scientists would, indeed, use other people as 'minions'

> *Liam: [Scientists would] get people to do some things.*
> *ED: Get people to do some things? What sort of things?*
> *Liam: Like, instead of him doing it, he, he demands other people to do it.*

With respect to the good scientist saving his friends from disaster, most of the children felt that, should the opportunity arise, real scientists might do the same

> *"…[real] scientists, in a way do act like, well, they don't run around saving people in real life but, y'know, they would go to war for some unknown reason or something tragic like that might happen – and they probably would know about the plants and … all the things in that area and they'd be able to figure out how to survive and… So, yeah, they might…" (Finn)*

The children of Cohort 2011 made no mention of whether or not a real scientist would do what their evil story scientist did (shoot someone).

When the children of Cohort 2012 were asked whether or not real scientists would do the things the scientists in their stories did (a kind scientist using a Taser-like device to heal; an evil scientist turning humans into hamsters; a mad-benign scientist mixing random materials/causing an explosion), the children seemed to look at the three fictional scientists all together/all at once – not separately, as in connection to the specific story to which each scientist belonged, as Cohort 2011 had done. The children, instead, tended to compare their story scientists to one another, rather than thinking about each scientist or each story separately. This could've been on account of the way or the particular (particular as in naturally different) context in which the question had been asked.

In response to *'Do you think any real life scientist would do the things the scientists in your stories did?'* some children felt quite certain

> *"[No] … they can be too dangerous" (Lynne)*

> *"[Yes] … erm, because they might want to be imaginative" (Donnie)*

> *"[No] … because scientists are ... well trained" (Sara)*

and other children, however, held mixed feelings as to whether or not real scientists would do the things the fictional scientists did

> *"…yes and no because some scientists might be working on trying to turn humans into hamsters somewhere and … no, because, erm, scientists actually think [about] things before they do it, they don't just do something exploding" (Anne).*

> *"Yes and no. [No] because a scientist wouldn't really use a Taser to cure someone … and yes because they do mix up chemicals and stuff" (Kyle)*

The majority of the children of Cohort 2012, however, felt that real scientists would not actually do those evil, mad or kind things, because, beside it being

> *"…impossible to turn hamsters into humans" (George)*

and

> *"I don't think [real scientists] would want to turn … a human into a hamster – only if [they] were really cruel…" (Jamie)*

real scientists, the children thought,

> *"…[spend] most of the time … planning for what they're going to do" (David)*

It was only with respect to the use of chemicals particularly, however, that some children felt that real scientists might do the things the fictional scientists did:

"Erm, yes, because sometimes, erm, scientists, erm, mix different chemicals and sometimes they go a bit wrong and sometimes the potions can, like, do something to you… (Danny)

Jack: *[Scientists use] chemical things, different, like, erm, potions and stuff and … usually get it wrong and blow stuff up…*

ED: *Right, so you think real life scientists do that?*

Jack: *Yeah.*

What Do Real Scientists Do?

Hence, besides the use of chemicals, the children of Cohort 2012 thought that real scientists, in the main, would not do the things their story scientists did, and when asked to think about what it is that real scientists actually do, the question *'What do real scientists do?'* became fused with ideas about how real scientists behave or 'feel', viz:

What they do:

"Real scientists … they're more likely to protect the ozone layer and [figure out] how to save the killer whale and things like that…" (Flynn)

"… [they'd] just be testing things and being creative" (Anne)

"Erm, they, kind of, they, erm, spend a couple of months <u>planning</u> out an experiment … and thinking what the consequence, the consequences would be – and then they, and then they spend, er, maybe a week or maybe two, <u>preparing</u> for the experiments by bringing all the stuff in and making sure they can close off the area (unintelligible) and then over the space of maybe about an hour or it could be a couple of months, they actually carry out the experiment…" (Jonah)

"Erm, they mostly do, like, erm, people, erm, what people, normal people do like go and do the groceries, but most of, er, most of the time they're, like, planning for what they, what they're going to do and, or experimenting…" (Donny)

How they behave/how they feel:

Mikey: Erm, they act calm.
ED: Act calm. Why is that?
Mikey: Er, because they're acting calm so they don't get anything mixed up.

Andy: I think of [scientists] as people that are normally quite grumpy and, y'know, that they don't really have so much time for other things so, y'know, if their experiment was going wrong, y'know, they probably, they probably wouldn't be very sociable but they'd be, but they'd be very focused on their work and they'd do it for good causes.
ED: … So why d'you think they're grumpy?
Andy: Erm, probably because they're stressed about their work.

"…they're not very friendly because they don't really know how to be friendly because most of the time they're, like, studying and things" (Frankie)

Callum: Well, most scientists are more or less really grumpy.
ED: … Why do you say that?
Callum: Because they don't really have much time with other people, like.
ED: Why don't they spend a lot of time with other people?
Callum: Because they're more or less too busy doing loads more experiments.

One idea, and this was the only idea of this nature, suggested that scientists were not their own bosses and might actually work for someone else

"Sometimes they might act a bit stressed like when they, when they've been told how to make something, and all the ingredients, and they're putting it in and it's not working, they might get stressed…" (Andy)

These examples did speak to the idea of real scientists living in and doing things in the real world. Other children, however, had alternative ideas as to what they thought real scientists might do and how they might behave, that again spoke to the idea of the existence of a real/fictional hybrid scientist. For example

Gabe: Erm, also, like, the scientists would, like, be jumping off, jumping off walls 'cos he could, like, do summat, like, like he just was so crazy he *thought he was something like a ninja 'cos there is ninjas in, like, China and stuff…*

ED: *Right…*

Gabe: *…I know, I know that a scientist could, like, do, do that, if he got really crazy – 'cos I've seen it on an advert for, like, like, this thing in, like this different country and they, like – d'you know, like, (demonstrates) slanted things like that, and then you can, like, jump across it, like…*

ED: *Oh, yes…*

Gabe: *…one foot at a time – and then it's got, like, water under it, under it and stuff…*

ED: *Right. So, you think a real life scientist would do those sorts of things?*

Gabe: *Yeah.*

What Gabe describes might be doable albeit by a ninja – and 'scientist as ninja' could be seen as no more unusual than scientist as 'astronaut', 'adventurer' or 'philosopher' (see *Chapter 7 – Discussion; The Identification of the Scientist in Existing Fact and Fiction*) – but Gabe's scientist only behaving like a ninja *'if he got really crazy'* spoke to the children's ideas of fictional (mad/crazy) scientists, too.

With respect to both the real scientists and the real/fictional hybrid scientists, in order to reinforce that we were talking about real scientists as opposed to fictional, the children were asked *'Have you seen or heard any real scientists behaving that way?'*.

Although some children had been to science/educational museums

> *"…when we went to Eureka which is a science museum, erm, there were some scientists, erm, showing how to make, erm, a mini volcanic eruption with soda and – like, with bicarbonate of soda and, erm, vinegar…" (Lee)*

> *"…I'd gone to the Manchester Science Museum … and there was a bunch of people and they had a kind of pot, and they had loads of stuff around it and they put loads of it in … and we heard a bit of an explosion…" (Jonny)*

the real scientists the children could recall seeing in action were mainly those they had seen on TV or YouTube, and despite feeling that real life scientists were grumpy or unfriendly, the children did not call to mind any examples of real life scientists being that way and only recalled scientists being happy and doing fun and interesting things:

Joanne: …it was on BBC News, one day.
ED: BBC News, right. What was he doing?
Joanne: (Laughs). He was running around with a, some bottle in his hand.
Class: (Laughter)

"Erm, yeah, 'cos I was watching this TV show … and they did a thing how you can get a football to not, like, leak air when it's being kicked about, 'cos they pump it up really hard…" (Bobby)

"…on YouTube there's, like, these two men, they're, like, in their twenties and they experiment on stuff 'cos they're scientists and then they got this big balloon and it was like that (demonstrates a big balloon) so they filled it with water and they tried to find out how they could pop it – but it was too hard to pop. So, so they got as many people as they could to jump on it in the end – but it took them, like, two days how to figure that out…" (Pip)

The children shared many more thoughts and ideas about the nature of real scientists in the real world, real/fictional hybrid scientists in the real world and fictional scientists in the real world. Some of these ideas are outlined in Theme 7b: *The idea of being a scientist in the real world*, below.

Theme 4: Conclusion

When asked why they thought real scientists do the things they do, the majority of the children said that real scientists, doing 'good things' in the world, do so because they are good people who genuinely want to make the world a better place.

This goodness, or lack of villainy, might have been why some children's explanations of their own or others' good scientists' and the mad-benign scientist's actions often reflected what the children thought were real life scientists' motivations.

The children's explanations of their good scientists' motivations were very detailed, however, more detailed than their explanations of real scientists' motivations. This could be on account of the children having thought carefully about the natures of their story scientists and what was going to happen in their stories. However, some children had particularly eloquent answers: for example, although one good fictional scientist *'wanted to protect the other people'* his more intimate motivation was *'he did what he did because he knew all about … his power … he knew he'd reached a point in his life where he can't go any further' (Flynn)*; and, having *'saved all his friends from basically certain death'*, another more intimate explanation was *'if he didn't do that then he probably … wouldn't be able to live with himself' (Pip)*.

Their mad-benign fictional scientist's motivation might also be seen to reflect how the children thought about real scientists in as much as *'he was … kind to people…'* and *'…he might not've wanted to be mad' (Jacob)*.

The children's evil scientists' motivations, however, did not reflect the motivations of real life scientists; actual motivations were unclear but did speak to the presence of inherent evil that the children recognised as not being 'normal'.

The children's thoughts about the motivations of both their good scientists and their mad-benign scientist seemed to reinforce the observation that (half) the scientists in the children's stories seemed to be a reflection of real life scientists: real life scientists being, the children believed, good people who do good things in the world.

This idea reinforced ideas garnered through the re-coding and re-analysis of the words and phrases the children of Cohort 2011 used to describe the characteristics of four identity types – Fictional Heroes, Fictional Villains, Fictional Scientists and Real Scientists (see *The Children's Stories; Heroes and Villains – and Scientists*, above): real scientists, having nothing in common with 'villains', are associated with fictional heroes (real scientists and fictional heroes both liking to save lives); and, like the children's good fictional scientists, real scientists were clever, creative and inventive people.

When thinking about who else might do the things the children's scientists did, bearing in mind the idea that the motivations of the children's good scientists seemed to reflect the motivations of real life scientists, together with the idea that real life scientists reflect fictional heroes (see *Figure 8: The Features of Real Scientists*), one might find one child's suggestion *'someone … similar to Superman'*

(Flynn) as being the sort of person who might do the things the good scientists did, consequently corroborative.

For one or two children, suggestions as to what other sort of person might do the things the evil scientists did, spoke to religious or nationalist extremism *'someone who really believes in religion or really believes in their country … [a] very, very strong Muslim or … someone a bit like Hitler' (Matthew)* or *'someone that's just wrong in the head' (Allie)*; and for the mad-malign scientist it was suggested that *'rich people [who] just think they can do anything' (Mary-Ann)* might do similar things.

Real scientists: reflection, part reflection, and no reflection of fictional scientists

Cohort 2011, looking at each of their scientists separately, felt that real scientists, should the opportunity arise, would do what the good fictional scientist did (save people from disaster), might or might not do what the mad-malign fictional scientists did (order minions about), and made no mention of the evil fictional scientist (who shot the young pretender before dying himself).

The majority of the children of Cohort 2012, however, felt that real scientists would not do any of the things their fictional scientists did (a good scientist healing people, a mad-benign scientist mixing random materials, and an evil scientist turning humans into hamsters). Real scientists, the children felt, are *'well trained' (Sara)*, *'actually think [about] things before they do it' (Anne)* and *'[spend] most of the time … planning for what they're going to do' (David)*.

It was only specific to the use of chemicals that some children thought that real scientists might do what their fictional scientists did. Real scientists using chemicals, however, would most likely lead to disaster as *'scientists … mix different chemicals and sometimes they go a bit wrong and sometimes the potions can, like, do something to you' (David)* or scientists *'[use] chemical things, different, like, erm, potions and stuff and … usually get it wrong and blow stuff up' (Jack)*.

Hence, for the children of Cohort 2012, real scientists would not do what the good scientist or what the evil scientist did because those things were 'impossible'. Only the mad-benign scientist mixing random materials might represent the 'real' chemical-mixing that real scientists might do.

When thinking about real scientists' motivations as to why they might or might not do the things the fictional scientists did, some motivations were seen to reflect what the children thought were real scientists' motivations for doing things in the real world: *'because they might want to be imaginative' (Donnie)*, for example.

When the children were asked about what it was they thought real scientists do, besides some answers reflecting what are most likely the actions and behaviour of real scientists, other answers seemed to again con/fuse the real and the fictional scientist.

Real scientists, besides doing 'normal' non-scientist things, for example, *'they mostly do [what] normal people do like go and do the groceries' (Donny)*, also do quite ordinary 'normal' things connected to science: they *'protect the ozone layer' (Flynn)* or might *'spend a couple of months* <u>*planning*</u> *out an experiment' (Jonah)*.

Why real scientists would do these things are, again, normal in a non-scientist way: *'to get more money' (Liam)*; and 'normal' in a connected to science way: *'to make the world a better place' (Andy)*, *'to help the world' (Alfie-Jack)*.

Real/fictional hybrid scientists, however, *'would, like, be … jumping off walls 'cos … he just was so crazy he thought he was something like a ninja' (Gabe)*.

Noticeable, too, was the children's beginning to reveal their feelings about how real scientists were in the world, that is, how scientists felt, their demeanour, in the world. Besides being understandably *'calm so they don't get anything mixed up' (Mikey)*, the idea that real scientists are grumpy, stressed and unfriendly began to rise: real scientists were *'more or less really grumpy' (Callum)* because *'they're stressed about their work' (Andy)* and *'they're not very friendly because they don't really know how to be friendly' (Frankie)*. This grumpiness and unfriendliness seemed to be because of the stress of working or studying hard and so did appear to be how the children really saw real scientists as opposed to real/fictional hybrid scientists or wholly fictional scientists.

The children were asked if they'd ever seen any real scientists doing these stressful things or behaving in these grumpy or unfriendly ways but the only real scientists the children could recall, besides 'scientists' in science museums (who might not be scientists at all) were the 'happy' scientists they had seen on TV or on YouTube.

This corroborated what the children had said, earlier, when asked to name real or fictional scientists in as much as the children mentioned real scientists they had seen in non-fictional television, *Brainiac Science Abuse*, for example, and non-fictional digital programming, *YouTube – World's Best Discovery*, for instance (see above, *Theme 2: The children are very much aware of science and scientists in film and television fiction*).

Hence, the idea that most of the children felt that real scientists were good people – as opposed to 'evil' or 'mad/insane' – went some way toward exploring the first research aim, *to understand how the children felt about science and scientists*, as besides exploring what they felt their good, mad and evil story scientists' motivations were, the children also articulated how they felt about real scientists motivations' and real scientists' 'being' in the world.

Real scientists, most of the children felt, are clearly different from fictional scientists. Real scientists, albeit grumpy, unfriendly and stressed are, in their own right, good people with good intentions; they want to do good things in the world and they plan accordingly by use of their tough work and study ethic and their inventive imaginations; they would not do what the evil or mad-malign fictional scientists did, but might do the things the good or mad-benign fictional scientists did – if it was doable.

The children's associated thoughts and ideas about the nature of real scientists in the real world and the nature of real/fictional hybrid scientists and fictional scientists in the real world are more fully explored in Theme 7b: *The idea of being a scientist in the real world*, below.

Theme 5: Young dynamic scientists in a story would not make the children think about being a scientist – but real science in a story might do so

After each cohort engaged in the shared reading of the original science fact/fantasy adventure story depicting four young scientists in an exciting positive light, the children shared how they felt about the same. Although they may have been being kind and polite to me as the story's author, they said very much enjoyed the story. Despite the story not at all being a horror story, however

> *"Erm, it was really good because it was like a mix – because some bits was horror, some bits was comedy and the rest was like a novel" (Flynn)*

nor a mystery story, *per se*

> *"I think it was really really good because I like mysteries and stuff…" (Lucy)*

the children did seem well engaged while the story was being read. The children said they looked forward to the scientist heroines' and scientist heroes' next adventures, coming to understand that whatever venturesome predicaments the young scientists found themselves in, they would meet their challenges, solve their problems and save the day using their science (particle physics, sports science, linguistics and cryptography) knowhow.

When Cohort 2011 was asked *'Could you imagine yourselves as a scientist in the story?'*, however, there was no response. The question was reframed *'Who could imagine themselves being a scientist hero [in any story]?'* wherein only 1 boy raised and purposefully wavered ('yes and no') his hand.

Similarly for Cohort 2012, only 1 girl and 1 boy felt they could imagine themselves as scientists in any story. Upon examination of the children's written work, these 3 children (from both cohorts) were some (but not all) of the children who could imagine themselves as scientists in real life and who had answered the question *'Would anyone here want to be a scientist?'* in the same vein (see also, *Theme 7b: The idea of being a scientist in the real world*, below).

The next question, however, *'Could you imagine any of your friends or family being a scientist?'*, immediately garnered lots of enthusiastic responses. These responses are also better presented below in Theme 7b where they are presented alongside *'Would anyone here want to be a scientist?'* – and where, weighing the enthusiastic response to the former question against the very few responses to the latter, it seemed that although the children could envisage many of their friends, classmates, family members and acquaintances as real life scientists, they could not envisage themselves as the same.

The children were asked *'If you read more stories like this, with young scientists in … scientists your age having fictional adventures … do you think that would change how you felt about science and scientists?'*. Answers were mixed.

Some children felt that remodelling or recreating the scientist stereotype (into young dynamic girls and boys) would not have any effect at all on the way they felt about real scientists

> *"…because it doesn't really help me knowing about scientists – it's just, like, a scientist in a story" (Jacob)*

Other children however, did feel that reading about young adventurous scientists would change the way they felt toward scientists. For these children though, when asked about whether or not such a change in feeling might persuade them toward thinking about a career in science, some children thought

John:	*Probably not.*
ED:	*Probably not. Why is that?*
John:	*Well, it might change, erm, how I, how I feel about them but I wouldn't, I just wouldn't want to, I still wouldn't want to become one…*
Aiden:	*I'm the same as John.*

Some children, however, felt the opposite. Feeling that reading about young adventurous scientists would not only change the way they felt toward scientists, but might also persuade toward them thinking about a career in science

Damian:	*Erm, yes, because, erm, I'll learn more new things about scientists.*
ED:	*You think … reading about young scientists having adventures would make you want to be a scientist?*
Damian:	*(Nods).*

The children's written work, however, in answer to the question *'Do you think stories like this – with [young] scientists as heroes or heroines – could affect the way you feel about scientists and science?'* revealed

No	=	*15*
Yes & No/Maybe	=	*5*
Yes	=	*4*

This was almost exactly opposite to the degree of positivity the same class of children felt when writing down their feelings about being asked to put scientists into their stories. Previously, the majority of the children were happy and excited to put scientists into their stories, and one might suppose that a child being happy or excited about putting a particular something or someone into a story might positively effect the way the child felt in relation to that someone or something. This did not appear to be the case.

In this instance, the majority of the children felt that having dynamic young scientists in a story would not at all affect how they felt about science and scientists. Where previously 67% (16 out of 24) of the children had had happy and positive feelings about having to put scientists into their stories, here only 17% (4 out of 24) of the children felt that having scientists in stories might positively persuade them toward thinking about a career in science.

Despite the majority of the children being happy and excited about putting scientists into their stories, only three children (all boys) from this majority, having enjoyed reading about dynamic young scientists, now felt that they might be persuaded toward thinking about a career in science. One other boy from the original minority, however, having been categorised as not happy (*'a bit nervous'*) about putting a scientist into his story, having enjoyed reading about dynamic young scientists, now also felt that he could be persuaded toward thinking about a career in science.

These four boys, who felt they could be persuaded toward thinking about a science career after reading the young dynamic scientists' story, had said they felt *'exsited* [sic]*'*, *'happier'*, *'very intreaged* [sic]' and *'a bit nervous'* when expressing, earlier on, how they felt about having to put a scientist into their story. That is, three boys from the original happy majority now felt disposed toward thinking about a career in science and one boy, originally nervous and so categorised in the negative minority, having now read of the young dynamic scientists, had positively embraced the idea of thinking about the possibility of a career in science.

Alternative Stories about Science and Scientists

Analysis in connection with objective C, *to explore whether children think they are influenced or inspired by fiction*, found that some of the children felt that if a story had something 'true' or 'real' about it, *'if it's, like, got real information [in it]' (Jacob)*, then maybe that story might have an effect upon them.

With this in mind, the children were asked what they thought might happen if a real scientist, as opposed to young dynamic fictional scientists, was put into a fictional story. In answer to the question *'[What'd happen] d'you think, if you put a real person, a real scientist in a story?'*, the general consensus for Cohort 2011 was summed up by one child

Andrew:	*…I probably wouldn't put him a story 'cos a scientist, erm, isn't so adventurous if he's not mad.*
ED:	*He's not so adventurous if he's not mad?*
Andrew:	*Because I mean, erm, if, you got just, y'know, a normal scientist and you put him in a story, y'know, he probably wouldn't be so attention-seeking as if you had a mad scientist in a story.*
ED:	*So to be interesting … he has to be mad?*
Andrew:	*Yeah.*

Cohort 2012, too, felt the same way in as much as

Harry:	*[It'd be] a boring story.*
ED:	*A boring story – why's that?*
Harry:	*Because … the person might start talking about loads of boring stuff … talking and talking and talking and talking and for someone who knew what it was, it might be interesting but [for] someone who didn't actually know what it was, it would just be plain boring.*

It seemed that a real scientist did not belong in a fictional story because a real scientist's behaviour might be boring and by definition, that is by both the definition of what a real scientist is and does (see *The Children's Stories; Heroes and Villains – and Scientists*, above; *Theme 7a: The idea of doing science in the real world*, and *Theme 7b: The idea of being a scientist in the real world*, below) and what good stories are (see *Theme 6: The fictional scientist has a place in the real world*, below), a real scientist just does not belong in any good story.

The children were so asked *'How about ... facts, y'know, actual facts – but mixed up in fiction, [mixed] into a story? Would that change how you felt?'*. One child answered

> *"Er, no, because ... I wouldn't know if it was true or not then..." (Andy)*

As a direct result of Andy's answer, the question was clarified further with specific respect to the story they had co-read and discussed. I asked *'If I told you up front – before you read the book – that all the science in [the story you've just read] was true … it was a story but the science was true, would that make you feel different about the science in the story?'*. Some children felt

> *Jonny: Yes.*
> *ED: In what way would it make you feel different?*
> *Jonny: …'cos if you've read a really interesting story and you've got actual facts in it, you'll want it read it again and again and again – and you'll want to read more books that are interesting and with facts in and you'll also get into science more…*

> *"Erm, yes … because … if you don't know that, that much about science and then … you tell us all that the facts in there are true, we would be able to pick up on, erm, all the facts in there so, so we would be able to get more information about science from the book" (Donny)*

> *"Yeah, because if you thought it was false you wouldn't really take it in but if you knew it was true you'd actually remember it…" (Leah)*

These thoughts about the appeal of real science within fiction were further corroborated by the answers to the question *'Do you think mixing science facts up with adventure stories or mystery stories – d'you think that'd affect how you felt about science and being a scientist?'*. Answers were again very positive; there were no negative responses

> *Lorna: Yes.*
> *ED: In what way?*
> *Lorna: Erm, because it might make the story a bit more interesting because it'll actually use facts in it … and if a child reads it who doesn't know about scientists, they'll be able to know a bit more.*

– and one child answered

Jonah: *Erm, probably … because … your respect for scientists might go up a bit…*

ED: *Your <u>respect</u> for scientists might go up a bit?*

Jonah: *Yeah, yeah, because you might think scientists were just crazy people who blow things up but then you might think 'Oh, scientists actually <u>do</u> something'…*

This latter response suggests that not only would putting interesting real science into a fictional story make the idea of doing science more interesting, but it might make the idea of being a scientist more interesting, too.

Theme 5: Conclusion

The third research aim, *to examine how children engage with positive images of science and scientists through writing, reading and discussion of fictions in connection with the same*, saw the children very much engage with a new story, the heroines and heroes of which were young dynamic – real life-like – scientists. None of the children, however, felt they could imagine themselves as scientists in the story and only a few children felt that they could imagine themselves as scientists in any story; some of these latter children being some of the children who already felt that they might actually like to be a scientist in the future.

When asked whether having young aspirational scientists in stories might change how they felt about science and scientists, some children felt it would make no difference at all *'it's just … a scientist in a story' (Jacob)*; some felt it might actually make them think about being a scientist, *'I'll learn more new things about scientists' (Damian)*, and some children felt that although it might change the way they feel about scientists, it still wouldn't make them think about becoming one: *'I just wouldn't want to' (John)*.

The children's written work, too, suggested that the majority of the children felt that having dynamic young scientists in a story would not affect how they felt about science and scientists.

Hence, the finding that real life-like young dynamic scientists in a story would not better persuade the children toward thinking about being a scientist goes some way toward corroborating Theme 3: *The children are without conscious awareness of the effect of fictions* above, wherein, contrary to the tenets of reader response theory, the children felt that they were uninfluenced by fiction (of any nature).

Aware, however, that they felt that they might be influenced by something 'true' or 'real' in stories, the children were asked whether putting an actual real scientist into a fictional story might affect the way they felt about science and scientists; the consensus was that real scientists by their very nature – being, for example, unadventurous or boring – did not belong in any good story. This corroborated the children's ideas about what they thought about the natures of real scientists in the real world (see *The Children's Stories; Heroes and Villains – and Scientists*, above).

Putting real science facts, however, into a fictional story had a much more positive response as *'it might make the story a bit more interesting … and if a child reads it who doesn't know about scientists, they'll be able to know a bit more' (Lorna)*, and *'if you've read a really interesting story and you've got actual facts in it, you'll want it read it again and again and again' (Jonny)*.

Hence, not only would putting real science into fictional stories possibly make the idea of doing science more interesting, it might also make the idea of being a scientist more appealing, too, in as much as *'your respect for scientists might go up a bit [because] you might think "Oh, scientists actually do something"…' (Jonah)*.

Theme 6: The fictional scientist has a place in the real world

The idea that the children do not feel they can relate to fictional scientists *'because they're not actually real' (Frankie)*, together with the idea that *'fictional [scientists] … don't really … relate to the real scientists' (Callum)* either, has been explored in Theme 3: *The children are without conscious awareness of the effect of fictions* in so far as the children didn't feel that any stories they had heard about science or scientists had influenced them in any way.

In exploring the idea further, it seemed that although fictional scientists might only superficially relate to real scientists in connection with what they generically do, in that they both 'do experiments' and 'invent things' – for example:

"…they relate a little bit because they do lots of, like, experiments and sometimes they do blow stuff up like the man who invented TNT … he was a scientist … because he invented the first, like, killing thing…" (Matthew)

– they still do not relate in connection with how they are, their demeanour, in the world

"Erm, scientists who are fictional they don't really relate to the real ones, like, before, really, because they're usually good – the real scientists…" (Lucy)

When I asked *'…d'you feel there is a difference between real scientists and fictional scientists?'*, the majority of the class nodded. Thoughtful answers spoke to the believability of whatever it was fictional scientists were doing

"The difference, there is a very big difference between scientists in stories and real scientists 'cos … the scientists in stories they're doing things like creating Frankenstein[17] and doing things that aren't really possible…" (Pip)

"It sort of depends on what [sort of story] it is because … in some books, y'know, like 'Swallows and Amazons' [18], they're, they're, they're there and you know that you could do that – and that's easy enough to actually do – but in other books so, there's some sort of magical books, y'know, erm, very imaginative books, they'd be very different – so it actually depends on what sort of story you read" (Andrew)

Some children, aware of the 'inventing things' connection that both fictional and real scientists have, still recognised the difference in how fictional scientists are, their demeanour, in the world

Nate: …they relate to them because they invents things and just, well, like, fictional scientists do invent things and, but there's one difference – the fictional ones are always, like, evil and…

---

[17] Shelley, M. (1818). *Frankenstein; or the modern Prometheus*. London: Lackington, Hughes, Harding, Mavor & Jones.

[18] Ransome, A. (1930). *Swallows and amazons* (The swallows and amazons series: Book 1). London: Jonathan Cape.

ED: *Why d'you think … that's the case? Why are fictional scientists always evil?*

Nate: *It's probably just, like, the editor's mind who's doing, like, the cartoon – that's how he sees them.*

Here Nate had also raised the idea that fictional scientists come from the mind of someone else – for entertainment (cartoon) purposes. Others corroborated Nate's thoughts

> *"It's like, most of the time in cartoons – like, mostly in cartoons, yeah – they're more, sort of, a comedy, comedy character, something that's funny – and then this person rushes in with loads of papers and sticky out hair and everything and it's, it's just something that, it's not, not normal … it's just so different from real scientists and what they do" (Mary)*

Thinking about whether or not reading about or seeing scientists in stories doing crazy things might affect how they felt about scientists, one boy felt that if he didn't know about real scientists in the world, he might believe the stories

> *"…well, if I was just, like, reading those books and I had no clue about scientists out in the world – then I probably would [believe – and if] someone told me that you can't make Frankenstein, I'd be like 'Nooo, you can – of course, you just sew some body parts together and shock it with lightning and then you've got a walking dead body…'" (Pip)*

but because Pip knew there were real scientists in the world, if he were to start watching a Frankenstein movie

> *"…then I start watching, and … I just know about normal scientists … and [I'd] watch Frankenstein and I'd be like (faux posh voice) 'Well, that is not possible because lightning only affects the limbs…'" (Pip)*

Aware of real science and real scientists in the real world, the majority of the children fully understood the difference between real scientists and fictional scientists and offered explanations as to why they thought fictional scientists were the way they were. Some children again invoked cartoons

"Erm, in life, it's probably just more the cartoons, like, that have started and the comics – there's a scientist and he was the bad guy and everyone's probably just read that and now they think: scientist – mad – bad guy" (Flynn)

Other children thought about movies and/or books

"I think one of the reasons they, sort of, they make it so scientists are, y'know, have got giant hair and everything is because if it's normal, it's not going to attract any attention because, I mean, if you've got a normal scientist who's just studying, that's not going to attract any attention for a book or a movie" (Andy)

"If you've got one who was completely strange and is mad … it's going to attract much more attention … and so it'll probably sell much better" (Brody)

Fictional scientists, the children suggested, are written the way they are to make for an interesting character to, in turn, make for good story. A boring character might stop a story dead in its tracks as

"…if [the character] was a really boring one … then you wouldn't want to read it" (Joe)

"I don't like characters … that are boring, because … you don't want to read on because … it'll be boring" (Jacob)

The character that is the fictional scientist cannot be boring. This idea that the fictional scientist must be entertaining was reflected in the children's written work. The children were asked to make up both a fictional scientist and a real scientist; here, for example, is written work of two girls, Amie and Helen, and two boys, Frankie and Jaike, from Cohort 2011:

Helen's Fictional Scientist

> *He's really mad and not human; his lab is inside a rat belly; watches Death by Day[19]; eats human hair; drinks out of sewer line that goes through his lab; Name: Dr Rathog; Age: 1111; Size: 2 inches; rats as servants.*

Helen's Real Scientist:

> *A person who wants to make a difference or who wants something to change; a person who is obsessed with science and making things.*

Amie's Fictional Scientist:

> *He has curly ginger hair; he has wonky glasses, one eye, a hairy wart on the end of his Pinocchio nose, mouldy teeth; snake skin for breakfast and he drinks melted ear wax; Dr. Mango.*

Amie's Real Scientist:

> *Brainy, clever, adventurous; addicted to learning new things.*

Frankie's Fictional Scientist:

> *He's mad and evil and has a robot dog that turns into anything; watches Midsomer Murders[20] and [has] got a deformed head; eats bran flakes for breakfast, lunch and dinner; goes to South America for the annual raisin parade and has lots of minions; wants to be a pop star.*

---

[19] 'Death by Day' does not exist as a work of film or television fiction but was 'made up'/imagined by Helen in the research moment.

[20] *Midsomer Murders* (Graham, 1997-) is a popular British television series. Genre: Crime, Drama, Mystery. Rated 12 (UK)

Frankie's Real Scientist:

> *A smart well educated person who is fit to work long hours and get very stressed.*

Jaike's Fictional Scientist:

> *Name: Thunder Storm; Weapons: thunder storm; he can [go] through thunder clouds and electrocute people; he has experiments and they go up to 626; he has got two pets … 501 and 502; 501 is weird like a Lavar one when it shoots lava and 502 is a water one when it gets all the water; there is this big monster and he has a 625 sandwich maker also.*

Jaike's Real Scientist:

> *A smart scientist; a clever, a fun person; good at science; fantastic at making.*

These children's fictional scientists are wonderfully drawn characters, straight from the children's vivid imaginations; they are awesome scientists, replete with outlandish looks, extraordinary eating and drinking habits, unusual living arrangements/labs, amazing weaponry and exotic pets. Their real life counterparts are, in the main, what we have come to expect the children believe real scientists to be: clever and well-educated people, addicted to learning, likely to become stressed, who want to make a change in the world.

Although these real scientists might also be seen to be and *'adventurous' (Amie)* and *'fun' (Jaike)* which might make them exciting in a story; so too, however, could the fictional scientists *'[watching] Midsomer Murders' (Frankie)* or *'[possessing] a sandwich maker' (Jaike)*, make them ordinary in a story.

Choosing between the two, however, the children agreed that the best scientists to put in a story would be the fictional scientists. They are larger than life, better than real; crazy, evil fictional scientists are what a good science and scientist story needs.

Theme 6: Conclusion

The children felt that although there may be a cursory connection between real and fictional scientists in that they both *'do lots of experiments' (Matthew)*, for example, this is as far as the similarities go. The things fictional scientists do are more often than not things *'that aren't really possible' (Pip)*; and fictional scientists are, as people, that is, their demeanour in their fictional world, bear little to no resemblance to how the children feel real scientists are in their real world. Fictional scientists are often *'evil' (Nate)*, whereas real scientists are good people, albeit grumpy, unfriendly and stressed (see *The Children's Stories; Heroes and Villains – and Scientists*, above; and *Theme 7b: The idea of being a scientist in the real world*, below).

Fictional scientists, the children suggest, can be the figments of someone else's imaginations. They are from, for instance, *'the editor's mind who's doing the cartoon' (Nate)* and are simply written the way they are to make for a good story that will *'attract … attention' (Andy)* and *'sell better' (Brody)*.

This corroborated the children's ideas as to what would happen if you put a real scientist in a fictional story as *'a [real] scientist isn't so adventurous if he's not mad' (Andrew)* and so would only make for *'a boring story' (Harry)* (see *Theme 5: Young dynamic scientists in a story would not make the children think about being a scientist – but real science in a story might do so; Alternative Stories about Science and Scientists*, above).

Boring characters, the children felt, are anathema to any good story, and the fictional scientist as protagonist in a story has to be exciting or interesting in some way. This idea was reflected in the children's own stories. The criteria the children were given for writing their stories, was that each story had to contain at least four compulsory characters; a woman, a man, a child and a scientist. In most cases (or in every case depending upon how one defines lead roles), although the idea of putting a scientist into a story would never have occurred to them, it was the character of 'scientist' that became lead or co-lead protagonist or main antagonist in the children's stories. It could be argued that when given the 'opportunity', a fictional scientist, not least by taking a lead role, is expected to make for a good story.

Indeed, the children's good and mad-benign scientists did do exciting things (crashing in the Peruvian rain forest and rescuing all his friends) or funny things (comically healing a person with a Taser-like device; comically mixing strange, funny or gross materials to make a potion that exploded); and the evil and mad-malign scientists did exciting things, too (sending a team of ninjas out to fend off the young pretender) as well as crazy things (changing people into hamsters and back again; ordering minions off the internet/minion-ifying a person). When given the 'opportunity', these fictional scientists did precipitate good, exciting or funny stories.

When asked to create fictional and real scientists side by side (without putting them in a story), the children displayed a very sophisticated awareness of fictional representations and stereotypes of science and scientists – and the extravagance and beauty of their imagined fictional scientists by far outshone the 'ordinariness', in the main, of their imagined real world scientists.

Theme 7: The children subconsciously differentiate between 'doing science' and 'being a scientist'

One might believe that doing science and being a scientist are the same thing as, professionally, to be a scientist one has to do science, just as doing science makes one 'be' a scientist.

Although the children did not recognise or articulate such a difference, what they had to say about doing and being seemed to indicate that a distinction between the two did exist, and so the idea of doing science and the idea of being a scientist are presented separately, below. Both ideas are described here as being done and existing in the 'real world' to reinforce (or to reinforce how I have interpreted) the children's point of view. That is, of course the children live in the real world and of course the science the children do at primary school is important real world science, but the children's idea of doing science or being a scientist outside primary school, at high school, in tertiary education and/or as an adult, could seem so remote to a child, something so far removed from one's cosseted or un-worldly-wise child life, as to be fully, personally, unimaginable. In as far as this research fully embraces fictional worlds of science and scientists, the notion 'real world' helps classify and establish a world – the real world – that is both remote and non-fictional.

Theme 7a: The idea of 'doing science' in the real world

For the children, the idea of doing science as an adult in the real world differed greatly from how the children felt about doing science at school. Although one or two children did not enjoy doing science in school

> *"…because … it's a bit boring and complicated … because you hardly spend any time on the experiments and loads of time writing down what to do. 'Cos I don't like writing…" (Joseph)*

the overwhelming majority of the children did look forward to and enjoyed their school science lessons very much.

This enjoyment did not seem to translate, however, into the children's considering the doing of science as a career (see also *Theme 7b: The idea of being a scientist in the real world*). The three most evident concerns, or fears, that the children had about having to do real science as an adult were that doing science

> *– is hard work, as in time-consuming and so socially isolating*
> *– can be dangerous*
> *– could actually kill you or could kill someone else.*

Doing science is hard work

The children felt that doing science as an adult/for a living would be hard work; hard work in as much as it was 'lots of work': it was extremely time-consuming, required an exceptional degree of dedication and necessitated almost perpetual study. The actual doing of science, was hard work in as much as it was:

– time-consuming and/or socially isolating

> *Lorna: They might be too busy.*
> *ED: Busy, too busy…?*
> *Lorna: For people to come over and stuff.*

> *"…they don't really have so much time for other things … they'd be very focused on their work" (Andy)*

"…they don't have time … [they] are constantly working" (Francis)

"…they don't have time to go out or have dinner with friends" (Lucy)

– requires an exceptional degree of dedication

"[A scientist] works … he works really hard at his work, and, y'know, he might not get very much sleep…" (Andrew)

"…they work a lot. They work most every day" (Alan)

– necessitates almost perpetual study

"[It's] studying more than talking" (Moira)

"Most of the time [it's] studying…" (Philip)

Although the children felt that science would be a lot of work, however, no child expressed an opinion that doing science would be particularly *difficult* work. That is, just as the children never suggested that science in school was 'hard' as in intellectually challenging, nor did they ever mention that science as a career/as an adult would be particularly intellectually challenging either.

Doing science is dangerous

When asked *'What is science?'* (an organic question) the children gave not only answers based upon the most memorable, or most recent, areas of the school science curriculum they had studied

"Investigating forces and sounds … and liquids and stuff like that" (John)

but also, unprompted, the children expressed their ideas as to the basic philosophy and nature of science

"Discovering new things" (Lucy)

"[It's] looking at different things and how it works" (Anne)

"Experimenting things and trying to work out <u>why</u> it actually happens" (Joey)

The children were also aware that there were many different types of science

"Some of them study how the world was made and stuff like that – the universe" (Kate)

"Astronomers … and forensic scientists" (Joseph)

"People that work on people's body parts" (Bobby)

"Archaeology" (John)

"I can think of three types of sciences. Biology … physics … chemistry" (Anne)

"…some people work with chemicals and some other people work with parts of bodies and different plants or some forensic scientists … go into crime scenes" (David)

Despite the benign nature of their school science studies and their thoughtful, optimistic – and safe – perceptions of what science is, however, the children expressed concern as to the apparently very risky nature of doing science outside school. The children felt that doing science as an adult would be unsafe, could physically injure you or could mentally injure you and send you mad (insane).

The doing of science was dangerous in as much as it was:

– unsafe

Jake: *Probably some really mad scientist probably won't even have a home – 'cos they would've damaged it really bad.*
ED: *Really? This is a real life scientist, is it – a <u>real</u> <u>life</u> scientist?*
Jake: *Yeah, they had an accident and they made it blow up and then they put a bad gas in it and blew a part of the house up and it wasn't safe to go inside.*

– can physically injure you

"…sometimes scientists mix different chemicals and sometimes they go a bit wrong and sometimes the potions can do something to you…" (David)

"[doing science] might actually take a toll, because if they have really long hair and they worked with something like nuclear radiation and it burnt all their hair away then that could be a result of the science that they work on" (Francis)

– can mentally injure you/make you go mad/crazy

Bobby: I think I know how some scientists get really mad 'cos they might make a weird potion … and then he could make himself really crazy and he could turn himself into a person that can bounce off walls 'cos he's so crazy…

ED: … A <u>real</u> life scientist would do that, a <u>real</u> person would do that, d'you reckon?

Bobby: Yeah.

"[scientists] can go very mad when they work a lot" (Andy)

Despite the children being aware that there were many different types of science, 47% of the children (9 out of 19 asked in this instance) believed that 'most scientists work with chemicals'. In the main, it seemed to be this working with chemicals that would send a scientist mad or crazy as

"Sometimes something can go wrong and it can make their brain go mad. Like, if someone dropped a chemical and it spilt all on the floor and it made a horrible smell and then it could turn their brain crazy" (Ryan)

"…<u>some</u> [scientists] might be mad because they might be using chemicals" (Allen)

"some scientists lose their minds and they're all crazy … because they always try some potions and get it wrong and it makes their minds go all fuzzy and stuff" (Lucy)

Doing science could kill you or could kill someone else

The children had previously, spontaneously, only given one example, factually incorrect, of a real life scientist dying

Jack:	*…wasn't Einstein a famous scientist?*
ED:	*Einstein was a <u>very</u> famous scientist, yes.*
Brady:	*He killed himself.*
Class:	*(Laughter).*
ED:	*Einstein didn't kill himself.*
Brady:	*He got electrocuted…*
ED:	*He wasn't electrocuted. He got very ill and died in hospital…*

and only one example of a real life scientist being threatened with death: Galileo (see *Theme 2: The children are very much aware of science and scientists in film and television fiction; Real Scientists*).

None of the children could recall any actual incidences of people dying while doing science or of people being killed by someone else doing science, and when asked why they thought

"…people have died from science…" (Allen)

although some answers reiterated

"…because it's dangerous and [it] could kill someone" (Aiden)

most answers seemed to suggest that such deaths would be accidental

"[Scientists] could kill themselves by accident with all the crazy stuff they do…" (John)

"…'cos you could get electrocuted or blown up on accident" (Jason)

It seemed that although real scientists, in the main, were not likely to do the dangerous things the fictional scientists did because real scientists were thoughtful about their work and spent a great deal of time planning their experiments and making sure all due safety precautions were put in place (see *Theme 4: The* *children believe that real scientists are good people who are motivated to do good in the world; Real scientists: reflection, part reflection, and no reflection of fictional scientists*, above), still some children felt that doing science in the real world was unsafe, harmful and could be fatal.

Theme 7a: Conclusion

The idea of 'doing science' in the real world, goes some way toward exploring the first research aim, *how children feel about science and scientists*.

Although the majority of the children very much enjoyed doing science at school, the idea of doing science for a living held significantly negative connotations – and no discernable positive connotations. This, the children believed, rendered the actual day-to-day doing of science not only physically exhausting but, most likely, emotionally exhausting and socially isolating, too, in that working or studying so long and so hard left no time for anything or anyone else.

The children felt the doing of science physically exhausting in as much as doing science was time- and life-consuming hard work: scientists, the children felt, *'are constantly working' (Francis)*, *'they work a lot' (Alan)* and they work *'really hard … and … might not get very much sleep' (Andrew)*. Some children also felt that, if the scientists weren't 'working' they'd be *'[m]ost of the time … studying' (Philip)*.

The children felt the doing of science emotionally exhausting and/or socially isolating in as much as *'they don't really have so much time for other things' (Andrew)*, *'they don't have time to go out or have dinner with friends' (Lucy)* – or they wouldn't even have time to talk to other people as doing science is *'studying more than talking' (Moira)*.

However, although the children thought that all this work and study would be physically and emotionally 'hard', they did not think of the doing of all this science or science study as being academically hard or challenging. The children did seem to believe that doing science/being a real scientist was for smart people or people who were good at maths (see *Theme 7b: The idea of being a scientist in the real world; Other People as Real Scientists in the Real World*, below), but no child ever said that doing science was 'hard' as in intellectually challenging.

When thinking about and sharing their ideas about different types of science, the children embraced the nature of science(s) as being about discovery, *'looking at different things' (Anne)*, experimentation and *'trying to work out why [stuff] actually happens' (Joey)*. The children were aware of many and varied types of science: *'study[ing] … the universe' (Kate)*, forensic science and *'work[ing] with parts of bodies and different plants' (David)*, for example.

All these interesting and well-informed ideas described types of science that seemed to be, to all intents and purposes, harmless and risk-free. Yet, even though the children felt that real scientists were thoughtful, careful and planned their experiments well in advance with the safety of both themselves and others in mind, still many children felt doing science for a living would be a dangerous and even fatal enterprise.

Hence, with respect to *how children feel about science and scientists*, with the children's idea of 'science' being so physically and mentally exhausting, socially isolating and so dangerous that one might even die doing it, one might expect that the idea of 'being a scientist' in the real world would similarly unappealing.

Theme 7b: The idea of 'being a scientist' in the real world

When the children were asked whether or not they thought that real life scientists would do the things the fictional scientists did, the children revealed mixed feelings. The children of Cohort 2011 felt that real scientists might do what the good and mad-benign scientists did, and the children of Cohort 2012 felt that real scientists would not do any of the things their good, mad-malign or evil scientists did because those things were not possible (with the possible exception of the mixing of chemicals and accidentally causing an explosion).

Real scientists, the children thought, might instead *'protect the ozone layer … and save the killer whale' (Flynn)*. Real scientists are thoughtful and dedicated people and even when they do ordinary things *'like … normal people do like go and do the groceries'* still, it seemed *'most of the time they're, like, planning for what they're going to do and, or experimenting' (Donny)*. The children had ideas, too, about why real scientists would do these things: *'to get more money' (Liam)*, for example, or *'to help the world' (Alfie-Jack)* and *'to make the world a better place' (Andy)*.

Besides being thoughtful, dedicated and helping to make the world a better place, however, the children also thought that real scientists were grumpy, stressed, anti-social and unfriendly people, and this tied in with the idea of doing science in the real world as being emotionally and/or socially isolating. Deeper analysis of the data drew more corroborative evidence for these ideas. When asked, more specifically, how they thought real scientists behave, again, although some children described what could be construed as the behaviour of a real/fictional hybrid scientist or a fictional scientist

> *Terry:* *He might be a bit crazy.*
> *ED:* *A real life scientist might be a bit crazy, why is that?*
> *Terry:* *'Cos he might get a bit carried away with some of his, like, experiments that he's doing.*
> *ED:* *Carried away – in what way?*
> *Terry:* *First he might try it on, like, an animal, then he just might go racing out of the, his house and then try it on random people on the street…*
> *Class:* *(Laughter).*
> *Terry:* *…and on bus drivers.*
> *Class:* *(Laughter).*

– other answers seemed to reflect how real scientists might actually feel in the world together with why they might feel that way:

> *Jason:* *The scientists could be excited because they could make something really good.*
> *ED:* *Good in what way?*
> *Jason:* *Like, it could be something that nobody else in the world has found out.*

> *Cathryn:* *Scared.*
> *ED:* *A real life scientist might be scared – why d'you think that?*
> *Cathryn:* *Because some of his experiments might go wrong.*

> *Alan:* *Mean.*
> *ED:* *Why would … a real life scientist be mean?*
> *Alan:* *Because they could experiment on animals, like, and then animals [get hurt]…*

Mia: *Erm, they could be quite soft?*

ED: *Soft. In what way?*

Mia: *Erm, because if they're trying to do something on animals but they don't really want to hurt the animals…*

Hence, real scientists, the children believed, could show a whole range of 'normal' real emotions.

When the children were asked *'Would anyone here want to be a scientist?'*, out of 46 children (Cohorts 2011 and 2012 together), 1 girl and 2 boys said yes; 2 boys and 2 girls were unsure and the remaining 39 children (17 girls and 22 boys) did not want to be scientists, nor could they imagine themselves as scientists at all.

When asked *'Could you imagine any of your friends or family being a scientist?'*, however, the children had lots of ideas about who would make good scientists and gave lots of examples of friends, classmates, family members and neighbours.

When the reasons why the children imagined these particular people as scientists were further analysed, these people were further categorised or characterised as being described as

– *real scientists in the real world or*
– *real/fictional hybrid scientists in the real world or*
– *fictional rather than real scientists in the real world*

Other People as Real Scientists in the Real World

The children's examples of other people being real scientists in the real world were further interpreted as people

– *already possessing 'knowledge' and/or being intelligent*
– *being specifically good at maths*
– *being hard-working*

Already possessing knowledge and/or being intelligent

Friends/Classmates:

"I imagine Maggie being a scientist … because she's really intelligent" (Honor)

"Jason 'cos he likes to find out stuff sometimes and he's smart, as well" (Bobby)

Family:

"I can imagine my sister being a scientist because she knows a lot about … some things but she knows a lot specifically about certain things" (Maggie)

"My brother because I think he really likes science and he likes discovering new things" (Alan)

"My sister because she keeps reading Horrible Science books" (Catherine)

Neighbours:

"My next door neighbour … because he seems really smart" (Philip)

Being specifically good at mathematics

Friends/Classmates:

"I just think Katie because she's really good at, well, maths…" (Moira)

"I think Katie because she's really good at maths and literacy" (Julie)

Family:

"I can imagine my mum being a scientist 'cos she is really, really, good at maths…" (Mary-Ann)

"I think my dad because when he was at school he was really really good at maths and so I think he would be a really good scientist" (Annie)

"Erm, I could kind of imagine my dad being a scientist … he's really, really smart at maths and things like that and he's just really clever on general knowledge" (Piper)

Being hard-working

Friends/Classmates:

> *"I can imagine Neil and Francis as [scientists] because I think they can work and work – they might not study things like biology or physics but they study … I think they could do quite well in a few different sciences" (Andrew)*

> *"I reckon John would be a good scientist 'cos he … works hard, he knows a lot of, like, science stuff" (Sally)*

Amongst all these friends/classmates, family members and neighbours being imagined as real scientists in the real world, there was an even female to male spread.

What was interesting to note, however, was that all the girls/females imagined as potential scientists were so nominated by girls. Although girls did nominate boys/ males, too, no boys nominated any girls/females.

Other People as Real/Fictional Hybrid Scientists in the Real World

The children's examples of other people being real/fictional scientist hybrids in the real world were interpreted as being real by virtue of their 'being smart' and/or already possessing knowledge, and being fictional by virtue of their being described as 'mad', 'bonkers' or 'crazy':

> *"I can imagine Andrew being a scientist [as] sometimes he does go a little crazy and would make a good mad scientist – and … he knows a lot about science" (Neil)*

> *"Joey … 'cos sometimes he's a bit bonkers like Jason and he's quite smart as well" (Allen)*

> *Paul: I can imagine Allen as a scientist.*
> *ED: Why's that?*
> *Paul: …he's <u>mad</u>, so he'd make a, he'd make a good mad scientist and he's, he's just good on general knowledge and whenever we do*

science he's always got his hand up and he's, he always knows the answers.

"I could imagine my Uncle Jack … he could easily be a scientist because he's madder than me – and people think I'm mad – which is something. And he's also good at maths – or he was anyhow…" (Andrew)

All these people being imagined as real/fictional hybrid scientists in the real world were boys or men – without exception; and the children doing the imagining were all boys.

Other People as Fictional Scientists in the Real World

The children's examples of other people being wholly fictional rather than real scientists in the real world were also interpreted as being fictional by virtue of their being described as 'mad', 'bonkers' or 'crazy':

"Jason 'cos he's mad" (John)

"I think Andy as well because … he <u>is</u> crazy. Basically crazy." (Philip)

Jason: *My brother because he's a bit, like, bonkers.*
ED: *(Laughs) What makes him bonkers?*
Jason: *He's, he's, 'cos he's, 'cos he's always – I don't know, he just <u>is</u>.*

As with all the other people who were imagined as real/fictional hybrid scientists in the real world, so too were all these other people being imagined as wholly fictional scientists in the real world, boys or men – without exception; and here, too, all the children doing the imagining were boys.

Me – a Scientist?

With respect to the actual 'other people', the friends and classmates, that the children could imagine as being scientists for real, none of the chosen children, boys and girls alike, could imagine themselves as scientists (of any nature, that is real, fictional or real/fictional hybrid) in the real world.

None of the girls chosen as potential real scientist material saw themselves as a scientist in the future. Only Anne, who had already declared an interest in being a scientist, but had not been nominated as potential scientist material – maybe because she had already shared her ambition and her potential as scientist in the real world was a *fait accompli* – shared her feelings

> *"I can imagine myself as a scientist … because I like looking at things and discovering new things" (Anne)*

All the boys, too, whom the class popularly thought would make good real and/or fictional scientists did not see themselves as scientists. Jason, John and Joseph, for example, when asked about what they thought about being chosen by their classmates and friends as being good scientist material, did not hesitate in expressing their disinclination. Imagined as real scientists in the real world, for Jason ('smart') and John ('hard-working'), the idea of being a scientist felt like too much hard work in that it would be too time-consuming and/or require a lot of dedication

ED: What d'you think about that? Would you like to be a scientist?
Jason: Er, no.
ED: Why's that?
Jason: I don't like to work. You have to, like, work all day. I would like to do it but… I don't wanna.

ED: Do you see yourself as a scientist?
John: No.
ED: No. Why's that?
John: 'Cos I like science but I don't want to do it every day of my life.

Imagined as a wholly fictional scientist in the real world, Joseph ('very bonkers'), felt that you do not have to be particularly clever, that is, science does not have to be your 'strong point' for you to be a scientist

ED: How d'you feel about that? D'you imagine yourself as a scientist, Joseph?
Joseph: No.
ED: Why not?
Joseph: Because science isn't my strong point.

ED: *D'you think that science has to be your strong point to be a [scientist]…?*

Joseph: *No.*

Hence, none of the children singled out as potential real life scientists (or real/fictional or wholly fictional scientists in the real world), felt able to agree with their peers.

Theme 7b: Conclusion

Just as the idea of 'doing science' had done, so too did the idea of 'being a scientist' in the real world go some way toward exploring the first research aim, *how children feel about science and scientists*.

The Children's Stories; Heroes and Villains – and Scientists had revealed that the children believed real scientists to be good people who want to do good things in the world; they are clever and imaginative people who work and/or study hard and carefully plan their experiments with all due safety for themselves and others in mind.

Real scientists, when thought about as real as opposed to real/fictional hybrid or fictional people, seemed to run the gamut of 'normal' human emotions. Besides being stressed, grumpy and unfriendly they could also feel excited *'because they could make something really good' (Jason)*; scared *'[b]ecause some of his experiments might go wrong' (Cathryn)*; and mean and regretful because *'they could experiment on animals' (Alan)* but *'they don't really want to hurt the animals' (Mia)*.

Only 3 out of the 46 children said they might like to be a scientist: 1 girl out of 20 girls in all and 2 boys out of 26 boys in all; that is 5.0% of the girls and 7.7% of the boys. There were 4 children, however, who felt unsure: 2 girls and 2 boys; that is 10.0% of the girls and 7.7% of the boys.

Because the sample size was small, even one child putting her or his hand up (or down) to be counted (or not counted) one way or another, could have made a big difference to the percentages above. It therefore might seem erroneous to try to construct arguments of any nature about such percentages. Bearing this in mind, however, it could still be argued that although there were more boys than girls, in this instance, who thought they might like to be a scientist in the future, there were more girls than boys who remained open to the idea of being a scientist when they grew up in as much as they had not already entirely dismissed the idea – as the remaining 39 children had done.

Notwithstanding the above, what might be more accurately construed is that both the girls' and the boys' enjoyment of doing science at school did not, for the vast majority of the children, translate into their thinking about science as a career.

The children's thinking about other people in careers as scientists, however, garnered lots of ideas about which friends, classmates, family members and others (these others usually being neighbours) would make for real scientists in the real world.

Deeper analysis of what the children actually said about the person they were imagining as a scientist, revealed three more subtle categories/characteristics: some people were imagined as real scientists in the real world, some as a real/fictional hybrid scientists in the real world and others as completely fictional 'mad' scientists in the real world.

The people who were imagined as real scientists were seen to already possess knowledge or be good at maths or be hard-working – or any mixture of the three. The hard-working aspect of being a scientist spoke to the children's idea of 'doing science' in the real world as being physically tough and time-consuming and so corroborated part of Theme 7a: *The idea of 'doing science' in the real world*. Not only that, but when some of those (boys) chosen as imagined scientists thought about why they did not want to be a scientist, reasons included *'You have to, like, work all day … but… I don't wanna…' (Jason)*; this, too, might be seen to corroborate Theme 7a's 'hard-work putting people off' ideas the children had about doing science.

Although there was an even spread of female and male other people imagined as real scientists, all the other people who were imagined as real/fictional hybrids and wholly fictional scientists were, without exception in this instance, boys.

However, all the children who thought 'other girls' would make good real scientists in the real world were, without exception in this instance, girls; that is, no boy mentioned imagining a girl or female as a real scientist (or a real/fictional or wholly fictional scientist) in the real world.

Interesting, too, was the idea that although most of the children nominated as possible real life scientists could see potential for the same in others, they could not see – or they could not feel – the potential in themselves.

Theme 8: In the children's minds there exists a real/fictional hybrid scientist

Most themes that arose from my analysis of the data were naturally connected to the research objectives and aims, and I have described these themes as being either, in the main, theory-driven (deductive analysis) or data-driven (inductive analysis). One other theme seemed to arise throughout, however, and this theme I felt was a mixture of both as it seemed to permeate the objectives, aims, and the other themes, too. It was the idea that the children seemed to think, speak and write about scientists – both real scientists and fictional scientists – as being one of three types: real, fictional or real/fictional hybrid types of people.

Most of the children had taken part in all the discussions we had had about real and fictional scientists. We had shared stories, thought about the motivations of both real and fictional scientists, thought about the things both real and fictional scientists might do and not do. On several occasions, however, it had become clear that for many children, the line between what was real and what was fictional with respect to science and scientists was blurred, and I had had to pause the discussions to make sure that the scientists we were all thinking and talking about, in that research moment, were the type of scientists we were supposed to be thinking and talking about. That is, I often had to check that when I'd asked questions about fictional scientists, the children did have fictional scientists in their minds when answering those questions, and when we were talking about real scientists, the children did have real scientists in mind.

However, despite reassurances from the children that they were thinking about the 'right' type of scientist, the children's answers demonstrated widely varying perceptions – ranging from an easy simple distinction between the real and the not real scientist to a confusing/fusing of the real scientist with varying degrees of the (especially mad/crazy) stereotypes often found in fiction.

For example, when we were talking about how all the different (good, evil, crazy) scientists in their own stories had turned out, I had asked the children *'Is that how you expected them to be?'*. Answers included:

reflections of real life scientists

> *"Yes, because … all the scientists in the world are different" (Allen)*

reflections of purely fictional scientists

> *"no – because I expected all of them to be, like, evil or mad" (Alfie)*

and reflections of real/fictional hybrid scientists

> *"yeah … because scientists are normally mad … or evil … because they might've been born like that [or] they might just want to be different to other people … because the world needs different things" (Jonny).*

When considering Theme 7b: *The idea of being a scientist in the real world*, too, when the children were asked why they could imagine particular friends or associates as scientists, the children's reasons fell into what were becoming familiar 'types' of scientist. Although designating specific friends, family and associates as real scientists in the real world, the children were choosing these people because they felt, to them, like real scientists or wholly fictional scientists or real/fictional hybrid scientists. For example:

real scientists

> *"I imagine Maggie being a scientist … because she's really intelligent" (Honor)*

wholly fictional scientists

> *"My brother because he's a bit, like, bonkers" (Jason)*

and real/fictional hybrid scientists

> *"I can imagine Andrew being a scientist [as] sometimes he does go a little crazy and would make a good mad scientist – and … he knows a lot about science" (Neil).*

The children's ideas – of how they expected their fictional scientists to be (see *The Children's Stories; The Scientists in the Children's Stories*); about why they could envisage other particular people as scientists (see *Theme 7b: The idea of being a scientist in the real world*); and of whether or not they believed real scientists would do the things their fictional scientists did (see *Theme 4: The children believe that real scientists are good people who are motivated to do good in the world*), for instance – presented notions of 'scientist' that seemed based on non-fiction, fiction or a mixture of both.

I interpreted the idea of what was 'real' as being characteristic of how real scientists are represented in the real world, in non-fictional contexts such as news items, documentary programmes and the like: the children knowing that all the scientists in the world are different; the children thinking that someone who was intelligent might make a good scientist; the children believing that scientists do not do impossible things (turning humans into hamsters). I interpreted 'fictional' as being something that was not 'normal' in the real world or something that the children themselves had already believed to be fictional: the children expecting scientists to be evil or crazy; the children thinking that someone who was 'bonkers' might make a good real scientist. Some children, however, took elements from both non-fictional and fictional sources to create hybrid scientists that, to me, began to feel not so much like a *confusion* of the non-fictional and the fictional, but a *fusion* of the two instead. That is, in the children's minds there existed an entity that was neither completely real nor completely fictional: it was a mixture, a fusion, of the two.

I also felt that the ease with which the non-fictional and the fictional worlds crossed over and interweaved – the ease with which the idea of 'scientist' moved between worlds – worthy of further examination.

Non-Fictional Representations in the Fictional World

Some children naturally brought thoughts from non-fictional representations to their explanations and descriptions of their story scientists. When thinking about how they expected the fictional scientists in their stories to be, for instance, although some children had expected fictional scientists to be like fictional scientists (evil, crazy), other children had carried their ideas of how real scientists are into their fictional story world and, for example, could fully understand how all their fictional scientists turned out to be different people because, they felt, scientists in the real world were different people.

I fully expected the children to bring real world ideas into their fictional world settings as, in making up stories, we use what we know; we take recognisable characters with recognisable traits or skills (which we may enhance or diminish) and we put those characters in interesting or entertaining situations or predicaments. That is, our imaginary worlds are based in some measure upon our real worlds. I anticipated less, however, the degree to which the fictional world was brought into the real world.

Fictional Representations in the Non-Fictional World

When thinking about real scientists' motivations, some children understood that real scientists wouldn't want to do (fictional) cruel or inhuman things. Other children, however, used the fictional idea of being 'crazy', though not necessarily cruel or inhuman, to explain non-fictional ways of being. Fictional scientists' ways of being and their motivations, were brought from the fictional world into the real world.

For instance, when thinking about who might make real scientists in the real world, some children thought clever people would, others thought 'crazy' people would and other children thought people who were a mixture of both clever and crazy would make good real world scientists. Hence, fictional scientists' ways of being, their attributes, were crossed-over from fiction and mixed with real life.

Theme 8: Conclusion

From a reader response and interpretive communities perspective, the children were drawing on what they knew already, on the meaning they had already made to date, in connection with fictional scientists and real scientists and were making fresh meaning when transacting answers to the research questions in the research moment.

The children did know of fictional scientists in the fictional world, and of real scientists in the real world. Their knowledge about both worlds had been re/created many times throughout their lives. As a matter of metaphysics, however, it might be considered impossible to 'know' (in as much as 'be absolutely sure of the existence of') of something 'fictional' in the 'real' world: unicorns, for example. Unicorns do 'exist' in as much as they are a something that we know of; they are a something that we might think about, or physically draw and then point at: that there, is a unicorn. We know of it, we can describe it, we can draw it and point at it – yet it is a conceptual rather than a material thing; it is not real, it is imaginary. We might say this about all fictional characters, or of anything and everything that is fiction. When we are talking about imaginary things, we 'know' we are talking about imaginary things; we point and, more often than not, we know that what we are pointing at is imaginary: *'it's just a story' (Cooper)*.

From what the children have told me about the nature and construction of stories, from what they have told me about their happy engagement with stories, from what they have told me about their own fictional scientists in their own stories and other fictional scientists' *raisons d'etre*, the children do 'know' that fictional scientists are not real. However, for very many of the children, despite this knowing, when coming to describe, draw, point to the fictional scientist, they seem to be saying that she or he is partly real. This is understandable in as much she or he is based on or might share the characteristics or motivations of real scientists – but, most interesting, when coming to describe, draw, point to the *real* scientist, although she or he might indeed share characteristics with fictional scientists, some children are saying that the real scientist, though 'real', is partly fictional.

Chapter 7 – Discussion

Introduction

This chapter draws on the themes described in the previous chapter in order to demonstrate the satisfaction of the research objectives and aims.

Resolutions of the research objectives are outlined first wherein the children's experience with science and scientists in existing fiction is discussed together with the identification of the scientist in existing fact and fiction. How the children felt about the influence of stories about science and scientists is explored and the children's ideas about 'truth' in fiction is examined.

Satisfaction of the research aims is then focused upon. The children's ideas about good, kind scientists and grumpy, unfriendly scientists are discussed. The possibility of alternative stories is raised and the idea of truth in fiction revisited but with particular respect to fictions connected with science and scientists.

The concept of the real/fictional hybrid scientist is also revisited, and the idea of a binary discord – or fluid discord/dissonance – arising between the idea of 'doing science' and the idea of 'being a scientist' is considered.

The idea of the children's own 'fantastic/fantasy' science is introduced and the scientist's identity, complicated by concerns about the possible 'feminisation' and/or 'masculinisation' of science learning together with the children's idea that doing science or being a scientist is a way of being for more able or more knowledgeable people, is discussed.

Satisfying the Research Objectives

Resolution of the first two objectives

A. *to examine how engaged children are with fiction (of any nature)*

B. *to investigate whether children are familiar with science or scientists in fiction* transpired in the shaping and exploration of the first two themes, viz:

> *Theme 1: The children are without conscious awareness of science or scientists in literary fiction*
>
> *Theme 2: The children are very much aware of science and scientists in film and television fiction*

which suggested that the children were very familiar with and engaged very well and very happily with fiction (objective A); and, although the children were also very familiar with and engaged very well and very happily with science and scientists in fiction, they first had to be prompted to do so, and then, once prompted, their thoughts and ideas about fictional representations of science and scientists were mostly gathered from live action and animated television and made-for-cinema film rather than literature (objective B).

Science and Scientists in Existing Fiction

Both this limited experience with science and scientists in general fiction (before prompting) and in literary fiction (after prompting) seemed particularly marked as, before being asked to specifically do so, the children of both cohorts never once referenced any existing stories that involved science or scientists.

Even the children of Cohort 2011, who had actually collaborated in writing, acting out and sharing their own stories about science and scientists before talking about stories in general, did not once mention science or scientists in stories of any nature whatsoever; they did not even reference their own science and scientist stories which had in fact been shared and very much enjoyed, applauded and, with much fun and laughter, discussed with myself and their classmates, just a few minutes before.

This raised the question as to whether it was the limited available experience with literary science and scientists – in as much as children's novels involving science or engineering activities or characters are not currently prevalent (Holbrook et al., 2009) – that would explain the lack of initial recall of such stories, or whether the lack of recall was simply a lack of interest.

The enthusiasm with which the children shared their ideas about science and scientists in television documentaries and television fiction series and fiction films, however, and, particularly their willingness to share and their enjoyment in listening to each others' greatly detailed scenes and storylines about the same, seems to strongly preclude a lack of interest or an unwillingness to engage.

Still, the evidence suggested that when asked to think about stories in general, stories about science and scientists were not brought to mind. This might be because when asked to think about stories of any nature, children might think first about literary fiction not television or film; that is, they might think about written down stories: children's books or the sort of creative writing stories that they themselves are often asked to write at school. Being asked to make up and write down stories in the research moment might have exacerbated the children's thinking of the written down word, the 'readable' story, as opposed to their bringing to mind the televisual or cinematic scene. Hence, this could be one reason why science and scientists, because they are not prevalent in written down story form, were not brought to mind.

The Identification of the Scientist in Existing Fact and Fiction

When asked to name real or fictional scientists, the children at first named only real scientists. However, the majority of real scientists the children mentioned were suggested in question form, *'Was Leonardo Da Vinci a Scientist?' (Matthew)*. When faced with an adult asking questions of them, though, children giving this type of question-as-an-answer could be a consequence of the child wondering of the adult *'Is this the sort of thing you want to hear?'*, *'Is this the sort of thing you expect me to say?'*: *'Thomas Edison?' (Mary-Ann)*, *'Isn't Stephen Hawking a scientist?' (Alfie-Jack)*, *'Erm, you know Brian Cox?' (Laura)*.

If this wasn't the case and the children actually were unsure how or who to categorise as 'scientist' in the real world, it was noticeable that no such uncertainty existed when the children were thinking about and answering questions about fictional scientists.

Examples of fictional scientists, albeit at first only coming from films and television, were given in statement, not question, form: *'there's a film called Flash Gordon and, erm, there's this crazy scientist who's got a few screws loose' (Jaime)*, *'The* *person from Back to the Future' (Mitch)*, *'There's also a dude on Spiderman with tons of electric arms' (Frankie)*. The (only) two examples of scientists from literary fiction were also made as statements not questions: *'Uncle Quentin' (Andrew)* and *'Uncle Monty' (Flynn)*.

This could mean that the children found the fictional scientists more easily recognisable or identifiable as such – maybe on account of the usually spectacular environs within which fictional scientists are situated and/or the usually elaborate faux-scientific paraphernalia with which fictional scientists are surrounded and with which they interact.

The children, most likely, had no memory of real scientists surrounded by or interacting with such colourful and memorable environs or paraphernalia. Real scientists, having never being situated or depicted as vividly, might so be less easily imagined or brought to mind, with or without the colour.

Also, the children's uncertainty as to whether or not the person they named actually was a scientist, might have been because the idea of who can be categorised as 'scientist' in the real world was not unknowable or vague, particularly, but instead actually faced a broader interpretation: *'Was Neil Armstrong a sort of Scientist?' (Damian)*, *'Was Alexander Bell an inventor ... or was he a scientist?' (Andy)*, '*…was Ben Franklin a scientist?' (Missy)*, *'…wasn't there also [someone] that tried to sail off the edge of the earth ... Was he a scientist?' (Frankie)*, *'Could philosophers be scientists?' (Finn)*, *'would most of the pyramid builders or pyramid designers, architects be, like, scientists?' (Pip)*. To the children, the idea of 'scientist' embraced the idea of 'astronaut', 'inventor', 'politician', 'explorer' or 'adventurer', 'philosopher', 'builder', 'designer', 'architect' and even *'ninja' (Gabe)*, among others.

If the children hadn't misheard or misunderstood the original question (when asked to name real or fictional scientists), although real scientists were brought to mind first – in all their wonderfully diverse vocations and occupations – it could be that, when the children were asked to think specifically about fictional scientists, 'fictional scientist' as a specific identity felt easier to recognise; they were more detectable to the children than real scientists were, and hence were volunteered with more confidence, that is, they were volunteered as statements, not as questions.

The Influence of Stories about Science and Scientists

Resolution of the third objective

> C. *to explore whether children think they are influenced or inspired by fiction*

transpired in the shaping and exploration of the third theme:

> *Theme 3: The children are without conscious awareness of the effect of fictions*

which suggested that the majority of the children felt that they had not been changed or influenced in any way by either stories in general or stories about science and scientists because, for example, *'they are just stories' (Julie)*.

From a reader response perspective, of course, a person's interaction with a text re/creates the text and re/creates the person, and this new person will look upon the world in a different way albeit, in most instances, in an imperceptibly different way. This does not mean, however, that the children – or anybody – would be particularly aware of any change in perception.

In the main, the children felt that literary stories about scientists did not/would not affect how they felt about real scientists. They said this was because scientists in stories:

did not seem real

> *"they're just, like, in a story which isn't the same as real life" (Frankie)*

the representations of the scientists in stories might be superficial

> *"story books … might only tell you what they wear" (Sara)*

the representations of the science in stories might be insubstantial or non-existent

> *"[the story's] not going to, like, say what [a scientist] does" (Liam).*

These stories that the children were referring to were not actual stories that the children had read or heard. Within the context of what we were discussing, these ideas about the superficial scientist and the insubstantial science in stories seemed to be what the children, drawing upon their in/experience in reading/viewing science and scientists in literary/visual fiction, were imagining scientists and science to be like if they did happen to come across them in literature (actual examples of science and scientists in literature being rare).

The children were calling into being superficial and insubstantial representations and putting these representations into 'fictional' – that is, non-existent – fictions. These 'non-existent' fictional scientists were not like 'usual' fictional scientists. What the usual evil or crazy fictional scientists wear or do in television or film is never an issue. The style (dress) and demeanour of the scientist character match the colourful environs of the story, and the science in science fiction, by reason of it being 'science' in 'science fiction', is always in some way enthralling. Crazy scientists, colourful environs and science in science fiction: this, these things, the children do have happy and engaged experience of. It didn't seem to make sense that they would think that a fictional scientist in a story book should be any different – and the children's own stories attested to this. The children's own creations of fictional scientists made for fun and exciting stories wherein the scientist characters were not superficial (they were the protagonists or antagonists) and the science, when used, was substantial and entertaining. In their individual written work, too, wherein the children had described a fictional scientist and a real scientist side by side, the children had been enormously inventive and creative. The children knew, too, about comics and cartoons, and the compelling fictional mad/crazy scientists therein – characters that had come from, for example, *'the editor's mind who's doing, like, the cartoon' (Nate)*.

Hence, when not making up stories and characters, and when instead thinking about whether fictional scientists in stories might change how they feel about real scientists, it would be reasonable to expect that the children might consider fictional scientists in story books to be not that much different from the scientists in their own stories and/or others' television series, films, comics and cartoons – but this was not the case. Even young dynamic aspirational scientists in a story would not, the children felt, influence them in any way – as *Theme 5: Young dynamic scientists in a story would not make the children think about being a scientist – but real science in a story might do so*, attests.

Truth in Fiction

When first asking the children to think and talk about stories in general (with no reference to fictional or real), and then about stories about science and scientists (no reference to fictional or real), I had assumed that the children would look to fictional stories as opposed to true stories – and this was the case.

When I asked the children whether they felt they had been affected or influenced in any way by any stories, I had assumed the same: I thought the children would look to fictional stories not factual. In the main, this, too, was the case. However, some children, unprompted, raised the idea that their being affected by a story would depend upon whether the story was true or not *'because if it's real it might [change me] but if it's not real it won't change [me]' (Jacob)*.

When asked to think about whether there might exist 'some sort of story' (no reference to fictional or real) that they hadn't come across yet, that might affect them, again the idea of a story being at least partially true came to light; some responses, for example, alluding to the presence of *'some real information' (Jonah)* in a story possibly having an effect.

When I asked the children whether they thought there could be written any type of story that might change the way they felt about science and scientists, again the idea of a story being at least partially 'true' was raised: *'a [fictional] story book – but about all the facts … that's actually <u>real</u> about scientists … all the bits that are being told in the story … are actually true' (Allen)* was suggested as an agent for change.

Hence, the children themselves, unprompted, raised this idea of truth in fiction, and when consequently asked whether they felt influenced by true stories about real scientists, evidence pointed to a reversal of the children's view that they were unaffected by stories; true stories about real scientists might make the children feel that real scientists were *'right nice people'* that the children could probably happily relate to and hence identify with if they had the opportunity *'to get to know them' (Cassie)*.

Satisfying the Research Aims

Resolution of the first and second research aims

1. *how children feel about science and scientists and*
2. *whether children have any insight into why they feel this way*

transpired in the resolutions of the three research objectives and in the shaping and exploration of many, if not all, of the themes presented. For specificity, however, the satisfaction of both these aims is discussed here in connection with themes 4, 7a, 7b and 8, viz:

Theme 4: The children believe that real scientists are good people who are motivated to do good in the world

Theme 7: The children subconsciously differentiate between 'doing science' and 'being a scientist'
Theme 7a: The idea of 'doing science' in the real world
Theme 7b: The idea of 'being a scientist' in the real world

Theme 8: In the children's minds there exists a real/fictional hybrid scientist.

Good, Kind – yet Grumpy and Unfriendly Scientists

Although they would never have thought of doing so, the children very much enjoyed putting scientists into their stories; and their stories described an even mix of good, evil and mad/crazy scientists. When looking to whether or not this mix was what the children had expected (in pursuit of the first research aim), the confusion or, better, the fusion, of that which was real and that which was fictional became apparent (Theme 8), and when looking to whether or not real scientists would do the things their fictional scientists did (in pursuit of the second research aim), the fusion arose again.

The first research aim revealed how the children felt about real scientists. The children believed that real scientists are good, self-sacrificing people who want to do good in the world (Theme 4) – and this was reflected in half of the children's stories. The children's good scientists were brave and kind; one risked his life to save others and one repeatedly healed someone; the children's mad-benign scientist was funny, apologetic and affectionate. These good fictional scientists, with good, kind, human (real scientist) traits stood in contrast to the children's evil and mad-malign scientists who turned people into hamsters or minions and killed a young pretender: not, on the whole, very nice (or real scientist) traits at all.

The good, kind scientist doing good in the world, however, upon deeper examination in pursuit of the second research aim, was revealed to be something else, besides: real scientists, the children felt, were grumpy, unfriendly and stressed.

Although this could be the case for some scientists, it is likely to be the exception rather than the rule. Hermanowicz (2003) asks "Are scientists happy?" and says that "surveys conclude that they are" (p. 69). The children, however, might think scientists are unhappy because, as Themes 7a and 7b suggest, the doing of science entails the sacrifice of oneself and one's family/social life to constant work and/or study – which might, quite naturally, occasion a grumpy, anti-social or stressed disposition in non-scientists, too.

The children had never seen any real life scientists behaving in a grumpy, anti-social or stressed/distressed manner; the few real scientists they had seen on television were doing fun and interesting things and, whilst doing as much, were not seen to be unfriendly or unhappy.

In considering this idea of the unhappy real scientist and where she or he comes from, one could argue that the children might feel that real scientists could be this miserable because this is how the children imagine they themselves might feel if they had to do science, that is, constant work and/or constant study, all day long/for a living.

As to *why* the children would think this, perhaps speaks to what the children believe are the real motivations behind real scientists and/or their doing of science. The children believe that real scientists do good in the world. They want to make a difference in the world and make the world a better place. Such good intentions, however, require focused dedication; and not just ordinary, conscientious-type dedication, but absolute, fully committed, life-consuming dedication; one must constantly work or study hard – because the health of the planet, and the future of humankind is at stake: it is an extremely big responsibility, and might feel like far too big a responsibility, for a child to, consciously or subconsciously, take on board.

Resolution of the third research aim

> *3. how children engage with representations of science and scientists through writing, reading and discussion of fictions about the same*

transpired in the shaping and exploration of themes 5, 6, 7a, 7b and 8, viz:

> *Theme 5: Young dynamic scientists in a story would not make the children think about being a scientist – but real science in a story might do so*
>
> *Theme 6: The fictional scientist has a place in the real world*
>
> *Theme 7: The children subconsciously differentiate between 'doing science' and 'being a scientist'*
> *Theme 7a: The idea of 'doing science' in the real world*
> *Theme 7b: The idea of 'being a scientist' in the real world*
>
> *Theme 8: In the children's minds there exists a real/fictional hybrid scientist.*

The children had revealed themselves to be open to the possibility that they might be influenced by stories that had something 'true' or 'real' in them (Theme 5). The majority of the children felt, though, that putting a real scientist into a fictional story would only make for a boring story. A real scientist by her or his very nature (being unadventurous and reserved, for example – see *Figure 8: The Features of Real Scientists*) does not belong in the sort of fun, funny or exciting stories that the children were interested in reading.

However, although the idea of writing a real scientist (as opposed to a fictional scientist) into a story did not sound appealing to the children, some children pointed out that perhaps the way the real scientist was written might make a difference, for example

> *ED: So, you reckon it's a bad idea to put a real scientist in a story?*
> *Mars: Erm, if you put a real scientist in a story … if you wrote a scientist that didn't really go on about stuff that's complicated then it might be*

a good story but if you did put something in like that then it would be pretty boring.

The way the real scientist was written, if she or he was written against perceived type – if she or he was adventurous, perhaps, and uncomplicated – then that might make for a character that the children could enjoy and potentially identify with.

When asking the children to think about putting real scientists into stories and when considering those perceived types of scientists, one might expect, however, whether written to type or against type, the scientist that is written about is still likely to be an adult.

This idea was demonstrated in the children's own stories. Part of the criteria the children were given for writing their own stories was that each story had to have at least one woman, one man, one child and one scientist in it. For both cohorts, when the stories were written and enacted, the scientists in the stories were never particularly depicted as children or young people. This may not have been the case as the children were never asked if the scientist characters in their stories were children or young people, but the 'children' in the stories were explicitly identified as such and the scientists (5 boys and 2 girls) who were not identified as 'Grandpa', 'Guinea Pig Man', 'bad guy' and 'Sir', could readily be seen to identify as grown-ups. This makes sense in as much as being a career scientist is something 'children' do not do.

When a child is making sense of the world, however, what grown-ups say and do in navigating the narratives of their grown-up lives may seem boring and complicated to a child. That is, besides 'real scientists' appearing to be boring and complicated, so too can 'adults' appear boring and complicated to children.

If a child is thinking about or is asked about what they might like to be when they grow up, in trying to inspire children toward a career in science, offering (real or fictional) representations of scientists as grown-ups, one might think, is the right thing to do. Evidence suggests, however, that this type of exposure to science and scientists hasn't worked, so far (see *Chapter 1 – Context and Aims of the Research; Discovering the Gap in Knowledge*; Boaventura et al., 2013; Grob et al., 2017; Zardetto-Smith et al., 2000), in persuading children toward a life in science, and maybe offering an alternative type of scientist, for example, the child as scientist, at the very least presents a different approach.

As the third research aim was *to understand how children engage with positive images of science and scientists through reading and discussion of fictions*, the research design called for the children to read or to have read to them a story containing positive images of science and scientists. The scientists in this story the children read and heard were not adults; they were two twelve year old girls and two twelve year old boys who were resident at a school dedicated to science.

These protagonists were purposefully written against type. First, to break away from the idea of (what I thought was) the stereotypical (fictional) scientist in her or his self, and second, to create real-life-like – but fun, adventurous, not boring – young scientists that the children might like to, or might be more easily able to, identify with.

Although the children said that they enjoyed reading and listening to the story, the majority felt that they could not imagine themselves as the young, dynamic scientists in the same. Also, despite some children feeling that reading about these sort of scientists might change how they felt about real scientists and might even persuade them toward thinking about a career in science, still, the majority felt that young, dynamic scientists doing fun, funny, adventurous things in a story would not affect how they felt. Scientists in a story, young and dynamic or not, are still just *'scientist[s] in a story' (Jacob)*: they are works of fiction and will have no effect. This idea corroborated the children's feeling that they felt uninfluenced by neither general fiction nor fiction including science and scientists.

Hence, the children, in the main, felt uninfluenced by neither dynamic young (fictional) scientists in stories nor the idea of putting real scientists into stories. The idea of putting real *science* into stories, though, had a much more positive outcome.

I told the children that all the science in the young dynamic scientists' story was true (which it was), and then asked them whether having real science in a fictional story might make them feel any different toward science and scientists. Besides making the stories *'more interesting' (Lorna)*, some children felt that having *'actual facts'* in a story would make you *'want to read it again and again and again – and you'll want to read more books that are interesting and with facts in and you'll also get into science more…' (Jonny).*

Real science in a story might not only help 'get children into science more' but might also, some children felt, help children come to know or understand real scientists, too: *'if a child reads it who doesn't know about scientists, they'll be able to know a bit more' (Lorna)*; or might even change the way children feel about scientists in as much as *'your respect for scientists might go up a bit [because] you might think "Oh, scientists actually do something"…' (Jonah)*.

There was only one negative response wherein one child felt that mixing actual facts into a fictional story might cause some confusion because one *'wouldn't know if it was true or not' (Andy)*. Whether Andy was referring to the confusion being on account of not knowing whether the facts were true or not, or whether the story was true or not, was unclear – but this led to the idea that if real science was to be put into a fictional story, then it would be a good idea to let readers know, before they started reading, that the science in the story they were about to encounter was indeed 'real' or 'true'.

It seemed, therefore, that in thinking about using stories connected to science and scientists as a possible way of persuading children to reconsider how they think about science and scientists and/or a career in science, stories wouldn't need to change the fictional scientists: fictional scientists are fine the way they are (Theme 6). What might need to change, however, is the fictional science.

The Hybrid Scientist – the Real/Fictional Fusion

Having, myself, interpreted the idea of the 'real' scientist as being characteristic of how real scientists are represented in non-fictional contexts (scientists being 'normal', 'doing good' in the world as seen in news items or documentaries, for instance); and having also interpreted the idea of the 'fictional' scientist as being represented by characteristics that were not 'normal' in the real world (being 'crazy', doing 'impossible' things like turning humans into hamsters, for instance), I came to understand that some children could clearly differentiate between the two. For example, some of the children's thoughts about real scientists included

Jason: *The scientists could be excited because they could make something really good.*

ED: *Good in what way?*

Jason: Like, it could be something that nobody else in the world has found out.

"I think … a real scientist would do what he does to get more money … to buy more things" (Liam)

"…all the scientists in the world – well, most of them anyway – are good guys because they help in the world" (Alfie-Jack)

and some of the children's thoughts about fictional scientists included

"…I expected all of [the fictional scientists] to be, like, evil or mad" (Alfie)

"…when you think [fictional] scientist you imagine them in an evil lair or something, making things happen, so you don't really expect a kind one…" (Amie).

When asked to imagine someone they knew who could be a real scientist (Theme 7b), some children recommended people on account of their real world/real scientists qualities

"I imagine Maggie being a scientist … because she's really intelligent" (Honor)

"I can imagine my mum being a scientist 'cos she is really, really, good at maths…" (Mary-Ann)

"I reckon John would be a good scientist 'cos he … works hard, he knows a lot of, like, science stuff" (Sally)

and other children made recommendations on account of qualities that were not those of 'real' scientists but were better attributed to fictional scientists

"Jason 'cos he's mad" (John)

"I think Andy as well because … he <u>is</u> crazy. Basically crazy." (Philip)

Jason: My brother because he's a bit, like, bonkers.
ED: (Laughs) What makes him bonkers?

Jason: He's, he's, 'cos he's, 'cos he's always – I don't know, he just <u>is</u>.

However, although some of the children clearly differentiated between the idea of the real scientist and the idea of the fictional scientist, other children seemed to combine aspects of both ideas. That is, it didn't seem that some children were without the ability to differentiate between ideas – they were not 'mistaking' the real scientist for the fictional scientist – rather, these children were drawing on both non-fictional and fictional sources to re/create a real/fictional hybrid scientist. For example, when talking about whether or not their story scientists had turned out how they expected them to be, what some of the children said seemed to seamlessly blend both ideas

> *"…[fictional] scientists are normally mad … or evil … because they might've been born like that [or] they might just want to be different to other people … because the world needs different things" (Jonny)*

and when imagining someone they knew as a real scientist, some children, blending both ideas, created a real/fictional hybrid scientist

Paul: I can imagine Allen as a scientist.
ED: Why's that?
Paul: …he's <u>mad</u>, so he'd make a, he'd make a good mad scientist and he's, he's just good on general knowledge and whenever we do science he's always got his hand up and he's, he always knows the answers.

> *"I could imagine my Uncle Jack … he could easily be a scientist because he's madder than me – and people think I'm mad – which is something. And he's also good at maths – or he was anyhow…" (Andrew)*

The children did not seem to be confusing the 'evil' or 'mad' scientist with the 'always got his hand up' or 'good at maths' scientist, they were combining the two. In the children's minds there seemed to exist an idea of 'scientist' that was a synthesis of how they saw fictional scientists and how they saw real scientists.

The idea suffused the research entirely. Despite my unwitting attempts to stop it in its tracks by asking the children to be sure that when we were talking about real scientists they really were thinking about real scientists, and when we were talking about fictional scientists they really were thinking about fictional scientists, the synthesis remained. The children did not seem at all surprised by my checking or asking for clarification; they just carried on what they were saying, continued their trains of thought and happily re/engaged with this synthesis as being nothing even remotely unusual or out of the ordinary.

I felt, when thinking about and coming to present the children's thoughts and ideas about real and fictional scientists, that discounting the idea of the real/fictional hybrid scientist would be not telling the whole 'truth', as it did seem that for a lot of the children, their personal thoughts and ideas about real scientists and fictional scientists sometimes seamlessly, naturally, combined.

Together, the real, the fictional and the real/fictional hybrid painted a sort of triptych, a three-panelled picture of how the children felt about 'scientist'. Each part of the picture was separate and identifiable, yet each part needed the other parts to show the whole.

Binary Discord/Fluid Dissonance

Analysis of the data revealed a lack of motivation toward a career in science, or toward even thinking about a career in science (Themes 7a and 7b). Initially, it seemed that being a scientist as an adult had barely been a consideration for the children; that is, it wasn't as if the children had thought about a career in science and subsequently discarded the idea, it seemed, instead, that the idea of being a scientist might not have even occurred to them. The idea that the vast majority of the children would never have thought of putting a scientist into their stories might go some way toward corroborating this: it could be that, being so far removed from the children's minds, science and scientists rarely make an appearance in the children's own stories (see *Chapter 6 – Results; The Children's Stories; The Idea of Putting Scientists into Stories*).

However, having put scientists into their stories, stories that were fun, funny and exciting and very much enjoyed and appreciated by everybody they were shared with, during our discussions about the same, the children were asked to consider and reflect upon science as a career. The children's subsequent disinclination toward a career in science did not seem to be arbitrary or ambivalent. It seemed that, having thought about it, the children felt that the doing of science embraced too many unattractive associations – associations that seemed to directly conflict with the children's own experiences of doing science in school.

This might imply that there is a difference between doing science in primary school and doing science in the outside world. From an adult perspective, there is, of course, a huge understandable difference; but it could be argued that children might not be expected to see such a huge difference. One might consider Alfie, for example, who likes ice-cream and *'would like to be an ice-cream man'* when he grows up; or Jacob *'I want to be a footballer'* and Cathryn *'I really want to be a journalist'*, who, respectively, like playing football and like writing. It seems reasonable to expect that at least some of the (majority of the) children who liked or loved their science lessons might think about being a scientist when they grew up – but this wasn't the case.

One reason could be because, to a child, there is indeed a difference between doing science at school and doing science in the real world; it is not the same difference that adults know exists between school science and real world science, but it is a huge difference nonetheless. Adults might believe that, career-wise, there is no disparity between what one 'is' and what one 'does'. A scientist does science. It is in the doing of science that one 'is' a scientist; and, vice versa, in being a scientist one has to 'do' science.

My analysis of the data, however, suggested that the children did not feel this way. Instead, there existed a binary discord: for the children, the idea of 'doing science' held different connotations to the idea of 'being a scientist'. Not only that but, although both these considerations were inextricably interlaced with one another, it was still both ideas, that is, the idea of doing science in the real world as well as the idea of being a scientist in the real world, that seemed to be putting the children off thinking about a career in science. The path to a career in science seemed doubly road-blocked.

The identification of these two interdependent themes – that of doing science and that of being a scientist – was neither an explicit nor an implicit part of the research objectives or aims. The children were never asked about any such distinction (such an enquiry might have been too epistemologically challenging for the children, of course), and both the distinctive themes became disclosed naturally from the data analysis.

Archer et al. (2010) working with children one year older than my children (and looking at the children's constructions of science through the lens of identity; see *Chapter 1 – Context and Aims of the Research*) also identified this "conceptual binary" (p. 623) between 'doing science' and 'being a scientist'. They felt that the importance of this conceptual distinction lay in its ability to explain why children could, on the one hand, enjoy school science (as most of their research participants and most of my research participants did) and yet, on the other hand, not want to pursue a career in science or 'be' a scientist (as, also, most of their research participants and most of my research participants did not).

Within my research, however, within the context of the children's engagement with fictional representations of science and scientists, and through the children's engagement with the doing of fictional science by characters identifying/being identified as fictional scientists and how these might or might not persuade children toward a career in science, the binary appeared to be both more complex and more contradictory. Not only that but, from a reader response perspective, the aesthetic and efferent transactional stances that the children employ when calling into being fresh fluid meanings in connection with doing science and being a scientist create not so much a binary (one or the other) discord rather than a re/deconstructed, re/iterative fusion – a fluid dissonance – of ideas about the apparent distinction or juxtaposition between doing science and being a scientist.

Being a Scientist Dissonance

For instance, thinking about my children's ideas of 'being a scientist', I could see this fluid dissonance further complicated by the idea that the 'being a scientist' element of the dissonance was fragmented into (at least) three themes: the idea of being a real scientist in the real world, the idea of being a fictional scientist in the real world and the idea of being a real/fictional hybrid scientist in the real world (Themes 7a, 7b and 8).

Archer et al.'s 'science type' of person therefore only spoke to one part of the 'being a scientist' half of the dissonance: the 'being a real scientist in the real world' part, and did not (because the study was not designed to) consider the ideas of the children's fictional or real/fictional hybrid scientist selves.

When looking to develop interventions, these fictional or real/fictional hybrid scientist ideas are very important as it is in considering the children's ideas about fictional or real/fictional hybrid scientists and the associated ideas of 'doing science' from these fictional or real/fictional hybrid (as well as real scientist) points of view, that interventions might lie.

Doing Science Dissonance – 'School Science' and 'Real World' Science

The constructions of these fluid separate/inseparable ideas of doing science and being a scientist are defined and restricted by issues of gender, race and socioeconomic and sociocultural status; that is, from a reader response perspective, the constructions are called into being both by and from within all the interpretive communities within which any child is situated.

Archer et al. found that their children, in associating the doing of real world science with the doing of secondary school science (where one might, for example, be allowed to literally 'play with fire'), the doing of safe, 'immature', 'not real' primary school science had become re/positioned as 'feminised' and secondary school science, seen as 'desirable' and 'exciting', had become re/positioned as 'masculinised' (2010, p. 622; see also *Chapter 1 – Context and Aims of the Research; The 'Leaky' Pipeline – or Gender Filter*: Clark Blickenstaff, 2005, pp. 371-372; Vincent-Ruz & Schunn, 2017, p. 790).

My children, however, in thinking about real science and real scientists more deeply (or differently, perhaps, than Archer et al.'s focus group discussions allowed) by writing, reading, sharing and discussing fictions in connection with the same, appeared to think/look beyond both primary and secondary school science to the actual doing of what they thought was real science in the real world: they felt that the doing of real science in the real world was dangerous, could harm or kill you and so was to be avoided at all costs.

Not only that, but although my children were 9-10 years old, one year less mature, their exploration of both fictional scientists' and real scientists' motivations revealed a deep understanding of what the 'doing of science' is all about: it is about doing good in the world; thinking, studying, working and preparing hard, to do good things that make good differences in the real world.

It could be argued that in transitioning to Year 6 and beyond, (my) children's ideas will change and they, too, will come to feel the feminisation or masculinisation of school science. Even if this is the case and all my boys were to recognise the off-putting feminisation of safe science at primary school, and all my girls were to recognise the off-putting masculinisation of playing with Bunsen burners at secondary school, still, they are only considering the doing of 'school science' at school; child-world and teenage-world science – at *school*, not in the real world.

Fantastic/Fantasy Science

It did seem that, when asked about it, all my children were considering 'real world' science, in the real world – not school science. They had been writing, acting and discussing stories about scientists doing science in real world environs; that is, they had been writing, acting and discussing stories about scientists (albeit fictional scientists) doing science (albeit fictional science) in real world (albeit fictional real world) environs. In these stories, the doing of school-like science in school-like environs was never mentioned or even alluded to. Whether, in their stories, this real world (non-school) science was being done by what the children imagined to be real, fictional or real/fictional hybrid scientists, it was still all the doing of real world (non-school) science. That is, in their engagement with their own and with others' fictions, using their imaginations, calling into being and transacting their own and others' texts about science and scientists from within their vibrant, on-trend, interpretive communities, all the children went beyond the school science they knew and the secondary school science they didn't yet know, and beyond 'real world' science (whatever it was that 'real world' science meant to them in the moment), too, to conjure fantastic creative 'fantasy' science, science from their own imaginations, with true motivation behind it and 'true' internal logic within it.

In inspiring children toward a life in science, one might argue that they might be better persuaded toward the same by being encouraged to think about this sort of science; to think beyond school science and beyond real world science, to think of creative 'fantasy' science that 'works' within albeit fictional worlds.

That is not to say that all worries about doing real science – the stress, injury, death – with fall away, rather, when coming to shape literary interventions with which to better persuade children toward a life in science, this fantasy science, this science that the children imagined and made real in their stories – science that 'worked' and was 'real' in its fictional world – might be considered to pair well with the real/fictional hybrid scientist that is already present in many of the children's minds.

The Scientist Identity

For my own research participants, this dissonance between the idea of doing science and the idea of being a scientist might go some way to explaining why, although looking forward to and very much enjoying their science lessons every week at school, doing school science seemed to have no bearing upon their even thinking about a career in science. One explanation is that the 'doing of science' and the 'being a scientist' are two different things. The idea of other people doing science or being scientists, however, wasn't at all anathema to the children and, although most of the children did not or could not imagine the idea of doing science or being a scientist as an adult themselves, the children found it easy to imagine lots of their classmates (who had probably never even expressed any inclination or desire toward a career in science), together with friends, family members and acquaintances as being scientists – albeit real, fictional or real/fictional hybrid scientists – as adults in the real world.

Even those children encouragingly imagined as scientists by their classmates and friends, could not imagine themselves as the same. Being a scientist, it seemed – not least, perhaps, on account of its association with loneliness, grumpiness and stress (Theme 7b) – is for some people but is not for oneself.

The children's belief that the 'other people' who would be good scientists would be so because they were smart or good at maths or hard working, or appeared to enjoy science and possess scientific knowledge, seems to suggest, as Archer et al. had also found with their 10-11 year old participants, that in the children's minds, "science [was] already operating as a marked identity" (2010, p. 631). My children did believe that the doing of science was for those who had a natural ability or a flare for it (or for 'hard work' in general) – this despite almost all of the children enjoying science, possessing scientific knowledge and never once asserting that their school science was particularly intellectually difficult.

This marked identity of 'the other person as scientist', appeared to be sometimes unclear or more complex for the boys especially. Many of the boys, although having thoroughly debated the differences between real and fictional scientists, the things these different scientists did and the motivations these different scientists brought to bear on their doing and being in the world, and despite, too, the class fully recognising fictional scientists' *raisons d'etre* (Theme 6), still, when asked if they could imagine any of their friends or acquaintances as scientists in the real world, were just as likely to envisage those friends as fictional or real/fictional hybrid scientists as they were to envisage them as real scientists.

The friends and acquaintances that the boys envisaged as fictional or real/fictional hybrid scientists, however, were only ever other boys or other men – and this might be seen to corroborate the (albeit becoming increasingly) old-fashioned stereotype of the both real and fictional scientist as being male and crazy. The idea that the notion of an evil/crazy (fictional) girl/female scientist wasn't/isn't prevalent could be both negatively and positively construed. Negatively, in that the idea of 'girl as scientist', crazy or not, is so remote that a stereotype has not developed, but better, positively, in that although a negative stereotype does not exist, what does exist is the idea that my children believed that girls would only make good real scientists in the real world and not (crazy) fictional or real/fictional scientists.

For the girls, the identity of other person as scientist seemed clearer, less complex or less complicated by their ideas about the nature of fictional scientists as, in the main, girls imagined their chosen girl or boy potential scientists as real scientists in the real world, and not as fictional or real/fictional hybrid scientists.

Also, with respect to potential real scientists only, it was only the girls that ever mentioned other girls as being possible real world scientists; girls saw both girls and boys as real scientists, whereas boys saw only boys as real scientists. Why this might be is unclear: although maybe girls, being more 'comfortable' with Archer et al.'s 'feminised' school science, recognised some sort of clearer connection between girls and school science and, hence, a clearer connection between girls and real science. That is, girls might have more easily envisaged girls as doers of 'feminised' school science and extrapolated that idea to girls as doers of real world science.

I acknowledge that Archer et al.'s recognised parallel discourse of "natural interest" or "natural ability" (2010, pp. 629-632) might go some way toward explaining why the children felt others rather than themselves could be scientists. These others, being smart or good at maths, enjoying science and possessing scientific knowledge might have been considered by the children to have an innate flare for science, and this might have underpinned the idea that there does exist a type of person who becomes a scientist, that is, a 'science type' with a 'science mind' – any type or any mind being, of course, re/constructed from within its unique interpretive communities in association with how that particular type or that particular mind comes to re/create meaning about science and scientists.

My own participants had engaged in a similar discourse at an earlier age; the scientist identity, already defined and restricted by constructions called into being by the children's positionings within their own interpretive communities – and further complicated by fluid dissonance and their ideas about real, fictional or real/fictional hybrid scientists – might have already become focused through this lens of a too-special type.

This focusing of the lens, this specialisation, might further marginalise or alienate the scientist identity. From the point of view of a child's own re/developing sense of self, the scientist identity might seem set beyond one's sights; it is made harder to relate to, harder to become. This, in terms of all the children (girls and boys alike) thinking about being scientists, is disheartening because all the children enjoyed science, possessed knowledge and never once mentioned that the doing of science was intellectually beyond them.

For both girls and boys alike, then, not thinking about a career in science, not taking on this peculiar and complex identity that is 'scientist', might present a clearer or more open path – or a path of least resistance.

Conclusion

Drawing on Themes 1, 2 and 3 disclosed from the analysis of the data, the research objectives were fully resolved. The children were happily and enthusiastically engaged with both general fictions and with fictions connected to science and scientists. The children's experience with these latter fictions, however, was mainly limited to made-for-cinema film and television fiction, not literary fiction. This was because there appeared to be a scarcity of literary fiction (for children of this age range) connected to science and scientists and not on account of any unwillingness on the children's part to engage with the same.

The children recalled many examples of fictional scientists (from film and television), and these examples were often accompanied by detailed and entertaining descriptions of the spectacular environs and/or shenanigans with which these fictional scientists were associated.

Although the children's recollections of 'real' scientists seemed to be met with some uncertainty in as much as, far more often than not, the children's ideas were related in question form: *'would most of the pyramid builders or pyramid designers, architects be, like, scientists?' (Pip)*, for example, this seemed to be because the idea of who might be categorised as 'scientist' was not particularly esoteric, ambiguous or difficult to grasp, but rather because the idea of 'scientist' seemed to embrace very many and very diverse vocations, occupations and/or professions.

Despite the children's enthusiastic engagement with both general fictions and fictions containing science and scientists, the children did not feel that they had been or could be affected or in any way influenced by the same; even if fictional scientists were written against (existing) stereotypes and were represented as young, charismatic, aspirational scientists, still, the children felt they would remain unaffected. What they felt might affect them, however, was the idea of something in a fictional story being 'true' or 'real'.

Drawing upon Themes 4, 7a, 7b and 8, the first and second research aims were also fully resolved. The children believed real scientists to be good, kind people (Theme 4) but being so and doing so means that they have to constantly work and/or study and hence sacrifice their family and/or social life for the betterment of humankind (Themes 7a and 7b). This degree of dedication and self-sacrifice, makes scientists lonely, grumpy and stressed; and both the degree of self sacrifice/dedication and the idea of being 'unhappy' in one's work/life seemed to be putting the children off the idea of being a career scientist.

Drawing upon Themes 5, 6, 7a, 7b and 8 the third research aim was also fully resolved. The children felt that neither real scientists nor young adventurous fictional scientists (Theme 5) belonged in any good story; crazy, larger than life fictional scientists are fine the way they are and have a proper place in the world – in entertaining, fun or funny stories (Theme 6). Having real science in a fictional story, though, might go some way, the children felt, toward changing how they might think about science as a career.

Themes 7a, 7b and 8 permeated all three of the research aims.

Theme 8 suggested that there existed in many of the children's minds a type of real/fictional hybrid scientist; that is, many of the children drew on both fictional and non-fictional sources when coming to speak about the idea of 'a scientist'. Hence, for some of the children, neither the idea of 'the real scientist' nor the idea of 'the fictional scientist' seemed particularly clear cut or separable.

Themes 7a and 7b suggested there existed a fluid dissonance between the idea of doing science and the idea of being a scientist – and both ideas presented challenges to the children. Doing science can be lots of work, dangerous and even fatal, and being a scientist is a lonely and stressful enterprise. That said, the children's in-depth connection with – their thoughtful and creative ideas about – science and scientists brought about through their creation, sharing and discussion of stories about the same, did reveal a deep understanding of what it means to do, or to want to do, real world science or be a real world scientist: it is about 'doing good' and 'being good' in the world.

The idea of being a scientist, however, might be complicated by the idea that, in some children's minds, there exists Theme 8's real/fictional hybrid scientist who perhaps blurs the idea of and the identity of the real scientist. When thinking about developing literary interventions with which to better persuade children toward thinking about a career in science, however, using this pervasive hybrid – by pairing it with the children's own 'fantastic/fantasy' science, science that is 'real' (has true motivation and 'true' internal logic) albeit within fictional worlds – could be advantageous.

For the children, the lack of appeal of doing science/being a scientist in later life, besides the negative connotations associated with the same – the loneliness, grumpiness, stress, and possible injury, madness or death – seemed further exacerbated by the idea that science is for other people: people with a 'natural' flare or ability for it, people who are smarter than oneself, people who seem to possess more knowledge; a 'science type' with a 'science mind'. With respect to inspiring children toward a life in science, these beliefs were discouraging in as much as most of the children enjoyed their science lessons, had aptitude and knowledge, yet even the children who were believed, by other children, to possess flare, aptitude and knowledge, could not embrace the idea of being a scientist.

Hence, if occupational awareness and career aspirations begin during the early childhood years (Hartung, 2015; Holbrook, Panozza, & Prieto, 2009; Watson, Nota, & McMahon, 2015) then trying to cultivate the desirability of science as a career in the last couple of years of primary school, might already be too late – unless proprietary interventions are devised.

Chapter 8 – Conclusion

Introduction

In considering how primary school children engage with fictional representations of science and scientists, my intention was to come to understand better how children's engagement with these fictions may be shaping their perceptions of real science and real scientists. It was my intention, too, to use "one of the world's most powerful and pervasive ways of communicating ideas – the narrative form" (Reiss et al., 1999, p. 69) to explore this engagement – all with a view to shaping interventions that might encourage, in primary school children, more positive impressions of a life in science.

In this regard, my research aims had become to understand how children feel about science and scientists; to consider whether children have any insight into why they feel this way; and to find out how children engage with positive images of science and scientists through the writing, reading, sharing and discussion of fictions about the same. In order to achieve these aims, some initial objectives were identified: it was necessary to, first, consider how engaged children were with fictions of any nature, not just fictions connected to science and scientists; then to investigate how much existing experience children did have of fictions connected to science and scientists; and then to also explore whether or not children thought they were in any way influenced or changed by fiction.

This chapter very briefly summarises the research findings and then looks to the development of interventions with which, perhaps, to better engage primary school children with the idea of a life in science. The importance of both the scientists and the science in stories is outlined, and two possible interventions are described.

Concluding the Objectives

In Chapter 1, *The Context and Aims of the Research; The Gap in Knowledge*, I outlined two gaps in knowledge, the first being with respect to

1. *how primary school children's engagement with stories connected to science and scientists may be shaping their perceptions of the same and,*

hence, may be shaping the children's ideas, or absence of ideas, about a career in science.

The original contribution to knowledge that the pursuit and resolution of the research objectives made, went some way – 'some' way in as much as there is always room for the re/creation of more knowledge, especially from a reader response perspective – toward closing this gap, viz:

Although the children engaged very well with fictional characters and stories of many genres in literature, they were not at all familiar with fictions about science and scientists in the same. The children were, however, very familiar with fictional science and scientists in both live action and animated television series and made-for-cinema films, a good many of which were actually targeted at well above the children's 9-10 year old age range. With respect to fictions of any nature, the children initially felt that they had never been and were not likely to be inspired or changed by their encounters with the same.

The children themselves, however, raised the idea of 'truth' in fiction, and suggested that stories with something 'true' or 'real' in them might go some way toward influencing how they might feel about something.

The children's ideas as to who could be real scientists or what kind of jobs or vocations might be representative of science, were very diverse and wide-ranging and so their identification of 'real world scientist' was met with some uncertainty. Fictional scientists, however, as seen in television and film were more easily identified, and were more identifiable (as fictional scientists) than real scientists were identifiable (as real scientists).

Concluding the Research Aims

The second gap in knowledge I identified was with respect to

2. *whether or not the power of the narrative form, employed in the children's own writing, reading, sharing and discussing of stories about science and scientists, might reveal – or change – the children's deeper perceptions, or absence of perceptions, of science, scientists and ideas about a life in science.*

The original contribution to knowledge that the pursuit and resolution of the research aims made, went some way – again, 'some' way in as much as, especially from a reader response perspective, the re/creation of knowledge is temporal and fluid – toward closing that gap, too:

Building upon the research objectives, analysis of the research aims re/created some important ideas with respect to children's thoughts and feelings about fictional scientists, about real and fictional scientists' motivations, about the ways of being/demeanour of real scientists in the real world, and how the children felt about the influence of positive representations of both science and scientists in stories.

Fictional scientists

The evil and/or crazy fictional scientist, in all her or his entertaining glory, has a place in the world: it is in stories. Without them, stories about science and scientists would be boring – and, hence, the 'mad scientist stereotype' does not need to be changed or replaced (with a view to somehow better persuading the children to think upon science and scientists in a more positive light).

The children did not associate fictional scientists with real scientists. Real scientists, the children felt, were better associated with fictional heroes because they are both types of people who strive to do good in the world and/or want to make the world a better place.

The children's own good and mad-benign fictional scientists' motivations, however, reflected what the children seemed to feel were real scientists' motivations as they both did/do 'good' and 'kind' things.

Real scientists

Despite associating real scientists with fictional heroes, the children thought that real scientists do not belong in any good story – perhaps because, the children believe, real scientists are grumpy, lonely and stressed in the world and spend most of their time studying or working, and such a protagonist would only make for a dull and boring story.

The children do not know how they have come to feel that real life scientists are unhappy, as evidence (that they have seen on TV and YouTube) exists to the contrary. The grumpy, unhappy demeanour, is likely to be a fiction – a fiction, however, that might speak to the children's idea of having to do real science for a living themselves; that is, the children seem to believe that 'being a scientist' necessitates the sacrifice of one's family life and social life to perpetual work and/or study – and this idea, albeit incorrect, might be going some way toward putting the children off a life in science.

This 'being a scientist', the children felt, was for other people: 'clever' people, 'crazy' people or people who were a mixture of both. Most of the children – both those who were singled out as potential real scientists and those who did the choosing – could not see the potential in themselves.

Real science

Although the children 'knew' that real scientists were thoughtful careful people who planned their experiments with all due care toward themselves and others, the children felt that 'doing science' was dangerous, was physically/mentally exhausting, was socially isolating, might injure you and could even be fatal.

Engagement

The children, although very happily engaged with positive images of science and scientists in stories, felt that such engagement would not persuade them toward thinking about a career in science.

Despite thinking that real scientists do not belong in fictional stories, the children felt that putting real *science* into fictional stories, however, might influence how they felt about both science and scientists.

Hence, as the fictional scientist has a proper place in fiction, in better persuading children toward a life in science through fiction, one might look to stories that do not change the fictional scientists at all but, instead, change the fictional science.

Developing Interventions

Having resolved the research aims and objectives and, by doing so, gone some way toward closing the two gaps in knowledge, it was also my intention to make a further original contribution to knowledge by developing a possible intervention or interventions with which to better engage primary school children with more positive and/or appealing ideas about a life in science – as current interventions (role-modelling, lab visits, STEM weeks and science museums, for instance) do not seem to be persuading young people toward careers in science. In this respect, two possible interventions have been shaped.

Fictional Worlds

When thinking about the scientist in fiction, one might first look to the fictional world that these scientists occupy. Children's fictional story worlds, full of fictional characters of any nature, are fun and funny, exciting and adventurous worlds. Everything about these worlds serves a unique purpose: to engage and entertain the reader, the observer or the listener. Everything a story is and does is geared toward keeping the reader, observer or listener, almost relentlessly, engaged and entertained. If a story stops being fun or exciting, if it becomes boring – then children will stop reading, will stop watching or will stop listening. Hence, science and scientists in the fictional world, just like all the other characters, must be delightfully 'extra-ordinary' or otherwise engaging and entertaining.

When the children were first asked to think about and share their ideas about stories, they did not bring to mind stories about science and scientists. Even though Cohort 2011 had shared their thoughts and feelings about stories *after* they had written and shared their stories that featured scientists, as opposed to Cohort 2012 sharing their thoughts and feelings about stories *before* they knew they were going to write a story that featured a scientist, still, nobody mentioned any stories or story ideas or story characters connected to science or scientists.

When, and only when, prompted and encouraged to think about the scientist in fiction, the children looked not to literary fiction but to television and film fiction: big and bold, amazing, colourful, fun and funny, science and scientists brought to life on screen for the children to enjoy; and the children did very much enjoy and remember their television and film science and scientists.

All the stories the children created were very engaging and entertaining; they were very much appreciated by all who heard, saw and shared them. Half the stories the children created reflected what I interpreted as real scientists' motivations and ways of being in the real world (good, kind, affectionate); and the other half reflected what I interpreted as fictional scientists' motivations and ways of being in the fictional world (evil, mean). Each story had its own internal and external logic; that is, the scientists had their reasons for doing the things they did in the world of the story and, standing outside of the world of the story looking in, one could fully understand why they did those things.

The children did, of course, know of real scientists in the real world and could recall a few instances of having seen them on TV, *'running around with … a bottle in his hand' (Joanne*) and *'get[ting] a football to not leak air' (Bobby*), for example. The children knew, too, the difference between real and fictional science. In fact, some children felt that it was because of their knowledge of real scientists in the world, that they could differentiate between real and 'impossible' science: *'[because] I just know about normal scientists … and [I'd] watch Frankenstein and I'd be like … 'Well, that is not possible…'' (Pip)*.

When asked to call to mind real scientists, two main types of idea arose; ideas about *what* scientists are in the world, and ideas about *how* scientists are in the world. For what real scientists are in the world, the children had lots of ideas. Real world scientists could be astronauts, politicians, adventurers and philosophers – and designers, builders, sailors, astronomers, *'people [who] work with parts of bodies and different plants or some forensic scientists … go into crime scenes' (David)*; a vast array of careers and callings. The children are correct; all these people are scientists; Socrates, Stephen Hawking – philosophers to physicists – all these people *'looking at different things' (Anne)*, and *'trying to work out <u>why</u> [stuff] actually happens' (Joey)*.

For how real scientists are in the world, there were two further ideas: first, the children thought real scientists to be good, kind people who want to make the world better place; second, the children held a deep-seated feeling that real scientists were miserable and anti-social.

It is difficult, when interpreting ideas and transacting meaning therein, to remain wholly impartial, and as especially impartial as one should be when one is, for example, carrying out research of this nature. I cannot escape, however, my own interpretation of these two ways of real scientists' being in the world: I feel that the idea of scientists being 'good' in the world does not necessarily correlate with their being 'unhappy' in the world. I might feel this way because, as an adult, I have a great deal of experience of people's different and changing ways of being. I believe that although scientists may at times feel grumpy, lonely, unhappy or stressed, they are not like this all the time as the children believe. I understand scientists to be quite ordinary folk who have good and bad days, just as non-scientists do; from time to time, non-scientists and scientists alike, might feel grumpy or unloved.

This idea of the unhappy real scientist, however, has to be set alongside the children's other ideas about real scientists: children see real scientists as wonderfully diverse people engaged in an array of fascinating, interesting and exciting enterprises and doing good in the world.

In looking to persuade children toward thinking about a career in science, we could build upon these ideas and look, too, towards the original, resourceful, internally and externally logical, inventions – the stories – of the children's own imaginations and the fantastic/fantasy science that the children can invent and create therein.

This 'fantastic/fantasy' science could be interpreted as the children's engagement with their own and with others' ideas about science and scientists; it is their calling into being their own and others' texts about science and scientists. It is about imagining beyond the primary school science they know, imagining beyond the secondary school science they are being pushed toward, and it is imagining, too, beyond whatever it is the world, and the child, thinks 'real world' science is.

It is about the calling into being, as only children are able – using their own unique interpretive tools at their disposal from within their own unique interpretive communities – extra-ordinary fantastic/fantasy science, with real, fictional or real/fictional scientists' logic behind it.

Throughout our time together, the children did not appear, on the whole, to be misunderstanding or misinterpreting the questions they were being asked. Nor did it seem (on reflexive reflection) that the questions were asked in such a way as to evoke misunderstanding or misinterpretation as, in all their open discussions and in all their shared out loud thoughts, the children seemed to take the questions at face value and, simply, answer them with honesty and enthusiasm. The children never appeared flustered or frustrated with themselves or with others; thoughtful and inquisitive, they accepted each others' answers, rarely contradicted themselves or one another, and seemed to settle quite naturally into an organic ebb and flow between the natures, actions and motivations of fictional scientists and the natures, actions and motivations of real scientists; that is, the organic ebb and flow between the real worlds and the fictional worlds of science and scientists.

Within the context of the fictions we were thinking and talking about, one interpretation of this phenomenon could be that, with barely any literary frame of reference from which to draw – or from which to observe – the nature of science and scientists in children's literary stories, perhaps it was the children's ability to so easily and to so fully engage with literary fiction itself that made the ebb and flow between real and fictional worlds so easy and so natural.

In looking to develop literary interventions which might persuade children toward thinking about a career in science, it makes sense to embrace this easy organic ebb and flow; it makes sense to fully embrace the children's own imaginations and ideas about both real and fictional science and scientists – and to use both the real world and the fictional world when thinking about how we might better persuade children toward a career in science.

Holbrook et al. (2009) argued that "if perceptions of occupation are to be shaped [junior fiction] is a good stage to start" (p. 732). One of the main messages emerging from their study was that junior fiction authors rarely dealt with science or engineering and hence there was, for example, "very little in children's literature ... that would highlight engineering as a possible career choice" (p. 737), and they found that stories involving any type of science or engineering activities or characters were indeed "rare" (p. 731). My finding that the fictional scientists the children were aware of came from both adult and children-oriented television and film and not from children's literature could be seen to corroborate this idea.

That more stories about science and scientists are needed is without doubt; and for younger children, especially. The construction of these stories, however, as the children themselves have intimated, needs to be quite specific with respect to both the scientist and the science therein.

The Scientists in Stories

The scientist needs to be the sort of fictional scientist that the children have already come across in television and film or have presented within their own stories and their own ideas about fictional scientists: larger than life, better than (boring) real. They can be good, kind, life-saving adventurers or crazy, evil, mischief-makers, eating snake skin for breakfast, drinking melted ear wax, off to South America for the annual raisin parade with their sandwich maker and robot dog – what every entertaining/engaging science and scientist story needs.

Although some (adults) might argue that the 'mad scientist' stereotype is exactly what the children do not need, especially when trying to persuade children toward a serious down-to-earth career in science, I would argue the opposite: it is exactly what the children need in a story about science and scientists. This is because the children fully understand the *raison d'etre* of the fictional scientist; they understand her or his presence in the fictional world, her or his ways of doing in the fictional world and her or his ways of being in the fictional world. Fictional scientists are fine the way they are – and real scientists, of course, do not belong anywhere near a good story.

In the world outside fiction, the stereotype of the scientist, apocryphal or not, is fading anyway. How fast it fades or whatever else it fades into is, for the children in this study, of little consequence. Even though some of the children clearly understood that real scientists and fictional scientists are entirely different entities and other children embraced a hybrid type of scientist, still, it is not the stereotype or representation of the real or the fictional or the hybrid scientist that seems to be influencing the children away from the doing of science: they are influenced away by the idea that 'real world' science is something they do not want to do.

The Science in Stories

It is true that the children have told me that they think real world science is physically and mentally exhausting, and too dangerous to do. They have also told me, however, that they understand that real world scientists doing real world science think long and hard before or as they plan their experiments, with all due safety precautions, both for themselves and for others, in mind. These ideas present a juxtaposition – or another binary discord/fluid dissonance, perhaps – between the idea of thinking/planning/keeping safe and the idea of danger/ accidental death when doing science.

This being the case, in order to persuade children to look upon the doing of science more enthusiastically, we might invite them to look past real world science to their own fantastic/fantasy science: to that science that is the children's engagement with their own and with others' ideas/fictions about science and scientists; science that is beyond school science and career science; science that can win you a 'great award' for your Laser-Phaser 3000; that can zap a person back to health in an instant; that can put armadillo bogies and frogspawn to inventive use; or that, when you're feeling mean and evil, can turn someone into a hamster – then turn them back again, when you've lightened up.

When looking to the enormity and unlimited possibilities of the children's own fantasy science, thinking about primary and secondary school science as being, for example, re/framed as 'feminised' and 'masculinised' seems to further limit and restrict the idea of science and science learning; that is, when thinking about and figuring out fantasy science, school science, re/framed or not, pales in comparison. That's not to say that school science isn't important: it is, of course, extremely important and serves a vital purpose, but it seems to side-step all that science is supposed to aspire to – humans, with their vast imaginations and brilliant ideas, changing the world for the better.

School (primary, secondary, tertiary) science and the career prospects that school science projects, might best be thought of as something not to be aspired to, but to be aspired beyond; it should be re/framed, perhaps, as the necessary (primary, secondary, tertiary) educational grounding that children and young people have to work through to get to the good stuff, to get to the brilliant ideas and the changing of the world.

The children know that real scientists are good people who do good in the world. Real scientists' motivations are, of course, admirable. Doing good in the world, making things better for the planet and humankind are motivations we should perhaps cultivate in our young people. I would speculate as well, that, in the main, children would not baulk at the idea of doing good in the world, and when looking beyond real world science to their own kind of fantastic science, the apocryphal degree of life-obstructing dedication and/or self-sacrifice that is also putting children off thinking about a career in science, might fall away too; science need not be one long relentless slog, it can be amazing and spectacular – as can the people who do it.

In looking to develop interventions, we might therefore look beyond real world science, to the science that is done by the adventurers and astronauts, the philosophers and physicists – and the ninjas – in the imaginations of the children.

Hence, one sort of interventional story science has to be the children's own fantastic/fantasy science – but children have to be given the opportunity to create it and use it.

Another sort of interventional story science is the sort of science that the children have told me they might like to see in stories: real science.

I feel, therefore, that there could be two types of intervention:

1. *stories created by the children themselves using their own fantastic/fantasy science and*
2. *stories created by others using real science*

wherein, in both cases, the spectacular fictional scientist remains as she or he already is.

The Interventions

In thinking about what the conclusion to this research might be (throughout the entire research process), I had envisaged, or hoped for, at least one idea around which to think about shaping at least one intervention.

It is in coming to actually write this conclusion, however, that I now realise that the research itself presented an intervention. Children are often given the opportunity to write stories – but rarely are they given the 'opportunity' to write stories specifically about science and scientists; that is, children do not think about putting science and scientists into stories, and nobody ever asks them to. Hence, we might provide the opportunity for them to do so.

This idea of fantastic/fantasy science can only be realised through the making up of stories by the children themselves. Although, as adults, we can draw upon our knowledge of both the fictional and the real worlds to create fantastic/fantasy science and use it in as many stories as we wish – and these stories might be read or heard by as many children as we wish – still, the reading of someone else's fantastic/fantasy science is not the same as the making up of one's own fantastic/fantasy science.

Also, importantly, it is not just the making up of fantastic/fantasy science stories that might take the children beyond real world science – it is in the sharing of those stories, and then in the discussion of those stories, that exponential cascades of transactions and makings of meaning – re/transactions, re/creations and re/makings of meaning – occur.

From a reader response perspective, of course, having done this research, having created, shared and discussed so many stories, my own and the children's lives will never be the same again. Furthermore, because this research is about science and scientists and all the stories we have created and shared have been about science and scientists, in this respect especially, my own and the children's views and ideas about science and scientists will never be the same again: we have re/transacted, re/created and re/made meaning in connection with science and scientists many, many times.

In giving the children the opportunity to create their own fantastic/fantasy science and thereby imagine science beyond 'school' and 'real world' science – that is, thereby imagine fantastic/fantasy science being done by fantastic/fantasy scientists – the first intervention could be a replication of part of this research's method.

Intervention 1: Children are given the opportunity to create fantastic/fantasy science and scientist stories; for maximum effect, the children should write these stories in groups and share and discuss the stories between the groups

In Chapter 3, *Theoretical Framework*, in thinking about shaping any intervention that might evoke in children more positive impressions of a life in science, I suggested that the use of an aesthetic transactional stance in the creation of meaning might have a greater – or richer, more emotive – effect upon a child, than an efferent stance. This was because with an "'aesthetic' stance … the reader's primary concern is with what happens during the reading event" (Rosenblatt, 1978, p. 24); that is, as a person reads, her or his thoughts, feelings, emotional responses and reactions serve to re/create meaning that is deeper and emotionally richer than the efferent, simple taking away of information, stance. Hence the idea that fun, funny and exciting stories – devices – about science and scientists that evoke fun, laughter, the excitement of high adventure, might serve to better engage the reader with the same.

This, of course, formed the basis of the research, and an even deeper aesthetic engagement (deeper than simply 'reading') has been to encourage the children to create their own stories – that is, to write their own stories as opposed to call into being texts 'created' by others.

Writing stories makes one think more deeply not only about the mechanics and the grammar of the work but about the nature, content and logic of the work, as well. In the planning, writing, revising of these stories – in the making up of fabulous protagonists and antagonists, in the exploration of protagonists' and antagonists' moods and motivations and in the formulation of entertaining plots and themes; in the conscious and subconscious re/checking that these characters, drives and themes are, indeed, fun, funny and exciting and are each true to their own internal logic – layer piles upon layer of rich emotional engagement. As each child re/creates their text – both as authors and as readers or actors from within their unique interpretive communities – cascades of meaning are re/created about what it means to do fantastic science and be a fantastic scientist.

Although working individually can be effective, working in groups, bouncing thoughts and ideas about what might or might not be possible in stories about science and scientists, adds further layers of thought and engagement. Sharing those stories (perhaps especially by acting those stories out instead of simply reading them out) – adds more layers. Discussing those stories between groups/as a class, adds even more.

As the research has shown, the children's ideas about real and fictional scientists are closely interwoven – even to the extent that, besides the fictional scientist and the real scientist, there exists an actual real/fictional hybrid scientist – and as the children's stories come to create meaning about fictional scientists so, therefore, do they come to create meaning about real scientists and about real scientists' motivations and ways of being in the world.

Hence, this first intervention suggests that children be invited – in groups (although a child writing alone is perfectly acceptable) – to make up, share and discuss stories about science and scientists. The children could be given 'personality sheets' to 'start them off' but this is not absolutely necessary as the children would be engaging in an intervention, not a research project; it would be primarily a motion to give the children an opportunity to think about and write about fantastic scientists and fantastic science.

This type of intervention, the nature of its actual execution, might occasion the sort of aesthetic transactions that really could change how a child felt about science and scientists as taking part would cause unique aesthetic – and maybe to a lesser extent efferent – transactions and makings of meaning in connection with science and scientists that would otherwise never have occurred. In this respect, just as the notions of 'science' and the identity 'scientist' will be freshly re/constructed as the intervention takes place, moment to moment, so will each child (and each intervention supervisor) be reciprocally re/constructed by way of this aesthetic transactional stance and the exploration of the thoughts, feelings and ideas therein.

This is the sort of intervention that requires hardly any 'equipment' and could take place in any 'down time' a school might have: after mock/SATs, for example, or just before school holidays – or even at rainy lunchtimes.

It could take place, too, in any year group. In fact, it would make for interesting further research for the children of younger year groups to take part in an intervention (or a research project) of this nature.

Intervention 2: The creation of children's science fact/fantasy literature – wherein the science is real (or based in real) science, and the reader is advised as much at the very start of the story

Notwithstanding the importance of the aesthetic stance in the creation of imaginative worlds and the rich and emotive connection that such a stance engenders, the children themselves told me that the idea of having something 'real' or 'true' in a story might go some way toward changing how they felt about something – and went as far as to say that real science in a fictional story, might make a person *'want to read it again and again and again – and you'll want to read more books that are interesting and with facts in and you'll also get into science more…' (Jonny)*.

Hence, not only did the children engage in aesthetic stances from which to transact meaning about science and scientists in creative, emotive and enjoyable ways, but they actually requested an efferent, informational, stance alongside. That is, the children thought that transacting from both stances, simultaneously, might better engage them and hence might better persuade them toward thinking about a career in science.

In these new stories, however, the science does have to be, in some way, 'real'. Not only that, it has to be beyond 'school science'; it cannot be science that reflects school curricula because school science is exactly what we are trying to avoid when trying to persuade children toward a career in science. It has to be doable (real world) science or maybe a mix of doable (real world) and fantastic/fantasy (almost doable) science. Important, too, however, is that in order to avoid confusion as to whether or not the science in the story is real, the reader has to be told up front, that is, at the very start of the story, that the science that is about to transport them to and through a fictional world is real (or based in real) science.

These stories, currently, do not exist – or, at least, as children's books and stories about scientists and science are rare, then books and stories about fictional scientists and *real* science are, most likely, rarer.

Here, we must look to the publishers and commissioners – and the writers – of children's literature. If publishers or commissioners were to argue that there is no demand for these sort of books, I would respond that perhaps there is no demand because the children do not think about science and scientists in literature – maybe partly because it seems that they are not inclined – or encouraged – to do so but, maybe, partly because such literature, or even the idea of such literature, especially for young children, is rare and so is not there for them to think about.

When actually given the opportunity, when encouraged to think about science and scientists in stories, the children themselves have very seriously considered reasons as to why they feel the way they do about both fictional and real science and scientists. They have thought very seriously too, about what they think it might be, in connection with stories about science and scientists, that might change the way they feel and that might make them look more positively upon a career or a life in science. The children had never previously been asked what they needed to change the way they feel: now, they tell me they need fun, funny and exciting narrative that conjures both an aesthetic and an efferent stance.

Story's End

We are currently experiencing a revolution in cosmological and theoretical physics. The well-publicised decades-long search for the Higgs boson ('The God Particle') ended just one week before Cohort 2012 began this research with me (CERN, 2014); the imminent (though not actually expected by myself, at that time) discovery of the Higgs boson and what might have happened when its existence was eventually proven, formed the premise of the young dynamic scientists' story that I shared with children. This was true science; cutting edge science, science that the children themselves thought, on account of it being real science, could change the way they felt about doing science or being a scientist. Now the hunt is on, not so much for dark matter anymore even, but for dark energy – and, in other scientific spheres, green energy. It is the children of the current generation – the children who were kind enough to take part in this study – or the children of the generations who follow them, who will both solve these mysteries and find new mysteries to solve.

I do hope that all the children who took part in this research, in the five years from the start of the pilot project in 2007/2008 through to the end of the doctoral study in 2011/2012, benefitted in at least some small way from the adventure and have gone out into the world, into their higher education and beyond, with different ideas about science and scientists and what it might mean to be a scientist for real.

The rich selves that the children brought to the research were as precious and as immeasurable as the new selves that the children took away. These children are part of the generation in whose hands lie the current and future challenges the planet faces and it is upon them and the generations to follow, that the planet and the people upon it will rely.

Not only from the perspective of the theories of reader response and interpretive communities, but through the lens of all their own original contributions to knowledge, their own unique de/reconstructions and re/creations, through science, of fresh fluid meanings, I hope that these children, these new generations, from their own ever-fluid perspectives might always feel

> I am the sum total of everything that went before me, of all I have been seen done, of everything done-to-me. I am everyone everything whose being-in-the-world affected was affected by mine. I am anything that happens after I've gone which would not have happened if I had not come.

(Salman Rushdie, *Midnight's Children*, 1981, p. 510)

References

Abrams, J. (Director). (2011). *Super 8* [Motion picture]. United States of America: Paramount Pictures, Amblin Entertainment, Bad Robot & K/O Camera Toys.

Acker, S. (Director). (2009). *9* [Motion picture]. United States of America: Focus Features, Relativity Media, Arc Productions, Starz Animation, Teen Cartoon Films & Tim Burton Productions.

Anderson, I. (2006). *The relevance of science education: As seen by pupils in Ghanaian junior secondary schools*. (Doctoral dissertation). University of the Western Cape, Department of Mathematics and Science Education.

Archer, L., Dewitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2010). "Doing" science versus "being" a scientist: Examining 10/11-year-old schoolchildren's constructions of science through the lens of identity. *Science Education, 94*(4), 617-639.

Arnold, M. (1864). The function of criticism at the present time. *The National Review*, November, 1864.

Arnold, M. (1895). *The function of criticism at the present time in The National Review: Essays in criticism*. Macmillan: London. (Original work published 1864)

Avraamidou, L. (2013). Superheroes and supervillains: Reconstructing the mad-scientist stereotype in school science. *Research in Science & Technological Education, 31*(1), 90-115. doi:10.1080/02635143.2012.761605

Barthes, R. (1977). The Death of the Author. In R. Barthes *Image music text* (S. Heath, Trans.) (pp. 142-148). London: Fontana. (Original work published 1967)

Becker, F. (2010). Why don't young people want to become engineers?: Rational reasons for disappointing decisions. *European Journal of Engineering Education, 35*(4), 349-366.

Bleich, D. (1980). Epistemological assumptions in the study of response. In J. Tompkins (Ed.), *Reader-response criticism: From formalism to post-structuralism* (pp. 134-163). Philadelphia: American Society for Aesthetics.

Blyton, E. (1942). *Five on a treasure island (The famous five series: Book 1)*. London: Hodder & Stoughton.

Blyton, E. (1942-1962). *The famous five. (Book series – 21 books)*. London: Hodder & Stoughton.

Boaventura, D., Faria, C., Chagas, I., & Galvão, C. (2011/2013). Promoting science outdoor activities for elementary school children: Contributions from a research laboratory. *International Journal of Science Education, 35*(5), 796-814. doi:10.1080/09500693.2011.583292

Bodmer, W. (1985). *The public understanding of science/The Bodmer Report: Report of a Royal Society ad hoc group endorsed by the Council of the Royal Society*. London: The Royal Society of London.

Bosacki, S. (2001). Spirituality, gendered subjectivities, and education in preadolescents: Canadian preadolescents' reflections on gender-roles and their sense of self. *International Journal of Children's Spirituality, 6*(2), 207-221.

Bosacki, S., & Ota, C. (2000). Preadolescents' voices: A consideration of British and Canadian children's reflections on religion, spirituality, and their sense of self. *International Journal of Children's Spirituality, 5*(2), 203-219.

Boyatzis, R. (1998). *Transforming qualitative information: Thematic analysis and code development*. Thousand Oaks: Sage Publications.

Boylan, C., Hill, D., Wallace, A., & Wheeler, A. (1992). Beyond stereotypes. *Science Education, 76*(5), 465-476.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101.

British Board of Film Classification (BBFC). (1912-). Retrieved from http://www.bbfc.co.uk/

British Educational Research Association (BERA). (2011). *Ethical guidelines for educational research*. London: BERA.

Brooks, C. (1951). The formalist critics. *The Kenyon Review, 13*(1), 72-81.

Brooks, C., & Warren R. (1938). *Understanding poetry: An anthology for college students*. New York: Henry Holt.

Brooks, W., & Browne, S. (2012). Towards a culturally situated reader response theory. *Children's Literature in Education, 43*(1), 74-85. doi:10.1007/s10583-011-9154-z

Bruner, J. (1968). *Processes of cognitive growth: Infancy*. Worcester MA: Clark University Press.

Bruner, J. (1990). *Acts of meaning*. Cambridge MA: Harvard University Press.

Bruner, J. (1991). The narrative construction of reality. *Critical Inquiry, 18*(1), 1-21.

Bruner, J., & Lucariello, J. (2006). Monologue as narrative recreation of the world. In K. Nelson (Ed.), *Narratives from the crib* (pp. 73-97). Cambridge, MA: Harvard University Press.

Bruner, J., Wallach, M., & Galanter, E. (1959). The identification of recurrent regularity. *The American Journal of Psychology*, *72*(2), 200-209.

Buldu, M. (2006). Young children's perceptions of scientists: A preliminary study. *Educational Research, 48*(1), 121-132.

Carlone, H. (2004). The cultural production of science in reform-based physics: Girls' access, participation, and resistance. *Journal of Research in Science Teaching, 41*(4), 392-414.

Cattell, R. (1973). *Personality and mood by questionnaire*. San Francisco: Jossey-Bass.

Cattell, H., & Mead, A. (2008). The sixteen personality factor questionnaire (16PF). In G. Boyle, G. Matthews & D. Saklofske (Eds.), *The SAGE handbook of personality theory and assessment: Personality measurement and testing, volume 2* (pp. 136-159). London: SAGE.

CERN (Conseil Européen pour la Recherche Nucléaire/European Organization for Nuclear Research), (2014). *The Higgs Boson*. Retrieved from https://home.cern/topics/higgs-boson

Chambers, D. (1983). Stereotypic images of the scientist: The draw a scientist test. *Science Education, 67*(2), 255-265.

Chappell, D. (2008). Sneaking out after dark: Resistance, agency, and the postmodern child in J.K. Rowling's Harry Potter series. *Children's Literature in Education, 39*(4), 281-293.

Christensen, P., & James, A. (Eds.). (2008). *Research with children: Perspectives and practices* (2nd ed.). New York: Routledge.

Christidou, V., Bonoti, F., & Kontopoulou, A. (2016). American and Greek children’s visual images of scientists: Enduring or fading stereotypes? *Science & Education, 25*(5), 497-522. doi:10.1007/s11191-016-9832-8

Clark Blickenstaff, J. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender and Education, 17*(4), 369-386. doi:10.1080/09540250500145072

Claxton, G. (1997). Science of the time: a 2020 vision of education. In R. Levinson & J. Thomas (Eds.), *Science today, problem or crisis?* (pp. 71-86). London: Routledge.

Coleridge, S. (1814). Essays on the principles of genial criticism. *Felix Farley's Bristol Journal,* 13 August to 24 September, 1814.

Coleridge, S. (1817). *Biographia literaria*. London: Rest Fenner.

Confederation of British Industry (CBI). (2008). *Taking stock: CBI education and skills 2008*. London: CBI.

Confederation of British Industry (CBI). (2013). *Changing the pace: CBI/Pearson educations and skills survey 2013*. London: CBI.

Crain, W. (2016). *Theories of development: Concepts and applications*. Abingdon: Routledge.

Cronenberg, D. (Director). (1986). *The Fly* [Motion picture]. United States of America: SLM Production Group & Brooksfilms.

Daniels, H. (2006). The 'social' in post-Vygotskian theory. *Theory & Psychology, 16*(1), 37-49.

Davidson, J. (1993). *Bakhtin as a theory of reading: Center for the Study of Reading Technical Report no. 579*. Illinois: University of Illinois.

Deary, T., Hepplewhite, P., & Tonge, N. (1993-2013). *Horrible histories. (Book series/franchise – 60+ books)*. London: Scholastic.

Delaney, J. (2004). *The spook's apprentice (The Wardstone chronicles series: Book 1).* London: The Bodley Head.

Department for Education (DfE). (2015). *National curriculum assessments at key stage 2*. London: DfE. Retrieved from https://www.gov.uk/government/statistics/national-curriculum-assessments-at-key-stage-2-2015-revised

Department for Innovation, Universities and Skills (DIUS). (2009). *The demand for science, technology, engineering and mathematics (STEM) skills*. London: DIUS.

Derrida, J. (1997). *Of grammatology* (Corrected ed.) (G. Chakravorty Spivak, Trans.). Baltimore: The Johns Hopkins University Press. (Original work published 1967)

Docter, P., & Peterson, B. (Directors). (2009). *Up* [Motion picture]. United States of America: Pixar Animation Studios (as A Pixar Animation Studios Film) & Walt Disney Pictures.

Eliot, T. (1920). *The sacred wood: Essays on poetry and criticism*. London: Methuen. Retrieved from https://en.wikisource.org/w/index.php?title=The_Sacred_Wood&oldid=4281558

Empson, W. (1930). *Seven types of ambiguity*. London: Chatto & Windus.

Eugster, P. (2007). The perception of scientists. *The Science Creative Quarterly*. Retrieved from http://www.scq.ubc.ca/the-perception-of-scientists/

Fine, A. (1994). *Diary of a killer cat.* London: Hamish Hamilton.

Finson, K. (2002). Drawing a scientist: What we do and do not know after fifty years of drawings. *School Science and Mathematics, 102*(7), 335-345.

Fish, S. (1970). Literature in the reader: Affective stylistics. *New Literary History, 2*(1), 123-162.

Fish, S. (1976). Interpreting the variorum. *Critical Inquiry, 2*(3), 465-485.

Fish, S. (1980). *Is there a text in this class?: The authority of interpretive communities*. Cambridge, MA: Harvard University Press.

Fort, D., & Varney, H. (1989). How students see scientists: Mostly male, mostly white, and mostly benevolent. *Science and Children, 26*(8), 8-13.

Fung, Y. (2002). A comparative study of primary and secondary school students' images of scientists. *Research in Science & Technological Education, 20*(2), 199-213.

Garner, R. (2001). Potter's magic touch boosts boarding schools. *The Independent*. Retrieved from https://search-proquest-com.libaccess.hud.ac.uk/docview/311854522?accountid=11526

Garner, R. (2004). Boarding schools miss their Harry Potter magic. *The Independent*. Retrieved from http://www.independent.co.uk/news/education/education-news/boarding-schools-miss-their-harry-potter-magic-58153.html

Graham, C. (Creator). (1997-). *Midsomer Murders* [Television series]. United Kingdom: Bentley Productions & ITV – Independent Television.

Grahame, K. (1908). *The wind in the willows.* London: Methuen.

Greig, A., Taylor, J., & MacKay, T. (2007). *Doing research with children*. London: Sage.

Grob, R., Hirsh-Pasek, K., Golinkoff, R., & Schlesinger, M. (2017). "Oh, the places you'll go" by bringing developmental science into the world. *Child Development, 88*(5), 1403-1408. doi:10.1111/cdev.12929

Groening, M., Brooks, J., & Simon, S. (Creators). (1989-). *The Simpsons* [Television series]. United States of America: Gracie Films, 20th Century Fox Television, The Curiosity Company, Fox Television Animation (2016-) & Twentieth Century Fox Animation (2016-).

Gysbers, N. (1996). Meeting the career needs of children and adolescents. *Journal of Vocational Education Research, 21*(4), 87-98.

Handler, D. (as Lemony Snicket). (1999). *The reptile room (A series of unfortunate events series: Book 2).* London: HarperCollins.

Handler, D. (as Lemony Snicket). (1999-2006). *A series of unfortunate events series. (Book series – 13 books).* London: HarperCollins & Copenhagen: Egmont UK.

Harkin, P. (2005). The reception of reader-response theory. *College Composition and Communication, 56*(3), 410-425.

Hartung, P. (2015). Life design in childhood: Antecedents and advancement. In L. Nota & J. Rossier (Eds.), *Handbook of life design: From theory to practice* (pp. 89-102). Göttingen: Hogrefe Publishing.

Hartung, P., Porfeli, E., & Vondracek, F. (2005). Child vocational development: A review and reconsideration. *Journal of Vocational Behavior, 66*(3), 385-419.

Hay, D., & Nye, R. (2006). *The Spirit of the Child*. London: Harper Collins.

Heidegger, M. (1967). *Being and time* (J. Macquarrie & E. Robinson, Trans.). Oxford: Blackwell. (Original work published 1927)

Hermanowicz, J. (2003). Scientists and satisfaction. *Social Studies of Science, 33*(1), 45-73. doi:10.1177/0306312703033001177

Hirsch, E. (1967). *Validity in interpretation*. New Haven: Yale University Press.

Hirsch, W. (1958). The image of the scientist in science fiction: A content analysis. *American Journal of Sociology, 63*(5), 506-512.

Hodges, M. (Director). (1980). *Flash Gordon* [Motion picture]. United Kingdom & United States of America: Starling Films (as Starling Productions Ltd.) & Dino De Laurentiis Company.

Holbrook, A., Panozza, L., & Prieto, E. (2009). Engineering in children's fiction – not a good story? *International Journal of Science and Mathematics Education, 7*(4), 723-740.

Holland, N. (1975). Unity identity text self. *Publications of the Modern Language Association of America, 90*(5), 813-822. doi:10.2307/461467

Huber, R., & Burton, G. (1995) What do students think scientists look like? *School, Science and Mathematics, 95*(7), 371-376.

Hughes, K. (Director). (1968). *Chitty Chitty Bang Bang* [Motion picture]. United Kingdom: Dramatic Features (as A Warfield – D.F.I. Picture) & Warfield (as Warfield Productions).

Iser, W. (1974). *The implied reader: Patterns of communication in prose fiction from Bunyan to Beckett*. Baltimore: Johns Hopkins University Press.

Iser, W. (1978). *The act of reading: A theory of aesthetic response*. London: Routledge and Kegan Paul.

Jenkins, E. (2004) Science education: Research, practice and policy. In E. Scanlon, P. Murphy, J. Thomas, & E. Whitelegg (Eds.), *Reconsidering science learning* (pp. 235-249). London: RoutledgeFalmer.

King-Smith, D. (1991). *The guard dog*. London: Young Corgi.

Kinney, J. (2007). *Diary of a wimpy kid (Diary of a wimpy kid series: Book 1)*. New York: Amulet Books.

Klages, M. (2006*). Literary theory: A guide for the perplexed*. London: Continuum.

Koren, P., & Bar, V. (2009a). Science and it's [sic] images – promise and threat: From classic literature to contemporary students' images of science and "the scientist". *Interchange: A Quarterly Review of Education, 40*(2), 141-163. doi:10.1007/s10780-009-9088-1

Koren, P., & Bar, V. (2009b). Pupils' image of 'the scientist' among two communities in Israel: A comparative study. *International Journal of Science Education, 31(*18), 2485-2509. doi:10.1080/09500690802449375

Landis, J. (Director). (2010). *Burke and Hare* [Motion picture]. United Kingdom: Ealing Studios, Fragile Films, Aegis Film Fund, Hindsight (as Prescience) & Quickfire Films.

Lang, J. (2009). New directions for community colleges. *The Outlook in the Health Sciences, 2009*(146), 53-62.

Langer, E., Hatem, M., Joss, J., & Howell, M. (1989). Conditional teaching and mindful learning: The role of uncertainty in education. *Creativity Research Journal, 2*(3), 139-150.

Lea, S. (2006). Seeing beyond sameness: Using The Giver to challenge colorblind ideology. *Children's Literature in Education, 37*(1), 51-67.

Letterman, R., & Vernon, C. (Directors). (2009). *Monsters vs Aliens* [Motion picture]. United States of America: DreamWorks Animation.

Leung, L. (2015). Validity, reliability, and generalizability in qualitative research. *Journal of Family Medicine and Primary Care, 4*(3), 324-327. doi:10.4103/2249-4863.161306

Loretto, W., & Vickerstaff, S. (2015). Gender, age and flexible working in later life. *Work, Employment & Society, 29*(2), 233-249. doi:10.1177/0950017014545267

Lorre, C., & Prady, B. (Creators). (2007-). *The Big Bang Theory* [Television series]. United States of America: Chuck Lorre Productions & Warner Bros. Television.

MacDonald, T., & Bean, A. (2011). Adventures in the subatomic universe: An exploratory study of a scientist-museum physics education project. *Public Understanding of Science, 20*(6), 846-862. doi:10.1177/0963662510361417

MacFarlane, S., & Zuckerman, D. (Creators). (1998-). *Family Guy* [Television series]. United States of America: 20th Century Fox Television, Fuzzy Door Productions & Fox Television Animation (2000-).

Mackey, M. (2010). Reading from the feet up: The local work of literacy. *Children's Literature in Education, 41*(4), 323-339.

McMahon, M., & Watson, M. (2007). The systems theory framework of career development: Expanding its research influence. *Australian Journal of Career Development, 16*(3), 47-54. doi:10.1177/103841620701600308

Mead, M., & Métraux, R. (1957). The image of the scientist among high-school students. *Science, 126*(3270), 384-390.

Mendick, H. (2006). *Masculinities in mathematics*. Maidenhead: McGraw-Hill Education.

Mercury, F. (1977). We are the champions. On *News of the World* [LP]. London, United Kingdom: EMI & Elektra.

Micro Librarian Systems (MLS). (2016). Web-based library management software. *Junior Librarian 3*. Retrieved from https://home.microlib.co.uk/junior.html

Millar, R., & Osborne, J. (Eds.). (1998). *Beyond 2000: Science education for the future: A report with ten recommendations. The report of a seminar series funded by the Nuffield Foundation*. London: King's College London, School of Education.

Millar, R., & Wynne, B. (1988). Public understanding of science: From contents to processes. *International Journal of Science Education, 10*(4), 388-398.

Morpurgo, M. (1982). *War horse.* London: Kaye & Ward.

Morpurgo, M. (2007). *Born to run*. London: HarperCollins Children's Books.

Motion Picture Association of America (MPAA). (1922-). Retrieved from https://www.mpaa.org/

Murphy, C., & Beggs, J. (2005). *Primary science in the UK: A scoping study. Final Report to the Wellcome Trust*. London: Wellcome Trust.

Nuffield Foundation. (1998). *Beyond 2000: Science education for the future. The report of a seminar series funded by the Nuffield Foundation*. London: King's College London, School of Education.

Office for Standards in Education, Children's Services and Skills (Ofsted). (2011). *Successful science. An evaluation of science education in England 2007-2010*. London: Ofsted. Retrieved from www.ofsted.gov.uk/publications/100034

Office for Standards in Education, Children's Services and Skills (Ofsted). (2013). *Maintaining curiosity. A survey into science education in schools 2010-2013.* London: Ofsted. Retrieved from https://www.gov.uk/government/publications/maintaining-curiosity-a-survey-into-science-education-in-schools

Pelucchi, B., Hay, J., & Saffran, J. (2009). Statistical learning in a natural language by 8-month-old infants. *Child Development, 80*(3), 674-685. Retrieved from http://www.jstor.org.libaccess.hud.ac.uk/stable/29738646

Piaget, J. (1955). *The construction of reality in the child* (M. Cook Trans.). London: Routledge & Kegan Paul. (Original work published 1950)

Piaget, J. (2002) *The language and thought of the child* (M. Gabin, & R. Gabin Trans.). London: Kegan Paul. (Original work published 1923)

Piaget, J. (2007). *The child's conception of the world* (A. Tomlinson, & J. Tomlinson Trans.). Lanham: Rowman & Littlefield Publishers, Inc. (Original work published 1925)

Piaget, J., & Inhelder, B. (2000). *The psychology of the child* (H. Weaver Trans.). New York: Basic Books. (Original work published 1950)

Pilkey, D. (1997-2015). *Captain Underpants. (Book series – 12 books)*. New York: Blue Sky & Scholastic.

Poulet, G. (1956). *Studies in human time*. Baltimore: John Hopkins Press.

Pound, E. (1934). *ABC of reading*. London: Routledge.

QSR International. (2012). NVivo qualitative data analysis software. Version 10.

Raimi, S. (Director). (2004). *Spider-Man 2* [Motion picture]. United States of America: Columbia Pictures Corporation (as Columbia Pictures), Marvel Enterprises (as A Marvel Enterprises/Laura Ziskin Production) & Laura Ziskin Productions (as A Marvel Enterprises/Laura Ziskin Production).

Ransom, J. (1937). Criticism, inc. *The Virginia Quarterly Review, 13*(4), 586.

Ransom, J. (1941). *The new criticism*. Norfolk: New Directions.

Ransome, A. (1930). *Swallows and amazons (The swallows and amazons series: Book 1)*. London: Jonathan Cape.

Reid, A., Martin, S., Denley, P., Cloke, C., Bishop, K., & Dodsworth, J. (2003). Tomorrow's world, today's reality. *Science, Technology, Mathematics: A Review of Teachers' Perceptions, Views and Approaches*. United Kingdom: ETB and The University of Bath.

Reiss, M., Millar, R., & Osborne, J. (1999). Beyond 2000: Science/biology education for the future. *Journal of Biological Education, 33*(2), 68-70.

Richard, J. (1954). *Littérature et sensation: Stendhal, Flaubert, Fromentin, les Goncourt*. [Literature and sensation: Stendhal, Flaubert, Fromentin, the Goncourt brothers]. Paris: Éditions du Seuil. English translation retrieved from: http://www.seuil.com/ouvrage/litterature-et-sensation-jean-pierre-richard/9782020025935

Richards, I. (1929). *Practical criticism: A study of literary judgment*. London: Routledge & Kegan Paul.

Rosenblatt, L. (1969). Towards a transactional theory of reading. *Journal of Reading Behavior, 1*(1), 31-49.

Rosenblatt, L. (1970). *Literature as exploration*. London: Heinemann Educational Books Ltd. (Original work published 1938)

Rosenblatt, L. (1978). *The reader, the text, the poem: The transactional theory of the literary work*. Carbondale: Southern Illinois University Press.

Rosenblatt, L. (1982). The literary transaction: Evocation and response. *Theory Into Practice, 21*(4), 268-277.

Rosenblatt, L. (1986). The aesthetic transaction. *Journal of Aesthetic Education, 20*(4), 122-128.

Rousseau, J. (1948). *Emile, or on education* (B. Foxley, Trans.). London: J. M. Dent and Sons Ltd. (Original work published 1762)

Rowling, J. (1997). *Harry Potter and the philosopher's stone (The Harry Potter series: Book 1).* London: Bloomsbury.

Rowling, J. (1997-2007). *Harry Potter. (Book series – 7 books).* London: Bloomsbury & New York: Scholastic.

Rushdie, S. (1981). *Midnight's children*. London: Jonathan Cape.

Saffran, J. (2003). Statistical language learning: Mechanisms and constraints. *Current Directions in Psychological Science, 12*(4), 110-114.

Sagan, C. (1996). Interview by Psychology Today staff with author Carl Sagan about his book The Demon-Haunted World. *Psychology Today*. January 1996. Retrieved from: https://www.psychologytoday.com/articles/199601/carl-sagan?page=3

Sansom, C., & Shore, P. (2008). Meeting the demand for skilled precision engineers. *Education & Training, 50*(6), 516-529.

Saracho, O., & Spodek, B. (2010). Parents and children engaging in storybook reading. *Early Child Development and Care, 180*(10), 1379-1389. doi:10.1080/03004430903135605

Sargeant, J., & Harcourt, D. (2012). *Doing ethical research with children*. Maidenhead: McGraw-Hill/Open University Press.

Schibeci, R., & Sorensen, I. (1983). Elementary school children's perceptions of scientists. *School Science and Mathematics, 83*(1), 14-19.

Schultheiss, D., Palma, T., & Manzi, A. (2005). Career development in middle childhood: A qualitative inquiry. *The Career Development Quarterly, 53*(3), 246-262. doi:10.1002/j.2161-0045.2005.tb00994.x

Science Community Partnership Supporting Education (SCORE). (2009). *Government abolishes Key Stage 2 science SATs*. Retrieved from http://www.score-education.org/news/press-releases-and-media-coverage/abolishment-of-ks2-sats

Sharf, R. (2016). *Applying career development theory to counselling* (6th ed.). Belmont: Brooks/Cole Cengage Learning.

Shelley, M. (1818). *Frankenstein; Or the modern Prometheus*. London: Lackington, Hughes, Harding, Mavor & Jones.

Silver, A., & Rushton, B. (2008a). Primary-school children's attitudes towards science, engineering and technology. *Education 3-13*, *36*(1), 51-67. doi:10.1080/03004270701576786

Silver, A., & Rushton, B. (2008b). The effect of the Horsham greenpower goblin challenge on children's attitudes towards science, engineering and technology. *Education 3-13*, *36*(4), 339-350. doi:10.1080/03004270701752668

Simon, F. (1994-2015). *Horrid Henry. (Book series – 24 books)*. London: Orion Books.

Simon, R. (as Pseudonymous Bosch). (2007-2011). *The secret series. (Book series – 5 books).* New York: Little, Brown Books.

Simpson, M., Richardson, M., & Zorn, T. (2012). A job, a dream or a trap?: Multiple meanings for encore careers. *Work, Employment & Society, 26*(3), 429-446. doi:10.1177/0950017012438581

Sjøberg, S. (2002). Science for the children? *Report from the Science and Scientists-Project Acta-Didactica (1/2002)*. Norway: Department of Teacher Education and School Development, University of Oslo.

Smith, E., & Gorard, S. (2011). Is there a shortage of scientists?: A re-analysis of supply for the UK. *British Journal of Educational Studies, 59*(2), 159-177.

Song, J., & Kim, K. (1999). How Korean students see scientists: The images of the scientist. *International Journal of Science Education, 21*(9), 957-977.

Spelke, E., & Kinzler, K. (2009). Innateness, learning, and rationality. *Child Development Perspectives, 3*(2), 96-98. doi:10.1111/j.1750-8606.2009.00085.x

Spencer, J., Blumberg, M., McMurray, B., Robinson, S., Samuelson, L., & Tomblin, J. (2009). Short arms and talking eggs: Why we should no longer abide the nativist-empiricist debate. *Child Development Perspectives, 3*(2), 79-87. doi:10.1111/j.1750-8606.2009.00081.x

Spielberg, S. (Director). (1982). *E.T. the Extra Terrestrial* [Motion picture]. United States of America: Universal Pictures & Amblin Entertainment.

Strauss II, J. (1866). An der schönen blauen Donau (By the beautiful blue Danube/The blue Danube). Originally performed by the Vienna Men's Choral Association. Dianabadsaal, Vienna. [15 February, 1867].

Taber, K. (2007). *Classroom-based research and evidence-based practice: A guide for teachers*. London: Sage Publications Ltd.

Thomas, J. (1998). Bringing real science to school (S802). *Science and the Public*. Milton Keynes: The Open University.

Tickle, J., & Rowntree, J. (Presenters). (2003-2008). *Brainiac: Science Abuse* [Television series]. United Kingdom: British Sky Broadcasting (BSkyB) & London Weekend Television (LWT) (as Granada Productions).

Tompkins, J. (Ed.). (1982). *Reader-response criticism: From formalism to post-structuralism*. Philadelphia: American Society for Aesthetics.

Tyler-Wood, T., Ellison, A., Lim, O., & Periathiruvadi, S. (2012). Bringing up girls in science (BUGS): The effectiveness of an afterschool environmental science program for increasing female students' interest in science careers. *Journal of Science Education and Technology, 21*(1), 46-55. doi:10.1007/s10956-011-9279-2

United Nations General Assembly. (1989). *Adoption of a convention on the rights of the child*, November 17th. New York: United Nations.

Vincent-Ruz, P., & Schunn, C. (2017). The increasingly important role of science competency beliefs for science learning in girls. *Journal of Research in Science Teaching, 54*(6), 790-822. doi:10.1002/tea.21387

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. M. Cole, V. John-Steiner, S. Scribner, & E. Souberman (Eds.). Cambridge, MA: Harvard University Press. (Original work published 1930-1934)

Vygotsky, L. (1986). *Thought and language*. A. Kozulin (Ed.). Cambridge, MA: The Massachusetts Institute of Technology Press.

Vygotsky, L. (1998). Child psychology. In R. Rieber (Ed.), *The Collected Works of L. S. Vygotsky: Volume 5* (M. Hall Trans.). New York: Kluwer Academic/Plenum Publishers.

Ward, N. (2006). Iser's aesthetic response theory viewed in the context of collaborative hyperfictions. *CUREJ: College Undergraduate Research Electronic Journal, University of Pennsylvania*, April 2006, 1-30. Retrieved from http://repository.upenn.edu/curej/42

Watson, M., & McMahon, M. (2004). Children's career development: A metatheoretical perspective*. Australian Journal of Career Development, 13*(3), 7-12. doi:10.1177/103841620401300303

Watson, M., & McMahon, M. (2005). Children's career development: A research review from a learning perspective. *Journal of Vocational Behaviour, 67*(2), 119-132.

Watson, M., & McMahon, M. (2008). Children's career development: Metaphorical images of theory, research, and practice. *The Career Development Quarterly, 57*(1), 75-83. doi:10.1002/j.2161-0045.2008.tb00167.x

Watson, M., Nota, L., & McMahon, M. (2015). Evolving stories of child career development. *International Journal for Educational and Vocational Guidance, 15*(2), 175-184. doi:10.1007/s10775-015-9306-6

Whited, L. (2002). *Ivory tower and Harry Potter: Perspectives on a literary phenomenon*. Columbia: University of Missouri Press.

Wilson, J. (2009). *Hetty Feather* (*Hetty Feather series: Book 1*). London: Random House.

Wilson, J. (2009-2018). *Hetty Feather/World of Hetty Feather series.* (*Book series – 8 books*). London: Random House Children's Books.

Wimsatt, W., & Beardsley, M. (1946). The intentional fallacy. *The Sewanee Review, 54*(3), 468-488.

Wolf, M., & Barzillai, M. (2009). The importance of deep reading. In M. Scherer (Ed.), *Challenging the whole child: Reflections on best practices in learning, teaching, and leadership* (pp. 130-140). Alexandria, VA: ASCD.

Wolfreys, J. (2006). *Modern European criticism and theory: A critical guide*. Edinburgh: Edinburgh University Press.

Zardetto-Smith, A., Mu, K., Ahmad, S., & Royeen, C. (2000). A model program for bringing neuroscience to children: An informal neuroscience education program bridges a gap. *The Neuroscientist*, 6(3), 159-168. doi:10.1177/107385840000600307

Zemeckis, R. (Director). (1985). *Back to the Future* [Motion picture]. United States of America: Universal Pictures (A Robert Zemeckis Film), Amblin Entertainment & U-Drive Productions.

Zemeckis, R. (Director). (1989). *Back to the Future Part II* [Motion picture]. United States of America: Universal Pictures, Amblin Entertainment & U-Drive Productions.

Zemeckis, R. (Director). (1990). *Back to the Future Part III* [Motion picture]. United States of America: Universal Pictures, Amblin Entertainment & U-Drive Productions.

Zipes, J. (2009). *Relentless progress: The reconfiguration of children's literature, fairy tales, and storytelling*. New York: Routledge.

Zipes, J. (2012). *The irresistible fairy tale: The cultural and social history of a genre.* New Jersey: Princeton University Press.

Appendix

Letter of Parent/Guardian Consent

Dear Parent/Guardian,

Research Project with Year 5

I am currently undertaking a doctoral research project under the supervision of Dr [Supervisor], the Dean of Education, at the University of Huddersfield and I would like to ask your permission to work with your child in carrying out some research.

The study concerns the influence of the Narrative Form – that is, the influence of stories and children's literature – upon primary school children's education.

The project would entail me splitting Year 5 into groups and asking each group to make up a story that engages specific characters. Each group will then present their story to the class and the stories will be discussed in more depth.

It's my intention to see what sort of personalities the children give to their story characters, how such personalities affect the stories the children make up, whether the characters turn into hero/heroines or villains, and why.

Later on, or at a later date, I will present a story of my own to the class and this, too, will be discussed openly.

In order for me to properly examine exactly what the children say about their characters and stories, **it will be necessary for me to video- and audio-record the class presentations and discussions**.

All the children's contributions will remain entirely confidential and will never be shared or passed on to any third party: your child's name, for example, will be made anonymous and will never appear in the publication of any research results.

Because I already volunteer in the Early Year's Unit library and the main school library, I do have an Enhanced CRB Disclosure Certificate which remains up to date.

I have already gained Mrs [Head Teacher]'s and Mrs [Year 5 Teacher]'s permission to work with Year 5, and would be very grateful for your and your child's permission, too.

If you have any objection whatsoever to me working with your child then please let Mrs [Head Teacher], Mrs [Year 5 Teacher] or myself know as soon as possible or by **10th June**, as it's my intention to start the project **week commencing 12th June**.

If you have no objections now but, later on, during the study, wish to withdraw your child, then please feel free to do so.

If you would like to know more about the study then please do not hesitate to ask. I am always in the Early Years Unit library or the main library every Monday afternoon, and my 'phone numbers are [Home Telephone] or [Mobile Telephone].

Thank you for your help.

Kindest regards

Elizabeth Delaney
Parent Volunteer

Letter of Thanks to Parent/Guardian

Dear Parent/Guardian,

Research Project with Year 5

Further to my letter of June 7th, I'm writing to let you know that I very much enjoyed my time working with the children last week.

I mentioned, in the letter, that it was my intention to see what sort of personalities the children would give to specific story characters I gave them and how such personalities affected the stories the children made up – that is, whether the characters turned into hero/heroines or villains – and why.

One of the characters I gave the children to work into their stories was a scientist, and this was the crux of the research: children's attitudes to science and scientists and, more particularly, whether fictional representations of scientists (usually 'mad, bad and dangerous to know') affect these attitudes.

The children made up some fabulous stories and we all had great fun acting the stories out and talking about them, afterwards.

Although months and months of transcription and analysis lie ahead in my taking these ideas apart, some things, though, were immediately quite surprising: when asked, for example, if they felt that they/their stories had been influenced by any real or fictional scientists, the children gave examples, mainly, of real scientists not fictional ones. Fictional scientists, they felt, were mad and evil (perhaps because they were lonely and grumpy) and were mainly represented in cartoons not literature and were not at all representative of real-life scientists.

I'm sure a more in-depth analysis, in due course, will show some more interesting results but I've a long, long way to go before I get there and, perhaps, with your renewed permission, I might be allowed to speak with the children again when they're in Year 6.

It was a real pleasure to work with the children. Every single one. Their vivid imaginations, eloquence and honesty was almost overwhelming (as I'm not used to speaking to groups of people) and they were kind, too, and patient with me.

I'd so like to say thank you, again, for giving your permission. And I'd also like to thank Mrs [Year 5 Teacher] for being so kind and generous, too, with all her time and help.

Also, I'd very much like to know how you, as a parent/guardian, feel about the research or if you have any ideas or thoughts about it; or, perhaps, if you feel that you, yourself, have been negatively or positively influenced by real-life or fictional representations of science/scientists. If you'd like, therefore, to talk to me about any aspect of the research at all, I'll stay on after school this Friday - and, as always, I'll be in the Early Years Unit library or the main library every Monday afternoon and after school. My 'phone numbers are [Home Telephone] or [Mobile Telephone].

Thank you, very much, for your help.

Kindest regards

Elizabeth Delaney
Parent Volunteer

Example of 'Personality Sheet' – Scientist – Front of Sheet

YOUR NAME: .... ARE YOU A BOY OR A GIRL? ....

What sort of person is the SCIENTIST?

man	or	woman
age: ☐	or	age: ☐
kind / caring	or	unkind / uncaring
clever	or	not so clever
calm	or	nervous
bossy	or	not so bossy
cheerful	or	gloomy
follows rules	or	breaks rules
shy	or	not really shy
sensitive / feelings easily hurt	or	tough / feelings not usually hurt
trusts people	or	doesn't really trust people
has a lot of imagination	or	doesn't have much imagination
friendly	or	not so friendly
honest	or	dishonest
doesn't worry much	or	worries a lot
likes things to stay the same	or	likes to change things
likes to work in a team	or	likes to work alone
tidy	or	untidy
patient	or	impatient

MONDAY 16th JULY 2012

PLEASE TURN OVER

Example of 'Personality Sheet' – Scientist – Back of Sheet

What else could you say about the SCIENTIST?
YOU COULD DRAW THE SCIENTIST IF YOU LIKE.

MONDAY 16th JULY 2012

PLEASE TURN OVER

Extract from *Audacious, Endeavour and the God Particle Chronicles*

Sir Isaac Newton wore a slightly pained expression – as if there was a terrible smell emanating from somewhere beneath this, his magnificent portrait hung upon the east wall of Castle de Bois-Guilbert's Great Dining Room. Or maybe he simply knew exactly what they were up to and didn't approve one bit.

The brothers stared up at the portrait.

"Ah, yes," murmured Albere, joining them, "the father of modern physics..."

"The father of modern astronomy..." added Houdini.

"We're going to need a ladder," mused Endeavour.

Indeed, the painting was enormous – but the portrait of Galileo Galilei, hung about four feet away almost directly above Shakespeare's Death Mask, was rather smaller. Houdini moved towards it,

"Galileo Galilei," she announced.

"Ah, yes," murmured Albere, joining her, "the father of modern physics..."

"The father of modern astronomy..." added Houdini.

Endeavour rolled his eyes and looked impatiently between the two paintings,

"Well, which is it?" he asked hurriedly.

"Don't you think it's weird that *I* know you've got a safe and you two have no idea?" Houdini answered.

Endeavour and Audacious dared not look to one another. They each knew what the other was thinking: apparently Grandpa had been giving them all sorts of clues – about all sorts of things, probably. They hadn't noticed. Each felt like hanging his head in shame but, bravely, neither did. Instead, both watched as Houdini dragged a chair to the wall, stepped up, grasped Galileo Galilei with both hands and tilted him away from the wall a little.

There it was. A safe. *The* safe.

How long had that been there?

Forever.

"Y'know," said Houdini, "if I remember correctly, I think your Grandfather actually *wanted* me to see the combination."

"You know the combination?" asked Audacious, amazed.

"What's the point of knowing where a safe is if you can't get into it?" Houdini shrugged casually – then wondered, "How else did you expect me to get in?"

"With your little bag of tricks?" he indicated Houdini's trusty belt-pack, knowing she never went anywhere without it.

"I don't actually carry dynamite," she said.

"Not anymore," muttered Albere.

"Then 'knowing the combination' it is!" interrupted Endeavour, enthusiastically dragging another chair up next to Houdini's, hopping onto it and helping her unfasten

Galileo's portrait from its hook.

As Endeavour clutched the painting to his chest, Houdini took in the square of steel mounted perfectly flush within the wall. She grasped the outer door's cool handle, took a breath... and pulled it open. There lay the dial: a metal wheel within a wheel. Each cog had a hundred equally spaced markings around its rim – with only one single mark, a sort of tiny cross, to indicate, perhaps, where to begin.

"Where are you going to start?" asked Endeavour, peering around the edge of the painting.

"At the most easterly point," Houdini said – then looked to Albere, "That's 'the right hand side'…" she explained.

"I know which way is east!" Albere took exception to Houdini's simplification.

"But you don't know your left from your right. I just thought you might like to get a bit of practise in."

"I *do* know left from right! I, I, I, I just get... flustered!"

"You get totally flummoxed," stated Houdini, staring at the dial.

"It's no bad thing," said Audacious diplomatically.

"You over-think things," advised Endeavour from behind Galileo.

"Exactly. That's why you get flustered," agreed Audacious.

"Flummoxed," corrected Houdini. "Anyroadup, east, right, is where we start. That's what Grandpa did."

"When...?" asked Endeavour suddenly.

"Last Boxing Day. When you and your brother and were snaffling Albere's mum's apple strudel in the Kitchen."

Albere's jaw dropped. Her memory flew back to last Christmas – more specifically, the famous de Bois-Guilbert Boxing Day party. It happened every single year – just once a year, obviously – and it was fabulous. Everyone in the village was invited – and everybody came – but Albere and Houdini, being the boys' best friends, were, naturally, extra special guests and Grandpa made an enormous fuss of them. The magnificence of the decorated castle, not least the brilliance of the red and white light-bedecked turrets and battlements in silhouette against the Christmas moon, was unsurpassable – and strangely eerie but eerie in a safely spine-tingling, there's more to this life, more to discover, more to experience, yet, sort of way. Maybe it was the scrumptious cuisine, the live band (The Misfires – how cool was that?), or the subconscious comfort of a whole community coming together that made it an event that filled your heart with all those Christmassy feelings of 'Good Will to All Humankind'. The castle – and Grandpa – broadcast hope, somehow: Hope – that there was genuine goodness and kindness – glad tidings, indeed – out there. All over. There for the experiencing if we'd only give it out a bit more ourselves – and all of the time instead of just at Christmas.

It made Christmas Day less of an anticlimax, too, knowing that there was still the big bash at Grandpa Brian's to go to.

Albere whirled first to Audacious, then to Endeavour.

"*You two* snaffled the apple strudel?" she accused, her face alight with outrage.

Audacious' eyes sprang wide, feigning innocence. Endeavour concealed himself behind the painting.

Albere's mum made wonderful apple strudel – but only once a year, for the party.

"You told me the *monkey* ate it all!" Albere declared.

Last Christmas, most unusually, Grandpa had had extra visitors. Men and women they hadn't seen before. He said it was an old army convention, but it all seemed far more serious, somehow, than that. Everyone seemed grave, worried. They hadn't convened to celebrate the past rather than to prepare, with all due gravity, for an uncertain future. So, secretly, it hadn't been a very merry Christmas. One of the guests, though, Grandpa had greeted like a very special, very long lost old friend. He was a giant of a man. As tall and as thick set as a tank on a table. 'Aasim was his name. It was an Arabic name, Grandpa had said, and it meant 'protector' or 'guardian' – and as if to amplify his great height and breadth, 'Aasim had had the tiniest of pets. It was spider monkey called Kadin who, unfortunately, got taken ill on the very first night and took to lolling over the back of the big sofa in the Drawing Room for most of his stay.

The boys had told Albere the monkey was sick because it'd eaten all her mother's strudel – and they'd gotten away with it.

Until now.

Stuff always come back to haunt you.

Don't ever doubt it.

"You ate it *all*!! She only makes that strudel once a year! It's her *thing*! It's what she does!" Albere raged.

"Its her language of *luurrve...*" murmured Houdini.

"Her *what*?!"

"Oh, c'mon. You know your mum has a thing for their dad…"

Albere whirled to Audacious, whirled to Endeavour, flushed bright red with abject embarrassment – and whirled back to Houdini.

"Don't be ridiculous!" she glared, "If it was her language of love and she was interested in their dad, then she'd make a whole lot more strudel, surely – enough for a whole cartload of monkeys!"

"A 'tribe' of monkeys", murmured Houdini.

"A 'troop'," corrected Audacious.

"I think you'll find it's an actual *cartload*!" yelled Albere, her temper, obviously, risen. "If there's something I *do* know all about, it's *words*!"

This, indeed, was true. Albere had an astonishing flair for translation and, more importantly perhaps, in this world of cyber devilry, code encryption and decryption.

She saw patterns in things.

"So you do," Endeavour calmed her.

"Absolutely," agreed Audacious.

"'Cartload' it is," murmured Houdini.

"Now open that safe!" demanded Albere.

Houdini did. She set the top dial exactly due east, and began to turn it clockwise.

"Clockwise..." she murmured – then half turned her head toward Albere and opened her mouth to speak...

"I know which way is clockwise!" Albere interrupted before Houdini could say a word. Houdini smiled. Then concentrated hard. She turned the dial clockwise for sixteen clicks.

"Sixteen..." Houdini counted the very last click. Then set to turning the dial anticlockwise, counting inside her head until, "forty two..." She stopped. She released the dial. She leaned away from the safe. She took a deep breath... and she leaned back in. Her thumb and forefinger gently closed around the cool serrated metal. She dialled clockwise once more, "seventeen..." then switched the dial back to anticlockwise and executed another "twenty seven..." clicks.

"1642?" asked Audacious. "That's the year Galileo died."

"It's the year Isaac Newton was born," said Houdini. "And 1727 is the year he died. Newton, that is."

"So Isaac Newton's birth and death dates open the safe behind Galileo Galilei's portrait?" asked Albere dubiously.

"That's what Grandpa showed me," Houdini confirmed.

"Grandpa actually *showed* you?"

"Well, he 'let me see', then. And he was counting out loud."

"Don't you think that's a bit too obvious?"

"I'm telling you he wanted me to remember the combination!"

"Why *you*?"

"I don't know! Maybe because no one else was around at the time."

Pangs of pain and guilt filled Audacious' stomach; his solar plexus clenched and ached with the weight of it all. Endeavour's forearms trembled and his forehead touched the back of the painting as he felt his brother's pain mingle with his own. *They* should've been there. It should've been them. One of them. Or both of them. It didn't matter which. So long as one grandson, at least, had been listening to their Grandpa, taking heed, taking note, picking up on whatever it was he'd been wanting to tell them.

But they'd been too busy in the Kitchen stuffing their faces with Albere's mum's apple strudel and blaming the Great Pudding Robbery on a poor ailing spider monkey.

"Are you *absolutely* sure that's the right combination?" asked Albere. "If you've gotten it wrong, you could set some sort of alarm off. And knowing Grandpa de Bois-

Guilbert's fascination with alarms, there'll be a whole lot of bells and claxons sounding and steel shutters coming down, and maybe, maybe, what's in the safe might actually get obliterated – like one of those burn boxes that automatically destroys what's inside in case any secrets fall into enemy hands."

"I'm not wrong," Houdini said decisively – and reached toward the safe's inner handle...

"Wait!" Albere blurted. "Listen." Albere wracked her brains. "New Style date calculations say that Newton was actually born in 1643. On January 4th to be precise."

"Yes, but according to Old Style calculations – that's using the Julian calendar as opposed to the Gregorian calendar," Houdini explained, "he was born in 1642. On Christmas Day. A few months after Galileo died. And it's more romantic, don't you think? That in the same year as one father of modern physics died, another was born? And on Christmas Day, too?"

"Being 'romantic' has nothing to do with it," Albere said. "Grandad Brian was a physicist. Physicists are scientists; they're not romantics," Albere looked between Audacious and Endeavour, "Are they?"

The boys took her question in. Grandpa was, indeed, a cosmologist and an astrophysicist. A quite famous one. But was he an old romantic?

Audacious' thoughts flew to the Library. All those books. All those stories. Where better to be locked away, Grandpa had mused, than with a lifetime's worth of books to read. With all those stories, all those fictional – and real – lives to explore within all those adventure-crammed pages.

There were many, many lifetimes, Grandpa had often, *often* told them, to be discovered in the Library.

Endeavour thought about Grandpa's amazing film collection, too. He remembered Grandpa's favourite film. The film he and Audacious and Dad had watched last night. *Casablanca*. And he remembered this morning, in the mausoleum:

'So, yeah,' Endeavour, this morning, had suddenly spoke up, as if to scare away the onerous silence – or as if to put off, at least for the time being, the awful wrenching feeling that Grandpa was actually dead… and gone. 'This is it. Nothing amounts to…' Endeavour had faded away.

'A hill of beans,' Audacious, this morning, had finished for him.

Last night, they'd watched *Casablanca*.

Through their silent tears.

Now, today, Audacious knew what his brother was thinking.

Now, today, Albere brought them back to the present, to this evening,

"Well, was he?" she pressed. "Was your grandad an old romantic?"

Without a look between them, the brothers simultaneously answered,

"Yes."

"Then 1642 it is!" declared Houdini.

She grabbed the handle.

She turned it once...

...and, as Audacious' heart thudded, as Endeavour's stomach tightened, and as Albere clamped her hands over her ears, Houdini wrenched the door open...

To no bells, no claxons, no steel shutters or burn boxes.

Just a rectangular steel box with a handle flush within one smooth surface.

Lying there.

Ready. Waiting.

The metally box-case thing.

Albere gingerly pulled her hands from over her ears,

"We're in!" she proclaimed with glee. She flung her arms wide... and accidentally whacked Shakespeare's Death Mask right across the temple. The mask rocked backward, teetered, twisted sideways, then lurched off its mounting and plunged to the floor. Albere, immobile with horror, watched...

As Audacious, as if in actual slow motion, dived toward the mask where, with the mask all but three inches from the floor, he thwacked it upward with his right hand, juggled with it a bit, and caught it mid-flight with his left.

All four souls stared at the Death Mask. Audacious couldn't resist, he fitted his own face into the back of the mask – whereupon Houdini, shuddering at the sight, shoved her hands inside the safe and hauled out the smooth metal box.

"Hello, my Darlings!" declared Albere's mother, popping her head around the door.

Everybody froze.

Except Ms Girard – Ms Geneviève Girard – who came right on in.

Everybody, simultaneously, turned to her – and presented a rather suspicious tableau: of Houdini robbing the safe, Endeavour hiding behind Galileo's un-hung portrait and Audacious wearing Shakespeare's Death Mask. Only Albere, empty-handed, was a picture of serene innocence.

She stepped calmly around the other three and headed toward her mother.

"John and I are having a bit of supper," her mother smiled, "and thought the boys might like a little something…"

"They've eaten," Albere assured her, "and they were just saying how much they enjoyed it!"

"Enjoyed what?" asked Albere's mum with interest.

"Your Christmas apple strudel," Albere wrapped an arm about her mum's waist and guided her back through the door.

"Really? Did they freeze it?" Albere's mum smiled with delight at the boys – but, letting herself be guided out, she suddenly frowned, "I thought that ape ate it all..."

"It wasn't an ape," Albere ushered her mum into the hallway.

"Chimpanzee, then..."

"It was a monkey, Mother, a spider monkey."

The tableau, as one, breathed with relief.

Then sprang back into frantic action.

Houdini pulled the box entirely from the safe, closed the door and free-wheeled the dial. Endeavour re-hung the portrait. Audacious carefully replaced the Death Mask upon its podium. Once the two chairs were back where they belonged, no one would ever've guessed anyone had been anywhere near the place.

Except Ms Girard – who'd soon forget everything. As she always seemed to do. She only ever saw the best in anyone and everyone – and would've only taken safe robbing, portrait pinching and death mask wearing as the sort of simple hobbies that today's pre-teens enjoy.

Indeed.

Five minutes later, with the boys' dad and her mum safely ensconced in the Kitchen over a ham and cheese sandwich and a fragrant pot of Darjeeling, Albere bolted through the Library door.

Upon the Library's great granite table lay the rectangular steel box.

It lay there... waiting.

Audacious and Endeavour stared at it... waiting.

Houdini, on the other hand, paced back and forth impatiently behind the boys.

"It's not going to open itself," she muttered with rising frustration.

This was true.

So Audacious reached a hand toward the metal catch upon the front face of the box. And flicked it up.

The catch flew back with a satisfying CLIP! – then, exchanging a quick glance with his brother, he touched his fingers to the outer edge of the box... and lifted the lid.

Handprints.

Rather, the contours of two handprints lay outlined on a smooth pale blue glass surface. A left hand. And a right hand.

"A hand scanner!" Albere stated the obvious. As she liked to do. Just in case anyone wasn't keeping up.

"I don't suppose it matters which of you puts your hands in," Houdini observed, excitement replacing her frustration.

"It isn't as simple as that," murmured Endeavour thoughtfully.

"But if this is what Grandpa has left you both then, what with you two being *identical* twins, surely *either* of you can put your hands in..."

"Identical twins aren't *exactly* identical," continued Endeavour.

"We have the same DNA," Audacious advised, "but we don't have the same fingerprints – or handprints."

Albere looked to the handprints with dismay.

"Whose handprints, then?" Albere's brow furrowed. "I only ask because you do realise there could be another whole 'burn box' thing going on here..."

"You're too suspicious," accused Houdini.

"All I'm saying is the possibility exists that unless you get it right the first time, the box might self-destruct so that any secrets inside..."

"...don't fall into enemy hands, we know," Houdini finished for her.

The girls looked to one another with consternation. The boys looked to one another... and exchanged a thought.

"We're a special kind of identical, though," said Audacious. "We're mirror twins."

"You're *what*, exactly?" asked Albere.

"Though we're identical, we're actually the mirror image of one another," said Endeavour.

"He's left handed," Audacious indicated his brother.

"He's right handed," Endeavour did the same.

The girls frowned. They'd noticed the boys each favoured the opposite hand from one another, but the idea of that being on account of some weird twin phenomenon had never occurred to them.

The boys swiftly changed places.

With Endeavour stood to the left of the box and Audacious to the right, Endeavour reached his left hand and Audacious reached his right hand toward the cool blue glass.

Their fingers hovered for a second above the plate... then, at exactly the same instant, descended to firmly press their palms to the glass.

Immediately, a horizontal beam of bright blue light rose up from beneath the glass, and travelled from the front of the steel box to the back, scanning the boys' hands.

It scanned once.

It scanned twice.

It scanned three times... then abruptly switched off.

The glass plate shifted fractionally.

The boys automatically removed their hands and watched as the flat plate flipped up into the vertical to reveal itself to be some sort of plasma screen.

"It's a plasma screen TV!" Albere, once again, declared the obvious.

The screen seemed to ripple a little before a blaze of red sped across its surface… and a Templar cross pattée lay emblazoned there, right in the middle.

Then there it was.

Grandpa's face.

The brothers' hearts bounced with joy. Then stilled with shock.

Grandpa's face. Looking out at them. Motionless at first, then, after a fraction of a second, breathing into life: Grandpa looked at his watch, frowned – then looked back out the screen at them,

"What took you so long?" he asked, darkly. The boys, taken aback, felt their hearts plummet to their boots... until Grandpa suddenly grinned, "Kidding!" He raised his eyebrows and chortled like a madman. The boys didn't know where to put their thoughts. They were glad he was here, talking to them. But they knew he was dead. In reality, gone. This was just plain weird. They watched Grandpa struggle to calm himself down, wiping tears of laughter from his eyes with the back of his index finger. "I presume Houdini's done her stuff," Grandpa said and waved a little wave. Houdini, delighted at Grandpa's recognition of her genius, waved back.

"He can't actually see you," murmured Albere grimly.

"And I presume good old Albere is here," Grandpa went on, "Ready to direct our adventures with all due intrepid enterprise, eh, Albere?" Grandpa waved again – and Albere, thrilled to be described as an intrepid adventurer, beamed madly and waved right back. Then realised what she was doing; and quickly drew her hand down; and duly set her face in as serious an expression as her glee could muster.

"I hope your dad's not about," Grandpa looked to the left of the screen and then to the right as if he was actually scanning the room around them, "because this concerns him. And his work." The brothers might've glanced to one another – but didn't, each soul only too well aware that the only thing that *ever* concerned their dad was his work. "Next month," Grandpa continued, "your father'll be going back to Geneva. To CERN. Yes, that's the European Nuclear Research Agency, Albere, before you ask..."

Albere simply smiled. It didn't matter that there was stuff the boys knew and she didn't – yet. It mattered more that Grandpa de Bois-Guilbert knew her well enough to know that she liked to know things. She liked to ask questions. Whole loads – whole monkeys' cartloads – of questions.

"And it'll be ready," Grandpa stared seriously out at them. "You know what I'm talking about, lads. The LHC. The Large Hadron Collider. After spending twelve years rebuilding and upgrading it, it'll be ready..."

"The Large Hadron *what*?" asked Albere.

"Collider. It's a Particle Accelerator," answered Endeavour.

"It's massive," added Audacious, "The biggest on Earth."

"They're going to fire it up, boys," Grandpa said. "They're going to fire the accelerator. And, this time, there's an excellent chance they'll find what they're looking for..."

"What're they looking for?" asked Houdini.

"Alternative Dimensions," murmured Endeavour.

"Alternative Dimensions," said Grandpa gravely from the screen. "Since the discovery of the God Particle…"

"The Higgs boson," murmured Endeavour responding to Albere's questioning squint.

"The what what'son?" asked Albere, intrigued.

"The Higgs boson – the God Particle – was discovered back in 2012. It was the only particle in the Standard Model of particle psychics that hadn't, until then, been experimentally observed," Audacious explained. "They'd been trying to create it for decades – but the world's particle accelerators just hadn't been powerful enough."

"...the finding of Alternative Dimensions is the next obvious goal – and that's all well and good," Grandpa went on, "but, as you know, a by-product of their generation will undoubtedly be the creation of black holes..."

"Black holes?!" declared Houdini, a little freaked.

"*Primordial* black holes," Audacious advised, coolly. Like that'd actually put her mind at rest.

"*Primordial* black holes," Grandpa further explained.

"*PRIMORDIAL?!! BLACK?!! HOLES?!!*" exclaimed Albere, very loudly, trying hard not to shout. But hardly succeeding. "Your father will get *sucked in*!! Everyone at CERN will!! We *all* will!!" She whirled to Houdini, "How far away is Geneva, exactly?" then whirled to Endeavour, "Perhaps we should all head West?! America!! The Pacific Ocean!!"

"Primordial black holes are tiny," Endeavour soothed.

"Sub-atomically tiny," Audacious added.

"That's smaller than an atom," Houdini explained, she too, trying to cool Albere's anguish.

"I know what 'sub-atomically tiny' means!" Albere shot back at her. Then whirled to Audacious, "So: 'sub-atomically tiny' – what does that mean exactly?" she asked, anxiety rising.

"Well, you have the basic parts of an atom," Houdini interrupted, "protons, neutrons and electrons – all of which, of course, can't be seen with the human eye..."

"I *know* how tiny 'tiny' is!! I mean what does it mean in relation to the *STONKING GREAT PRIMORDIAL BLACK HOLES* that will shortly be wafting this way!!"

"They won't be wafting anywhere – they're so small they evaporate instantaneously," Endeavour said. "There's absolutely *nothing* to fear..."

"And this," said Grandpa from the screen, "is where there's absolutely *everything* to fear. Boys, girls..." Grandpa paused, looking out of the screen as if he really was taking in his precious grandsons and their best friends, "I believe the discovery of the God Particle marked the beginning of the end: the end of everyone – and everything."

"Lads?!" Dad shouted from somewhere along the hallway beyond the Library.

All four stomachs suddenly constricted with panic. But without a second thought, Endeavour reached for the box, grabbed the screen, folded it down and thumped the lid shut.

Audacious grabbed the box, yanked it from the table and bolted toward his desk

– but Albere was already bolting for the door...

They collided.

Not at so great a speed or with such a force as to split an atom or create a primordial black hole...

But awkwardly to enough to send the box irretrievably THUNK!ing to the ground.

It hit the floor on its side.

Four stomachs, momentarily, felt sick as they watched the box spin to the foot of the sofa. And rest there. All awry.

"Girls?!" Dad was almost at the Library door.

Houdini bolted for the sofa, grabbed a giant cushion, threw it down over the box and, grabbing a magazine, parked her feet upon it.

Albere dived to the cushion and, grabbing a magazine, languished all over one plump end of it – in case the box peeped out of its own accord, perhaps.

Dad pushed the Library door open and paused...

His sons were stood there, casual, empty-handed, at the table – like they'd been simply chatting or doing something equally suspicious. They simultaneously smiled at him – a picture of open virtuous honesty... and Dad came into the room, knowing, for sure, that they were up to no good.

Dad glanced to the empty table, to their empty hands and to their innocently empty faces trying to decipher the probably less than innocent goings on.

He looked to Houdini and Albere, flipping, apparently enthralled, through copies of *Professional Particle* and *Thermal Radiation Today*.

"Hey, Girls..." Dad said.

"Is it true," blurted Albere, showing Dad a page from *Thermal Radiation Today*, "that the 3 K Cosmic Background Radiation is thought to be radiation left over from the Big Bang?"

"Er... yes," said Dad, surprised, "...although it's actually 2.73 K – and your mum's made you all some soup and sarnies."

"Oooo, yum..." apparently Albere hadn't really been all that enthralled – as she speedily upped and headed to the door.

"Excuse me...?!" Houdini called after her. "What about the trip 'West!' you were planning? 'America!' 'The Pacific!'"

Albere halted in her tracks.

"You're going on holiday?" Dad asked.

"If only..." Albere mused, ruefully.

"Can we just have five minutes?" Endeavour asked his dad.

"Three minutes," Dad conceded as, glancing warily between them all, he backed out of the room and slowly closed the door – then reopened it a bit and left it ajar.

When his footsteps had rung away down the stone stairs Audacious bolted to the sofa, grabbed one end of the cushion and whipped it away from the box: Houdini's feet spun skyward.

"Sorry," Audacious duly apologised – and as Albere, thrown clear, scrabbled to an unceremonious stop a few feet away, he repeated, "Sorry..."

"D'you think it's broken?" Houdini wondered.

Audacious carefully retrieved the box and placed it on the coffee table.

"I daren't look," said Albere, looking, as she speedily crawled back to the table.

Audacious lifted the lid: a single simple fracture all the way from the left side of the box to the right, had cracked the blue glass plate. But it wasn't *entirely* broken in two.

"Plasma screens don't damage well," Endeavour murmured uncomfortably, gently easing the plate into the upright to examine the plasma screen beneath. He held his breath...

Grandpa's face, washed through with unease, was still there.

He was crystal clear.

But frozen.

Stuck.

Like a jammed digital TV signal. Or a DVD on pause.

Audacious tried to straighten the screen a little more.

But still, Grandpa's face stayed... stuck.

Endeavour folded the screen back down. He pushed the cracked halves of the glass panel closer together – and both boys carefully pressed their palms to the glass.

Nothing.

They eased the plasma screen back up.

Grandpa's face.

Stuck.

"I don't believe this," Endeavour felt the clammy escalation of a hot-cold sweat.

"How could we've done it again?" Audacious felt the same.

"Done what again?" asked Houdini.

"Disappointed him," Endeavour murmured miserably. "We disappointed him when he was alive…"

"And we're still doing it now he's dead," Audacious finished, hearing uneasy anger in his own voice.

"It was an accident," Houdini sought to reassure them.

"I'm so sorry..." said Albere to Audacious, her own guilt rising, "I crashed into you. I made you drop it."

"It's my fault," said Audacious, "I should've been more careful..."

"It should've been me," Endeavour interrupted.

The boys looked to their grandfather's face upon the screen.

Endeavour reached a hand toward his brother's elbow and just as the weight in his own heart began to bring him down, he felt his brother lean back into his fingers. Both boys' gazes dropped from the screen...

And landed upon the Templar cross pattée etched upon the steel plate that enclosed the rest of the inside of the box.

Simultaneously both boys' hands shot out. Then paused... as each realised what the other was thinking.

Endeavour dropped his hand away.

So Audacious pressed his fingers to the pattée. He felt the cool smooth steel and the lines of the etched emblem beneath his fingertips. Then felt the steel actually fall away as the emblem sank half a centimetre deeper into the box. The pattée's four arms then suddenly split four ways and the smooth metal sheath separated out and folded around and in on itself.

All four pairs of eyes leaned closer.

All four pairs of lungs held their breath... as the super-brilliant gleam of a super-smooth steel cube shone up from the interior of the box.

All souls stood stock-still as they took in what they were seeing.

Each side of the cube undulated for a second, then dissipated into nothingness leaving only each square edge of the cube maintaining a shining framework within which lay, or hovered, or was somehow suspended in actual mid air, a small sphere of – what? – steel? Light seemed to slide off the sphere's flawless surface. It seemed so still, so perfect, that all four pairs of eyes involuntarily leaned closer and closer.

"What on the planet is that?" murmured Houdini.

"There'll be instructions, surely," hoped Albere.

"I've never seen anything like it," said Audacious.

"Not even in any books or papers," agreed Endeavour.

"There must be instructions, somewhere," Albere dragged her eyes from the radiant sphere and leaned closer still to scrutinise the inside of the box.

Audacious carefully reached his hands toward it.

"Don't touch it!" warned Albere. "Find the *instructions*!"

"Grandpa had the instructions," guessed Endeavour.

"He was probably going to tell us exactly what to do," agreed Audacious.

"Or what not to do. Y'know what's going to happen. Your grandad's face is going to spring back to life and he'll say, 'Whatever you do, don't touch the big shiny red button...'"

"There is no button," observed Houdini.

"Well, *obviously*, there isn't an *actual* button. I'm just saying... Ow! OW!!" Albere grabbed at her earlobes and whirled to Houdini, "Stop it!"

"Stop what?!"

"Pulling at my earrings! If you want to borrow, just ask!"

"I never touched you!" Houdini defended.

Albere let go of her lobes. And felt her earrings... pull. She worriedly tugged at them – but her attention was suddenly drawn to Audacious, cautiously positioning both his hands fully inside the box.

He gently grasped the cube's outer edges.

He lifted the three dimensional square... up... and out.

The hairs on his forearms bristled.

As did everyone else's.

Albere let go of her earlobes to lightly brush her fingers over her arm, smoothing down the risen hairs and raging goose bumps... and felt the strange tug at her ears again. She re-grabbed her lobes and whirled to Houdini – but Houdini was stood a little way away from her staring at the luminous orb.

The air began to crackle.

"What's that?" said Houdini, looking, unseeing, into the air about them.

"What's *this*?!" said Albere, letting go of her lobes and feeling them tug more strongly, now, and backwards, away from her neck.

"It smells like the seaside," Houdini realised.

"Ozone?" wondered Audacious.

"It smells like lightning," said Endeavour.

"Ionisation?" supposed Audacious – then whirled to Albere, "Your earrings. What are they made of?"

"Hematite, I think."

"That's the mineral form of iron oxide..."

"They're getting magnetised..." Endeavour realised – then looked to the shining orb. "It's a giant magnet!"

"It doesn't look very giant," mused Houdini.

"It's *powerful*, I mean," Endeavour looked to Albere, "Take them off!"

"Excuse me?" Albere frowned, not a little affronted.

"Your earrings! Take them off!"

Albere, realising Endeavour's demand was not, in the circumstances, entirely unreasonable, hurriedly removed both shiny black studs and clutched them tight in the palm of her hand. She looked to the super-shining sphere.

"If they were to attach to it, d'you think we'll ever be able to prise them off?" she asked, holding her hand out toward it.

"Any sentimental value?" Houdini wondered.

"eBay," explained Albere – and, with a worry-free shrug, opened up her fingers…

The earrings shot ceiling-ward.

Four faces swiftly followed the flight and saw the studs slam right into Jupiter's bottom. Where they stayed. Riveted.

One of Grandpa's celebrated treasures was his Great Orrery: it was an ancient work of art. It was mechanical. Metal. Meticulous. It was a replica of our own solar system – not to scale, obviously, but wherein each planet moved in the correct orbit at the correct relative velocity around the central sun. It was suspended from the Library ceiling. Now, though, Jupiter was wearing jewellery.

That'd surely knock its orbit out of whack.

"Shouldn't magnets *attract* iron molecules?" Albere speculated, head back, neck straining as she picked out her tiny earrings glued to Jupiter's great underside.

"Depends on the magnet's polarisation..." Audacious' jaw dropped.

As did Endeavour's.

And Houdini's.

Behind Albere, one whole wall of the Library seemed to undulate.

Surge.

Crumple.

From what must have been a single pinprick at the centre of the wall, concentric circles like the ripples spreading out from a drop in a pond, purled outward like a shockwave.

And dissolved the wall into... nothingness.

Blackness.

Dark.

Night?

With rolling mist and drizzle.

With bare crooked trees and the splintered bones of wintering shrubs spiking out from the ground like poorly disguised man-traps.

It looked like the very last place on earth you'd want to visit on a night… like this.

And...

What...?

What was that?!

A few hundred metres away?

In the waning moonlight, the two-storey-house size... crypt?

Jet black against the sprawling Yorkshire Moors.

Was it? Was that the mausoleum?

Grandpa's mausoleum?

Endeavour, Audacious and Houdini stared through the grim moonshine to the mausoleum.

Albere dragged her gaze down from Jupiter's polished golden surface and looked to her friends.

They couldn't speak.

"What?" Albere spoke. She indicated her earrings, "Oh, don't worry about them..."

Still, nobody spoke.

"I know, I know," Albere went on, "we can't be sure where anything on eBay has been…"

Still, all three stared out past her, behind her...

They couldn't feel the obvious chill of that visible night.

The air was still, and calm, and warm. It was the Library's air. Not the cold night hillside air.

"...but I *did* sanitise them before I wore them!" Albere assured. "With iodine!"

Still, the three couldn't raise a word. Three brains struggled to make sense of what they were seeing. Or not seeing. Could this be some sort of mass hallucination?

Albere glanced to her earrings again,

"They were quite sweet though," she murmured, and as she slowly lowered her gaze and looked to her three stricken friends, she realised they weren't in fact angsting about her eBay shopping and sanitation habits.

Houdini abruptly met her gaze. Fear and dread within her stare.

Albere's eyes widened.

Audacious and Endeavour recognised those long thick columns of condensation that snorted out from the invisible nostrils... of the invisible beast.

It approached.

"Am I missing something?" said Albere, worry rising.

Invisible.

Indeterminate.

The beast was suddenly at Albere's shoulder.

It snorted.

Albere froze.

The air turned cold.

A long thick column of condensation shot right over her left shoulder, down to the cold stone floor at her feet.

"What, what, what..." she whispered slowly "...what's that?" she watched another column of condensation appear from nowhere. She closed her eyes – as, simultaneously, the boys' eyes shot to the orb.

Then shot to the box.

The brothers dived toward to the table.

Audacious braced the orb. Endeavour oriented the box.

Audacious shoved the orb in.

And Endeavour slammed the lid shut.

Behind Albere, the panorama that was the mausoleum upon the sprawling Moors began to undulate, surge, crumple...

Albere felt the hot breath of the beast against her cheek.

Her eyes flew wide.

And she suddenly about turned to face the demon – just in time to witness, all as if in a single slow-motion moment, the revelation of the great beast. Its invisibility fell away like dissipating fog, and an immense white horse in a pure black mantle reared up, its forelegs ranging high. Its lofty rider, bulky beneath his own black mantle and his hefty gauntlets, his homogenous deep grey chain mail and his burdensome black cloak... stared down at them.

As the mausoleum scenery and the night upon the Moors began to dissolve, as the actual Library wall began to uncrumple back into existence, the knight threw back the left side of his cape to reveal a four-armed, eight-pointed Maltese cross, pure white, emblazoned right across his chest.

His left hand reached swiftly down.

His gauntlet grabbed the scruff of Albere's neck.

He hauled her out of the Library...

...into the night.

The knight, the horse, the hillside – and Albere – almost immediately disappeared as the Library wall steadied itself into solidity.

Silence.

A chill.

Endeavour, Audacious and Houdini stared at the familiar array of ancient tomes lined up neatly upon the wall of weirdly dustless shelves.

They couldn't take it in.

Albere was gone.

* * *