Reading for Science: The use of scientific literary materials in primary schools

1. Introduction

In order to be able to make informed decisions in key areas of scientific citizenship and wellbeing, such as health and climate change, children need a firm understanding of scientific concepts and an understanding of how this knowledge is generated (the nature of science). Science should therefore be made accessible and appealing to all. However, many teachers may lack the specialist knowledge to achieve this. Only 5% of UK primary teachers have science degrees (DfE, 2016), and this lack of specialist knowledge often impacts negatively in the way in which science is taught and learnt (Harlen and Holroyd, 1997, Aalderen-Smeets et al, 2012). Consequently, children are often provided with inaccurate science content and miss the true story of scientific research.

One potential way to address these issues is to provide new gateways into science in forms which are accessible and appealing to non-science specialist, and non-science enthusiasts. Science based literary materials (SLMs) could achieve this by presenting science concepts, and the nature of science, in literary forms such as poetry and narratives. SLMs have the potential to provide a context for exploring science concepts (McLean et al 2015), to engage non-enthusiasts and to help children and teachers to understand the nature of science itself (Popov 2017) as well as cultivating positive dispositions towards science (Pearson et al 2010).

Despite SLMs appearing to be a powerful tool in helping to address some of the issues surrounding science education, little is known about how they are used by teachers and children. This research aimed to address this gap by evaluating how and if SLMs are used in science and English lessons and more generally in the classroom by teachers and children. It is proposed that if more could be learnt about the use of SLMs then targeted SLMs and support materials which address any factors preventing their more effective widespread use could be produced in order to present science in a welcoming and accessible format for all. This paper aims to address the following questions:
What can we learn about how and if SLMs are used within the classroom by teachers and children?

- What is the current range, genre and availability of SLMs?
- What are teacher's and children's practices around the use of SLMs?
- What can we learn about the development of SLMs?

2. Methodology and Methods

2.1 Methodology

An interpretive and pragmatic informed methodology was adopted in order to provide rich and detailed data about the experience of using SLMs within the classroom, for both teachers and children. A mixed method approach was employed in order to analyze a range of interconnected factors and to triangulate between findings.

2.2 Methods

In the UK, primary teachers teach all curriculum subjects but usually have a subject specialism. For this research, teachers who were English, rather than science specialists were invited to participate. The findings reported in this paper drew on audits of the availability and range of SLMs within classroom (child and teacher focus groups, library audits); analysis of pedagogical use of

SLMs by teachers (n=10) (focus groups and content analysis of documentation); and analysis of use of SLMs by children (n= 90) and teachers (focus groups, book sorting and categorising activities). During the book sorting activities, the children were shown 30 books containing scientific content. These covered a range of genres and topics. The children were asked to identify those which they thought had any scientific content. Qualitative responses provided with the focus group interviews and content analysis were analysed separately by four of the project researchers using Thematic Analysis (Braun and Clarke, 2006). Using a process of inter-coder constant comparison, the thematic hierarchies were combined.

3. Findings and Discussion

3.1 Availability of SMLs

Examinations of SLMs in schools showed that there were a large number of resources available. These overwhelmingly coved the same scientific topics (space, ecology, animals) and were almost always non-fiction in genre. Teachers were rarely able to identify any potential scientific content in books of other genres within other sections of the library.

3.2 Children's use of SLMs

3.2.1. Book sort

Of the books identified by the children as having scientific content, 75% had 'science identifiers' in their titles (vocabulary directly related to scientific content such as 'star' or 'telescope' etc.). However, only 31% of the books thought not to have science content, had 'science identifiers' in their titles. Children appeared to decide whether books had scientific content on the basis of their genre. 92% of those identified as not having any science content were fictional compared to only 37% of those identified as having scientific content. Books which were identified as having science content, only covered narrow and specific aspects of the science curriculum (space, environment) or were more widely related to engineering.

3.2.2 Childrens' focus groups

The following themes emerged from children's responses during their focus groups.

Theme	Freq.
Children know where to find books with scientific content.	35
Children can see the value in using fiction to learn about science	28
Children read a narrow range of scientific topics (space, ecology and ecology)	24
Children do not read science for leisure	17
Children view science books as only having factual content	17
Illustrations are important in supporting understanding	15
Children do not recall using any science texts in English	13
Texts that are used in science lessons are only used for research	11
Choosing to read science books or not is based on mood/emotion	8
Some children read science content online	8
Children find it hard to find science books at the correct level for them	5

Table 1: Thematic analysis of children's focus group responses

Children are aware of where they can access books with a scientific content within their schools but again, that their choices are narrow in the range of scientific topics covered. They only perceive non-fiction, factual texts, as having scientific content and only access literary materials with scientific content for research purposes, or when they are 'in the mood for it'; rarely to read for pleasure. They also only viewed SLMs as having a purpose in science rather than English lessons. Despite this, the children did report that they would welcome the opportunity to use fictional texts to learn more about science. They reported that the 'story' would help them to 'understand the science better' and would keep them more 'entertained' than factual texts may. However, even where they did read a text with scientific content, this is often pitched incorrectly for them to either access the content or maintain interest in the content.

3.2 Teacher's use of SLMs

The following themes emerged from teachers' focus groups and content analysis of documentation.

Theme	**No***	**Sub-theme**	**No***
Interpretations or views of the curriculum	24	knowledge	15
		Skills	9
Organisation (use of resources within the curriculum)	36	Freedom/ lack of choice	9
		When/How	29
Quality of science in SLMs	13	Inaccuracies	9
		Critical literacy of science content	4
Text type	17	Pictures/ Chapters/ Interactive	9
		Fiction/ non-fiction	5
		Age intended for	3
Barriers	11	Prior Knowledge	1
		Teacher Knowledge (science +Eng)	7
		Time	2
		Guidance around choice	1
Nature of science	10	The scientific method	3
		How to explain	1
		Diversity/ scientists	6

Table 2. Thematic analysis of teacher focus group

Teachers appeared to interpret the science and English curricula content in very different ways. Science was viewed as having an overwhelming factual content knowledge and the teachers were concerned about covering all of these requirements. Conversely, the English curriculum was perceived as skills to acquire or attain. This was reflected in distinct views about using factual, non-fiction genres to cover scientific content rather than through other genres. Where scientific skills were discussed, the teachers expressed a lack of confidence about the nature of the scientific process, were concerned about how they would explain this and how they could emphasise the diversity of scientists involved.

This would appear to present challenges in bringing these two aspects of the curriculum together. Where teachers did show a desire to bridge this perceived difference they reported many barriers

in being able to do so. One aspect was a lack of freedom of choice about which text they were able to select as these were often agreed upon at a whole school level. They also reported that the texts which were available to them did not provide appropriate opportunities to engage in cross curricular work i.e. texts containing scientific content did not contain the appropriate features needed for English lessons and vice versa. It was reported that finding such texts would be too time consuming.

A further barrier related to scientific knowledge. Teachers were concerned that the children may have insufficient prior knowledge to access the science within SLMs and that their own subject knowledge may also be insufficient to use SLMs effectively (particularly around forces and electricity). It was felt that SLMs would need to be accurate and cover large amounts of simplified knowledge content. The teachers were also aware that many fictional texts contained scientific inaccuracies (e.g. a badger tidying up a park). Teachers felt that children would not have sufficiently develop levels of critical literacy to distinguish between literary tools and scientific inaccuracies. The teachers reported that they felt that the format of texts (e.g. short sections) would be import in helping children to engage with any scientific content, and that different formats many be useful for different groups of children (e.g. those with English as a second language or with additional needs). There was much thought about the importance of illustrations in helping the children to understand the scientific content, even for older children. As reported by the children the teachers emphasised the importance of SLMs being age appropriate, using the correct vocabulary.

4.Discussion

Materials which are designed for, and only appeal to science specialists within schools will only go so far in meeting the challenges of science education. SLMs appear to address some of these issues (McLean et al 2015; Popov 2017 and Pearson et al 2010) and so we must ensure that these are as appealing, useful and appropriate as possible in order to encourage their wider use across the curriculum by a wide range of teachers and children.

Simply making SLMs available does not guarantee their use by either children or teachers. However, there is an appetite for this from both groups. Texts are becoming a more popular mechanism for teaching science (Sackes et al, 2009) but presently, it appears that teachers do not use SLMs within English lessons. SLMs should be presented alongside support materials such as English lesson plans and activity ideas. Not only would this reduce planning time for teachers but would also increase the choice of texts and learning materials available to them. It may also help to address teacher's concerns about covering large amount of scientific content. SLMs offer an additional way to cover content outside of science lessons rather than be an additional extra burden to timetables. Where SLMs are available these are narrow in range and genre. Teachers and children seldom identified potential scientific content in genres other than non-fiction and so these links need to be made more obvious, signposting to the scientific content. This could be with a 'science identifier' which would this make the content more obvious and, again, reduce the amount of time taken to find suitable texts.

One critical concern with SLMs is the identification of scientific inaccuracies (Trundle and Troland, 2005; Ganea et al, 2014). By using literature containing such inaccuracies teachers may be

unwittingly introducing misconceptions to children. Using scientists and literary specialists as co-authors of SLMs may address this. However, teachers also expressed concerns about the pitch, curriculum coverage and appropriate content of SLMs. It is unlikely that a specialist in one area alone would be able to address each of these factors and so a team of authors containing scientists, science and English education specialists as well as literary specialists may be more appropriate.

SLMs should also cover a wide range of genres. This may help to ensure that they are used more widely throughout the curriculum, and encourage non-science enthusiasts to read SLMs for pleasure, broadening their exposure to science content in general. Narrative SLMS may also strengthen scientific understanding as the conceptual connections present within fictional texts may be supported by narrative links (Bannister and Ryan 2001). The range of topics covered by SLMs and how these are made available also needs to be broadened, using online materials may be one way to address this.

Teachers expressed concerns over their subject knowledge and therefore their ability to use SLMs effectively. SLMs should therefore be made available with additional subject support for teachers and glossaries for teachers and children. Use of illustrations was also highlighted as an important conceptual tool. Within SLMs attention should be paid to the nature of science. High quality science content can support both children's understanding of the nature of science and their understanding of science concepts (Cervetti, et al, 2012; 2009). This could help to address perceptions of science curricula as being knowledge rather than skills focused and may also help to address perceptions about science itself. Primary children hold misconceptions about scientific activity and about scientists and engineers with traditional ideas about men in laboratories prevailing (Zhai et al, 2014; Archer et al., 2010). If we want children to understand the nature of science we need to embed the use of reading as a tool to support learning and inquiry as this reflects an important part of the scientific process and is one of the best ways to help children to cultivate positive dispositions towards science (Pearson et al 2010). Biographical SLMs could address these perceptions and help teachers to demonstrate the diversity of scientists working on current and key issues.

5. Viability, Limitations and Future Work

This study was conducted on a small scale and within a UK context, so the findings should be generalized with caution. However, within any culture and context, there will be those who do not engage with scientific content and materials readily and so the findings presented here may provide a way in which these people can be reached. It must also be considered that simply producing a set of materials and resources does not mean that these will either be used or that they will have any impact. For this reason, the research team have now produced a SLM toolkit for use in schools. This includes SLMs of varied genres (biography, story, poem, letter, a factsheet and a piece of argumentative writing) accompanied by teachers' subject knowledge support, English and science lesson plans, a glossary, curriculum links for English and science and links to wider resources. Also included in the toolkit is a video about the scientist involved, her background and details of how she works. The impact of these materials on teacher's and children's understandings, pedagogies, attitudes and dispositions are currently being evaluated.

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