Review of scientific literacy and oracy in primary school education

Prof Sarah Earle, Dr Anne Parfitt and Dr Stuart Read
Bath Spa University

May 2025

Commissioned by the Royal Society

Table of Contents

Executive Summary

This Royal Society commissioned rapid literature review maps the current landscape for scientific literacy and oracy in the context of primary school education in the UK. The aim is to identify challenges, gaps and opportunities for oracy-rich primary science (age 5-11).

Searches of academic databases for 2015-25, alongside the collection of national curricula and UK sector reports, resulted in the screening of 81 academic articles and 68 grey literature documents.

Key definitions were collated to provide a starting point for the review, leading to the identification of the following for supporting current primary science practice:

> An inclusive definition of **oracy**:
> 'Articulating ideas, developing understanding and engaging with others through speaking, listening and communication' (Oracy Education Commission, 2024).
>
> A new definition is proposed for primary:
> **Scientific literacy** for primary-aged children involves purposeful and active engagement with science ideas and real-world contexts, to discuss and apply scientific thinking.

Oracy was identified as a core element of scientific literacy, as a crucial means to support the development of scientific understanding and reasoning. Active participation in dialogue about science ideas and practical applications helps children to engage with science-related issues, communicate their findings and develop understanding of science as a discipline.

This review found that both scientific literacy and oracy are rarely made explicit in UK national curricula, with only Scotland naming them in objectives for Topical Science. Talk for communication was represented but it was often framed as a precursor to writing, rather than an important skill in itself. Oracy was more frequently described as an outcome (learning how to talk, oracy education), rather than a process (learning through talk, dialogic teaching) (Cambridge Assessment, 2022).

Reports within the grey literature promoted oracy, but these were rarely discipline-specific. A small number of reports described oracy-rich primary science explicitly. For example, the latest Education Endowment Foundation guidance recommended schools 'capitalise on the power of dialogue' (Luxton & Pritchard, 2023) and the recent Nuffield Foundation funded practical work study promoted multimodal communication in 'hands-on, minds-on' practical work in primary science (Earle et al., 2025).

Two large-scale studies in the UK related to oracy-rich primary science and both found a positive impact on science learning: Dialogic Teaching (Jay et al., 2017, Alexander 2018) and Thinking Doing Talking Science (Hanley et al., 2015, Hanley et al., 2020). The majority of relevant international studies were on a smaller scale and explored a range of different strategies to support oracy-rich primary science. Common themes around pedagogical strategies from the UK and international studies were found to be:

- **Making space for oracy-rich primary science**, in terms of both a conducive class environment and time for the children to engage in extended discussions.
- **Opening out talk to build cumulative thinking**, via open questions and scaffolds to encourage scientific reasoning and explanation (e.g. use of sentence stems such as: 'This is because…', Hackling & Sheriff, 2015).
- **Prompts to spark the discussion**, including teacher questioning, activities to instigate dialogue (as found in the large Explorify database), practical prompts and enquiries.

The review was limited by the small number of reports and studies that were explicit about oracy and scientific literacy. The following opportunities are presented for the Royal Society and others in the sector:

- **Champion oracy and scientific literacy in the curriculum and across the sector**: promote oracy-rich primary science to underscore the importance of applying science ideas and thinking, by making this more explicit in guidance, resources and curricula.
- **Exemplify oracy and scientific literacy in primary science**: demonstrate the value of oracy-rich primary science by exemplifying what this looks like for different ages and across topics, so that teachers and schools have clear examples to apply to their own context.

The key finding from this review is that oracy, scientific literacy, and the power of utilising both together, are not made sufficiently explicit in guidance or literature. This gap should be addressed by the Royal Society and others in the sector. Making the link between scientific literacy and oracy clearer, will raise the profile of **oracy-rich primary science** and help to demonstrate how dialogue can support the development and application of scientific thinking.

1. Introduction

Context: Importance of scientific literacy and oracy

Scientific literacy is increasingly important in modern society. The ease of access to information from a range of sources means that young people need to become critical consumers and recognise the evidence-base for their decision-making. Science is a social endeavour, with scientists collaboratively building evidence, together with multimodal communication of findings becoming essential for reaching target populations. Notably, the Royal Society originated with oral presentations and discussions between gatherings of scientists, marking the importance of oracy in science from the outset.

In order to apply scientific thinking to everyday situations, children need to see science as something that they can engage with, something that is 'for them' (Nag Chowdhuri et al., 2021). The development of oracy in schools can be a tool for supporting engagement with science. For example, opportunities for discussion and debate around science-related issues can help scientific content to be meaningfully related to children's lives. Oracy can also support learning of the content of science, providing opportunities to use and apply scientific vocabulary and knowledge.

Science is a statutory part of the primary school curriculum (age 5-11) in all UK nations, but its status lags behind literacy and numeracy. For example, in England, school accountability measures are determined by results in English and mathematics, meaning that time for science is often squeezed (Ofsted, 2021). Concerns regarding resourcing, professional development for teachers and depth of children's science learning have also been raised (Bianchi et al., 2021; Ofsted, 2023; Earle et al., 2025). Nevertheless, examples of innovative primary science practice are regularly celebrated and supported by a wide range of learned societies, organisations and charities across the UK. The challenge is to support such practice to be shared and enacted in all primary school settings.

Review purpose and aims

The Royal Society commissioned a rapid literature review on scientific literacy and oracy in primary education, in order to understand the current landscape and inform potential new evidence-based resources and initiatives for supporting primary science.

The following aims were set for this review:
1. To **map the current landscape**, exploring existing definitions, frameworks, and teaching practices for scientific literacy and oracy in UK primary education over the last ten years.
2. To examine how scientific literacy and oracy skills can be **effectively developed** with pupils from a young age and integrated into the curriculum and cross-curricular initiatives.
3. To identify the **challenges and gaps** where teachers face difficulties or barriers in developing pupils' scientific literacy and oracy.
4. To identify, from the review, **opportunities** where the Royal Society can leverage its strengths, such as connections with scientists and credibility in promoting evidence-based practices to address unmet needs with innovative, scalable and inclusive resources for teachers to use in schools.
5. To provide **recommendations** and actions to inform the creation of resources and initiatives that enhance the development of scientific literacy and oracy skills in primary pupils and suggest strategies to engage teachers, students and the broader STEM educational community effectively.

Scope of this rapid literature review

This review focuses on scientific literacy and oracy education for primary-aged children (ages 5-11) in the UK. It collates peer-reviewed academic literature, policy documents from the UK government and the devolved governments of Northern Ireland, Scotland and Wales, and other relevant reports, interventions and resources from educational charities and bodies.

The findings from this review of the current landscape of scientific literacy and oracy for primary schools in the UK are detailed in this report. After consideration of methodology, there is a mapping of recent academic and grey literature, followed by collation of emergent themes, gaps and recommendations.

2. Methodology

Literature search

Multiple searches were carried out to identify relevant academic literature. We utilised both more specific and broader search strings, since we found that ‘scientific literacy’ and ‘oracy’ were not commonly used in the same articles. The broadest view of learning science in a primary school context was taken (e.g. broadening from scientific literacy to science education), to avoid missing relevant studies.

Example search strings:

- Example academic databases (Academic Search Premier, Education Research Complete and ERIC) search string: (primary OR elementary school OR primary education OR elementary education) AND (argumentation OR oracy OR talk OR dialogue OR speaking) AND (scientific literacy OR scientific reasoning) AND (science education OR science teaching OR science learning OR science instruction).
- Example Google Scholar search string: (primary OR elementary) AND ("oracy" OR "talk" OR "dialogue" OR "argumentation" OR "speaking") AND ("science").

We initially included the UK nations in the search terms (i.e., “UK” OR “England” OR “Scotland” OR “Wales” OR “Northern Ireland”), but this did not prove to be useful, due to the small number of studies. Instead, we focused on including international research which had relevance to the classroom practice of primary science in the UK.

Inclusion criteria: primary age phase (4/5-11/12 years), published from 2015 onwards (or the latest statutory curricula guidance), published in English, full text access, relevance to classroom practice of primary science in the UK.

Exclusion criteria: studies of older students or pre-service teachers, non-classroom-based studies, books or book chapters (due to challenges in accessing complete texts, as well as the short time-span for completing the rapid review).

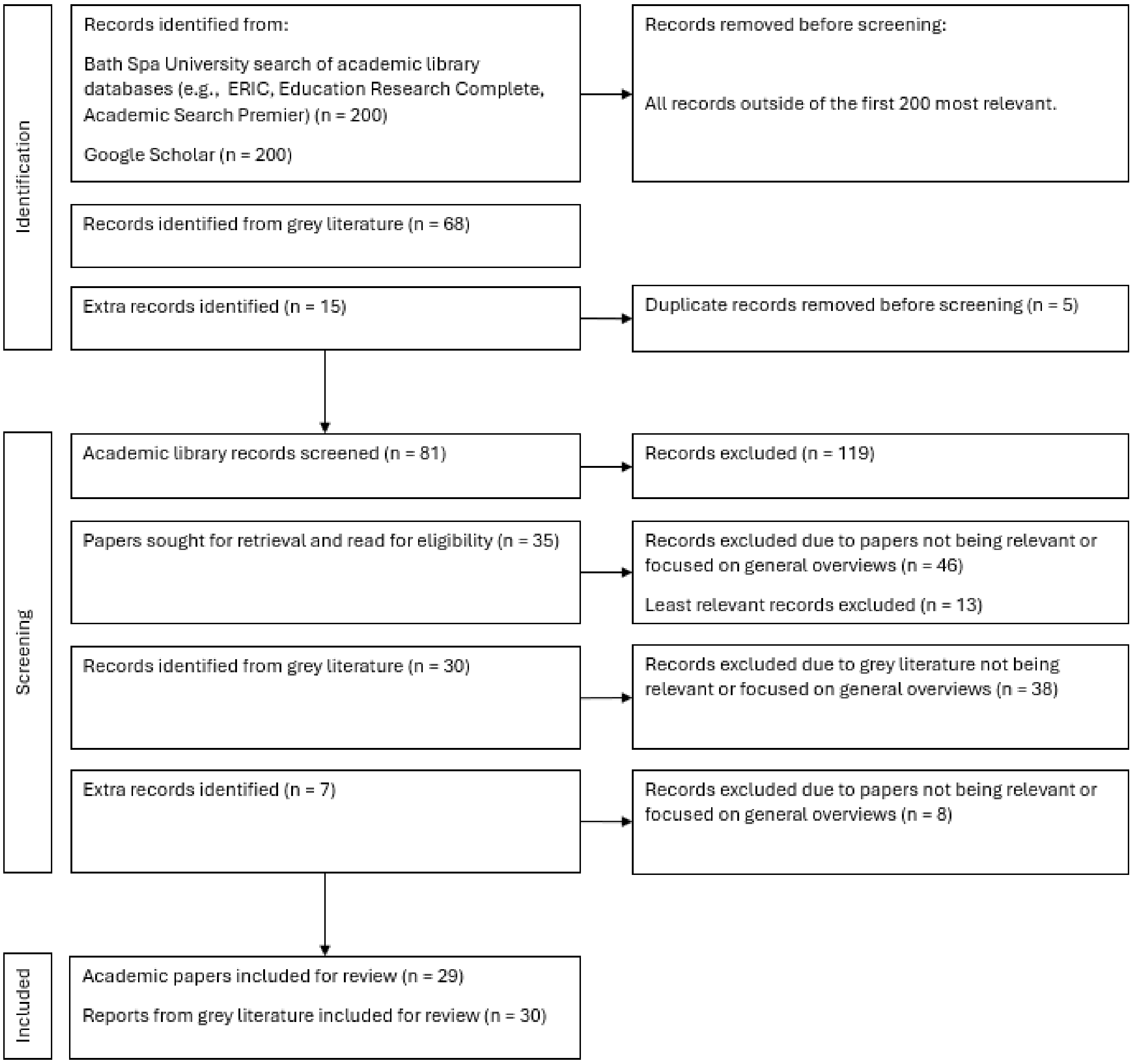
Grey literature (curricula, policy documentation and resources) were identified by:

- Extracting the latest relevant statutory guidance in each nation’s curricula from the national bodies: England’s Department for Education (DfE), Education Scotland,

Curriculum for Wales, and the Council for the Curriculum, Examinations & Assessment (CCEA) in Northern Ireland.
- Reviewing policy statements and relevant guidance from key UK organisations, for example: the Royal Society, the Association for Science Education, the Royal Society of Biology, the Royal Society of Chemistry, the Institute of Physics, the Wellcome Trust, the Education Endowment Foundation and the Chartered College of Teaching.
- Collating examples of recent and ongoing projects and resources for teachers, for example: drawing on website searches for the organisations listed above, together with charities who produce primary science focused materials such as: the Primary Science Teaching Trust, STEM Learning, the Ogden Trust, CIEC at the University of York and SEERIH at the University of Manchester.

A total of 81 academic articles and 68 grey literature documents were screened. A summary of the research process is presented in the diagram in Figure 1.

Figure 1: A summary of the search process



Applying the inclusion criteria, the academic and grey literature most relevant to oracy and scientific literacy within the UK primary science context were identified. Summaries were collated and data extracted to identify guidance, projects and studies related to oracy-rich primary science. Pedagogical strategies from studies were listed to identify common themes to inform recommendations.

Methodological limitations of the review

The rapid scoping review was focused on providing a broad overview of the current academic and grey literature. While our approach was rigorous and methodical, it was not our intention to conduct a full systematic review of the field (Page et al., 2021). This is due to both time constraints and the challenges in systematically reviewing research regarding scientific literacy and oracy, as described above. Our rapid scoping review should therefore not be seen as a complete account of the existing literature.

3. Definitions and inter-relations

The terms oracy and scientific literacy mean different things to different people, thus it is important to define how these key terms have been used in the literature and how they have been defined in this report. The meaning of terminology evolves over time, with changing contexts and shifts in thinking resulting in new meanings. In this section we explore the range of definitions found in the literature and highlight those that are most relevant to the current primary science context in the UK. Taking a primary science lens means that we are particularly looking for explanations that will support enactment for teachers in the primary school, whilst also being aware of younger and older phases of education to aid transition.

Oracy

An emphasis on spoken language is evident in many definitions of oracy, for example:

- ‘Oracy refers to the skills involved in using spoken language to communicate effectively’ (Cambridge Assessment, 2022, p1).
- ‘Oracy refers to the set of skills associated with speaking and listening’ (Millard & Menzies, 2016, p10).
- ‘Oracy is the ability to articulate ideas, develop understanding and engage with others through spoken language’ (Voice 21, 2025).

Embedded in these definitions is an emphasis on communication as a key reason for using the language skills. Broadening the scope from spoken language to communication, enables a more inclusive definition that encapsulates other forms of communication such as sign language. Therefore, this report proposes the following definition as a basis for the review:

> **‘Articulating ideas, developing understanding and engaging with others through speaking, listening and communication’** (Oracy Education Commission, 2024).

Oracy can be seen as an outcome, when the focus is on developing skills in speaking, listening and communication. Oracy can also be seen as a process whereby children ‘learn through talk, deepening their understanding through dialogue with their teachers and peers’ (Millard & Gaunt, 2018). Thus, oracy includes learning *how* to talk (oracy education) and learning *through* talk (dialogic teaching) (Cambridge Assessment, 2022). Dialogic teaching is a ‘pedagogy of the spoken word’ (Alexander, 2018, p562), considering the talk of both the teacher and the children, with particular emphasis on how teachers can facilitate children’s talk to enhance their thinking. Therefore, learning *through* oracy is of particular interest here, as we consider how speaking, listening and communication can support learning in primary science.

Scientific literacy

There is no universally accepted definition of scientific literacy. However, it is important to be clear from the outset that we are not referring to being able to read science texts, for the term is much broader and relates to understanding and using science. Scientific literacy definitions can be so wide-ranging that they appear to encompass the whole canon of scientific knowledge, the nature of science and its applications. Thus, definitions often appear too broad for the primary age-phase, seemingly needing a lot of prerequisite knowledge before they can be applied, as demonstrated in the PISA OECD definition (for 15 year olds).

- ‘Scientific literacy is the ability to **engage with science-related issues, and with the ideas of science**, as a reflective citizen. A scientifically literate person is willing to engage in reasoned discourse about science and technology, which requires the competencies to: explain phenomena scientifically; evaluate and design scientific enquiry; interpret data and evidence scientifically’ (OECD, 2015).
- ‘Science literacy involves **actively participating in informed discussions about science**, sustainability and technology to guide decision-making and action. This requires the ability to explain phenomena scientifically, design and assess scientific enquiry, and research and interpret data and evidence critically.’ (OECD current online definition, 2025).

However, consideration of the initial statements in the OECD definitions (indicated in bold), provide elements that can more easily be related to the primary school context. Engagement with science-related real-world issues and active participation in discussions about science, point towards the need for children to take an interest in the science around them on their path towards scientific literacy. The application of science thinking is a recurrent theme in definitions in the literature, for example:

- ‘The definition of scientific literacy has expanded to include more than just asking students to know science content. Instead, students are asked to **apply** their scientific knowledge by interpreting information critically using reasonable evidence, making scientific decisions with evidence, and managing their uncertainty and negotiating ideas with conflict claims’ (Chen, 2019, p51).
- ‘Critical, though, to being able to understand how science can be used as a way of thinking, finding, organising and using information to make decisions requires that students be scientifically literate’ (Gillies et al., 2015, p428).

Drawing together the active engagement with science and its application, a novel succinct definition to support enactment in primary science is proposed:

> **Scientific literacy for primary-aged children involves purposeful and active engagement with science ideas and real-world contexts, to discuss and apply scientific thinking.**

The ‘science ideas’ and ‘scientific thinking’ competencies are not specified further in this brief definition. This is because determining which scientific content and methods are applied will depend on the age of the child, although appropriate examples related to primary science will support enactment in practice. ‘Discussion’ is embedded within the definition, to raise the profile of linking oracy and scientific literacy.

Scientific literacy and oracy

Oracy is more than just complementary to scientific literacy, it is a core element, as noted in the latest OECD definition of scientific literacy above, which highlights the need for active participation in science discussions. Scientific literacy is 'not solely an individual process, but one that is situated in various social contexts' (Chen, 2019, p51), and 'a scientifically literate person is willing to engage in reasoned discourse about science and technology' (OECD, 2015, p22). The ability to communicate is essential for sharing and applying science findings, hence, oracy and scientific literacy are inextricably linked.

Scientific literacy can be related to argumentation (a process of reasoning), which also involves discussion and debate. 'Fundamental in such literate use of empirical argumentation is the ability of individuals to communicate effectively' (Vieira & Tenreiro-Vieira 2016, p664). The oracy element is not, however, always clearly expressed in studies of argumentation, and it is a process that is more often researched with older students. Nevertheless, whether considering a form of argumentation, or scientific reasoning in more general terms, a particular way of talking and communicating may be used in science that differs from other subjects. 'Disciplinary oracy' is needed since there are discipline-specific ways of thinking and knowing, with different vocabulary and types of dialogue (Oracy Education Commission, 2024, p22-3). For the primary age-phase, learning the vocabulary of science is a key curricula aim, with particular attention paid to polysemous words that might have different meanings in science contexts as compared with everyday conversation (e.g. attract, force, material) (Luxton & Pritchard, 2023).

Oracy is put forward as a means to support scientific thinking: 'we do not just use language to interact, we use it to 'inter-think', defined as the everyday process whereby people collectively and creatively use talk to solve problems and make joint sense of the world' (Mercer & Mannion, 2018, p17). The importance of dialogue and collaborative group work for cognitive development and critical thinking in science was also noted by the Royal Society (2010): 'dialogue and discussion are therefore important, both for the teachers to hear and monitor the children's ideas and how they are expressed, and for the children to hear how the teacher uses language to categorise and describe phenomena' (p69). The development of oracy can aid scientific literacy and vice versa, making this topic of particular interest to those supporting primary science teaching and learning.

To exemplify the inter-related nature of oracy and scientific literacy, Table 1 maps each element in turn.

Table 1: The inter-related nature of oracy and scientific literacy

Aspect of scientific literacy	Explanation	Relation to oracy education
Nature of science as a discipline	How science is a particular way of thinking, finding, organising and using information (Gillies et al., 2015, p428).	Class discussion can exemplify the way scientists collaboratively present and reason about evidence. Articulating ideas (Oracy Education Commission, 2024).
Scientific concepts (substantive content)	Explain phenomena scientifically (OECD, 2015) e.g. in biology, chemistry, physics topics.	Use of vocabulary to develop shared understanding of meanings. 'inter-thinking' to make joint sense of the world' (Mercer & Mannion, 2018).
Scientific method and skills (disciplinary knowledge)	Evaluate and design scientific enquiry, interpret data and evidence scientifically (OECD, 2015).	Classroom conversations support the development of enquiry (Wellcome, 2020). Statutory curricula require the communication of science findings in a variety of ways.
Real-world applications	Engagement with science-related issues (OECD, 2015), using science purposefully, to inform decision-making.	Actively participating in informed discussions about science to guide decision-making and action (OECD online). Linking science to real-world contexts and discussion to cultivate reasoning (Luxton & Pritchard, 2023).
Apply science thinking	Apply scientific knowledge by interpreting information critically using reasonable evidence, making scientific decisions with evidence (Chen, 2019, p51).	Fundamental in such literate use of empirical argumentation is the ability of individuals to communicate effectively' (Vieira & Tenreiro-Vieira 2016, p664). Collaborative discussion to support pupils to think independently (Bennett et al., 2023).
Attitude and engagement with science	Feel that science is something they can participate in (Nag Chowdhuri et al., 2021). Participation as a global citizen (PCAG, 2023)	Collaborative class discussions can be open to all, supporting active engagement via an inclusive approach. Engagement in reasoned discourse (OECD, 2015)

4. Mapping the landscape (2015-2025)

UK national curricula guidance

Each UK nation follows a different statutory curriculum. All of these include science at the primary age-phase, with some taking a more cross-curricular approach (Science and Technology in Wales and The World Around Us in Northern Ireland). The terminology of 'oracy' and 'scientific literacy' rarely feature within the curricula, but references to 'talk' and the application of science can be found. Oracy or talk in relation to science is largely implicit in most national approaches.

England

Oracy is not explicitly discussed in the science sections of the National Curriculum for England (DfE, 2013). The use of 'talk' is noted in the introductory section, for example: 'enable pupils to develop a deeper understanding of a wide range of scientific ideas. They should do this through exploring and talking about their ideas' (Upper Key Stage 2, DfE, 2013). However, oracy features are rarely explicitly mentioned in National Curriculum age-related expectations for science, from where teachers and curriculum developers source lesson objectives. There appears to be an implication that talk leads to writing: 'use some scientific language, first, to talk about and, later, to write about what they have found out.' (Lower Key Stage 2, DfE, 2013).

Northern Ireland

Communication is one of three cross-curricular skills and part of the social skills personal capabilities: 'communication is central to the whole curriculum' (Northern Ireland Curriculum, 2007, p5). Science is placed with the World Around Us section of the curriculum, alongside history and geography. Oracy is not a term that is used in the curriculum. Whilst talk is explicit in Foundation stage World Around Us curriculum, it is more implicit in Key Stage 1 and 2, e.g. 'from using everyday language to subject specific vocabulary' (Northern Ireland Curriculum, 2007, p85). In the more recent Progression Guidance (CCEA, 2019), talk is mentioned with regard to sharing learning, especially for younger children.

Scotland

Talk and discussion are explicitly mentioned and linked to scientific literacy, especially within the 'Topical Science' Curriculum for Excellence descriptors: 'I have contributed to discussions of current scientific news items to help develop my awareness of science. SCN 1-20a'. (Education Scotland, 2009). Discussion features in the more recent Benchmarks for Topical science: 'Discusses and expresses opinions about science topics in real-life contexts, including those featured in the media. Discusses how people use science in their everyday lives. SCN 1-20a'. (Education Scotland, 2017). The Topical Science objectives are listed separate to other science content, perhaps making them appear as additional rather than embedded as part of the science curriculum.

Wales

Ethically informed citizenship is one of four core purposes of the curriculum: 'Learners need to be able to evaluate scientific claims to help make informed decisions that affect our environment and well-being' (Being curious statement of What Matters, Curriculum for Wales, 2020). Scientific literacy is explicit in the Progression steps: 'I can engage with scientific and technological evidence to inform my own opinions' (Being curious, Progression step 3, Curriculum for Wales, 2020). Oracy is implicit: 'I can ask questions… I can communicate my findings' (Being curious progression step 2, Curriculum for Wales, 2020). It is also important to consider oracy within the bilingual experience for Welsh-medium schools (Mercer & Mannion, 2018).

Curricula conclusions

Talk for communication is represented within the curricula documents, but only Scotland explicitly links discussion with scientific literacy. Apart from Scotland's 'Topical Science' discussion descriptors, oracy is largely mentioned in terms of developing scientific language or in communicating findings. Talk is mentioned more often for younger children, perhaps implying that oracy could be seen as an early form of communication, with written work deemed to be more valuable for older children. Oracy is represented as an outcome, rather than as a process to support scientific thinking. This indicates that there is scope for updated guidance when curricula are reviewed.

Key reports and initiatives

UK guidance and reports from the 2015-25 grey literature relating to primary science and/or oracy are summarised below.

Oracy reports

There has been a range of recent oracy reports e.g. Millard and Menzies (Voice 21, 2016), Oracy All-Party Parliamentary Group (2021), Oracy Education Commission (2024). This indicates an increasing interest in oracy at policy level. The reports put forward the importance of **learning to, through and about talk, listening and communication**. Thus, oracy is both about becoming proficient in communicating but can also be used as a means to support other development; 'learning through' oracy is of particular interest for consideration of science communication. Seeing **oracy as a process**, for learning through talk, could be promoted as a way of deepening understanding through dialogue with teachers and peers (Millard & Gaunt, 2018). **Disciplinary oracy**, for communication appropriate to the subject, is an area that merits further consideration (Oracy Education Commission, 2024). The Oracy Skills framework (Oracy Cambridge & Voice21, 2019) includes a cognitive section that could be the basis for exemplification in primary science.

Oracy in primary science

Scientific literacy includes engagement and discussion of science issues, aligning with oracy aims, but **links between oracy and primary science are often not explicit** in sector guidance e.g. pupil talk does not have a high profile in recent reports such as 10 Key Issues (Bianchi et al., 2021), Primary Science Capital (Archer et al., 2022) or Ofsted reviews (2021, 2023). However, the most recent Education Endowment Foundation (EEF) primary science guidance (Luxton & Pritchard, 2023), arising from a systematic review (Bennett et al., 2023), includes oracy components within three of its six recommendations.

- Recommendation 1: Develop pupils' scientific vocabulary.
- Recommendation 2: Encourage pupils to explain their thinking, whether verbally or in written form:
    - 2a. Create collaborative environment.
    - 2b. **Capitalise on the power of dialogue**.
- Recommendation 3: Guide pupils to work scientifically… with opportunities for discussion and reflection.

The guidance clearly notes the 'power of dialogue' to support children to make their 'thinking explicit' and 'express their thoughts and ideas, refine their understanding, and think scientifically' (p9, Luxton & Pritchard, 2023). Dialogue is presented as a tool to support thinking and learning.

Multimodal communication is put forward as a core feature of practical work in primary science, supporting 'hands-on', 'minds-on' embodied science learning in a new report from a recent Nuffield Foundation funded study (Earle et al., 2025). It is proposed that communicating about practical work helps to develop science thinking, connecting the objects and materials that are being manipulated to science ideas and explanations.

A large bank of online resources called **Explorify** contains a wide range of short activities and discussion starters that can be used to stimulate talk in the classroom. An independent evaluation found teachers using Explorify resources reported increased contributions to classroom discussions leading to increased oracy e.g. use of scientific knowledge and vocabulary; confidence to contribute; inclusion of pupils who struggle with literacy (Wellcome, 2020). The resource bank includes science background notes for teachers and instructions on how to lead the activities. Nonetheless, the role of talk and oracy is less clearly presented.

While there is an expanding range of UK guidance reports available that supports the importance of oracy, its application in the primary science context is less well developed. In brief, oracy in primary science does not yet have a high profile.

Evidence from academic literature

From the 81 screened academic articles, surprisingly few recent studies had been undertaken within the UK and much of the international research was on a small scale. Oracy and scientific literacy have not been an explicit focus in many recent academic studies, with some authors embedding elements of these within other projects. The most relevant recent studies found in the review have been summarised below, with additional detail provided in Table 4 in the appendix.

UK studies

Whilst the number of studies related to oracy in primary science was low in the UK, those that had taken place were large-scale randomised control trials, with independent evaluations providing strong evidence.

- **Dialogic Teaching** EEF evaluation (Jay et al., 2017, Alexander 2018): the Dialogic Teaching intervention aims include maximising the quality and educational impact of classroom talk across the curriculum (measured in English, mathematics and science). The study found an impact of two months additional progress for science attainment in Key Stage 2 (76 schools, 4985 children).
- **Thinking Doing Talking Science (TDTScience)** EEF evaluations: found three months additional progress in science in the first EEF trial (Hanley et al., 2015, Hanley et al., 2020, 40 schools, 655 children), no significant attainment difference when scaled up (different CPD model) in the second EEF trial (Kitmitto et al. 2018), with the third trial report due Summer 2025.

Both the above programmes involved extensive teacher professional development (3 or 4 training days) to enhance the opportunities for dialogue within the classroom. This points to the step-change needed for some teachers to be able to place oracy centrally within their practice.

International studies

Beyond the UK, many of the academic studies found in the review were small in scale. Nevertheless, with small numbers of participants can come depth, with strategies closely observed in action, providing insights for the development of practice.

- Australian studies emphasised the importance of using questioning to scaffold learning and extended turn taking to allow more time for thinking through talking (France, 2021), with Deehan & MacDonald (2024) suggesting teachers ask open questions, and then question student answers. Woods-McConney et al.'s (2016) categorisation of talk included groups co-constructing meaning, which they proposed would indicate collaborative enquiry. They noted that this was observed at limited intervals with group work not automatically leading to collaboration.
- The Science, Oral Language, and Literacy Development from the Start of School (SOLID Start) approach in the US proposed that teachers ask 'driving questions' to promote students' science talk: ask, explore, read, write, and discuss (Wright & Gotwals, 2017; Anderson et al., 2023).
- Studies of argumentation noted the importance of problems and activities in which different views were explicit (Larrain et al., 2018) and engaging positively with uncertainty (Chen, 2020).
- Opportunities within practical work and enquiry for the development of talk were noted e.g. talking about phenomena, observations, open-ended questions to explore (Gerde & Wasik, 2022).
- A number of studies proposed ordered strategies, such as the 'Self-explain, Discuss, Re-explain' model (Chang & Hsin, 2021) or the 'Science Talk–Writing Heuristic (STWH) model' combining talking and writing in practical work (Chen, 2019). An ordered list was also evident when authors discussed the development of talk alongside practical enquiries, for example, the five Es: engage, explore, explain, elaborate, evaluate (Hackling & Sheriff, 2015).
- Strategies were also listed without a necessary order, for example, using 'This is because...' (increasing use of 'why' and 'because') to scaffold scientific reasoning (Hackling & Sheriff, 2015) or using collaborative mind-mapping (Fung, 2024).

Each study presented above adopted a different programme or proposed list of teaching strategies. Common themes emerged, which are discussed in the next section. There was not, however, one approach or format that stood out as the 'only way' or something that must be adopted in order to change practice.

The small number of recent academic studies with discipline-specific examples of oracy for scientific literacy/science education points to a gap in the field. The UK based EEF evidence of positive impact of oracy interventions on primary science attainment, has been based around CPD programmes (Dialogic Teaching, Thinking Doing Talking Science). This indicates the need for teacher development in this area. International studies provide some possible indicators and strategies that could be worthwhile, but these would need integration or translation into guidance appropriate for the UK nations.

5. How can scientific literacy and oracy be developed?

From the overview above, and the detailed list of studies within Table 4 in the appendix, a range of pedagogical strategies have been identified in the reviewed studies. Whilst each study names and describes different approaches, some common themes or principles emerge in relation to the development of oracy-rich primary science.

Making space for oracy-rich primary science

A safe space for talk is pre-requisite for oracy-rich primary science lessons. This includes having the time for extended discussions, together with creating a classroom environment that is conducive to dialogic talk, with teachers moving beyond quick-fire rounds of Initiation-Response-Feedback to more collective discussions (France, 2021; Alexander, 2018). Variation in structures and groupings, with time for talking with peers as well as whole class, provides space for developing a repertoire of 'everyday talk' and 'learning talk' (Alexander, 2018). Planning opportunities for children to communicate in multimodal ways can develop both their disciplinary oracy and their scientific reasoning, as they explain and apply their thinking.

Opening out talk to build cumulative thinking

Through communication, children can build and develop their scientific ideas and groups can co-construct meaning (Woods-McConney et al., 2016). Discussions need to be sufficiently open for the children to put forward their own ideas, listen to each other to develop their own thinking further and build ideas cumulatively. By so doing, children act as 'cognitive models for each other' (Hanley et al., 2020, p2559). Argumentation, where children examine a claim and build a proposal based on evidence, is a form of dialogue more often studied in the secondary context (Bennett et al., 2023), but structured scientific reasoning can still be developed in the primary context. Opening out the discussion, with dialogic pathways where uncertainty can be used productively (Chen, 2020), provides a space for scientific ideas to be explored. This does not mean that talk runs away in any direction, the teacher can use questions and wonderings to guide and maintain focus on the topic or prompt, with the aim being to achieve fewer quick-fire responses and more extended explanations. Strategies can be used to support children to explain, for example, using the sentence stem: 'This is because...' (increasing use of 'why' and 'because') to scaffold scientific reasoning (Hackling & Sheriff, 2015) or a 'Self-explain, Discuss, Re-explain' model (Chang & Hsin, 2021) to foster explanations of thinking.

Prompts to spark the discussion

Dialogic exchanges, for example, where teachers ask open questions and then question the answers (Deehan & MacDonald, 2024), often need an initial prompt to instigate the dialogue. The Thinking Doing Talking (TDT) Science programme proposed a range of strategies for Bright Ideas Time discussions (such as Odd One Outs) that inspired many of the Explorify online activities. The stimulus of, for example three or four pictures of animals or materials, provides a starting point for an open discussion with peers or as a whole class, because there is not a 'right answer' to the question regarding 'the odd one'; it is the justification and explanation that is of interest. TDT Science also utilised 'Practical Prompts for Thinking' and open enquiries to stimulate group discussions and scientific reasoning. Gerde & Wasik (2022) noted the opportunities within practical work and enquiry for the development of talk, for example, talking about phenomena, observations and giving open-ended questions to explore. Larrain et al. (2018) highlighted the importance of provocative curriculum materials (e.g. problems and activities in which different views were explicit), as well as a skilled teacher to foster dialogic talk. An easily accessible supply of discussion prompts (such as Explorify) is very helpful for teachers, but equally, they need space in the curriculum for extended dialogue, and professional development to support the enactment of dialogic principles (Alexander, 2018).

6. Challenges and gaps

Gaps in the literature

There were surprisingly few recent academic studies based in the UK, although those that had been carried out reported on large-scale randomised control trials, with a strong evidence base. The relevant international studies were mostly on a very small scale, in comparison (see Table 4 in Appendix). With regards to the vast majority of screened studies with primary age groups, oracy and scientific literacy were not explicit, pointing to a gap in the research base in this field. A wide range of grey literature from the UK was relevant to the topic. However, many dealt with either oracy *or* primary science, with few explicitly exploring the relationship between the two. The large and well used bank of resources called Explorify is currently freely available to teachers in the UK. Whilst talk features heavily in the activity instructions provided, the link between oracy and scientific literacy was largely implicit, with the rationale for encouraging children's talk not being as visible as it could be. The lack of explicit rationale for linking oracy and scientific literacy indicates a missed opportunity and justifies a call for reports and resources to address this area in their remit going forward.

Challenges described in the literature

International studies described challenges for the implementation of oracy-rich primary science. Dialogic talk, inviting student exploration, appears difficult to implement, with Anderson et al. (2023) in the US noting that: 'Teachers engaged in considerably more authoritative talk (83.22%) than dialogic talk (16.78%)' (p90). Argumentation was found to be less prevalent in the primary phase: 'only 32% of the lessons in US elementary classes required students to engage in classroom practices that required supplying evidence in support of their claims' (Chen, 2019). Gotwals et al. (2022) in their international review found a lack of high-quality science talk. Soysal (2023) in Turkey described how teacher talk was not as productive as it could be. The difficulties of implementing quality classroom talk were mirrored in a study based in the UK, which found less talk and lower reasoning within science, when compared to maths (Amodia-Bidakowska et al., 2023). The lack of oracy-rich dialogic teaching repeatedly noted in such studies indicates a need for further support in this area.

Challenges for scientific literacy and oracy in the UK

Scientific literacy and oracy are not clearly explained nor linked in most curricula documentation. There is a lack of explicit guidance and examples that explain the purpose of dialogue in primary science and that demonstrate how to implement it in practice. Oracy may be seen to be an addition or add-on, rather than being part of the curriculum; staff may lack connection with 'why' oracy might be important for their pupils (Chartered College of Teaching, 2024). The lack of visibility of oracy and its potential benefits for scientific literacy is a barrier for implementation because it does not raise the status of talk in science. Even when studies or guidance promote talk, the link between oracy and scientific literacy is either insufficiently explicit or it does not have a robust profile. It appears that other priorities may be overloading the primary school context.

Millard and Gaunt (2018) described concerns from teachers regarding discussion in that it could lead to disruption or make shy pupils feel uncomfortable, along with fears regarding accountability-based pressures to produce written evidence rather than have 'nothing to show' from holding an oral lesson. Resources and schemes of work may focus on teacher talk aimed at supporting large numbers of newer teachers with guidance on what to say when introducing science topics. However, these resources put much less emphasis on the importance of children's talk. Such barriers to implementation perhaps explain why support to develop oracy and dialogic teaching may require programmes of CPD (e.g. Hanley et al., 2015; Jay et al., 2017; Rees & Roth, 2019). The lack of explicit links between oracy and scientific literacy set out in curricula and resources, combined with accountability driving the need to create written evidence in lessons, suggest that talk in science may not register as a priority issue for staff development.

Limitations of the review

The small number of relevant studies indicates a lack of evidence in this field on which we can draw. This also means that conclusions cannot be drawn confidently with respect to the effect of oracy and scientific literacy on younger children or marginalised groups' learning. This may be, in part, due to the secondary-heavy definitions and terminology applied in this field, meaning that related studies with younger children or different groups may not employ the same terminologies. Moreover, it is a complex area to research, when, for example, younger children are not producing written lesson outcomes that could be used for analyses in a comparative large-scale trial. In addition, scientific literacy and oracy can be incorporated as smaller elements within a larger study or programme. For instance, studies that consider inquiry-based science education are likely to include talk and its application in science, but these are invariably embedded (or hidden), thereby making it impossible to draw conclusions about these distinct elements.

The rapid nature of this review meant that areas such as initial teacher education and transition into secondary school could not be included. However, it should be noted that these were not visible during the literature search, perhaps suggesting further gaps in the field. The interdisciplinary nature of much primary teaching indicates that oracy across the curriculum could be another line of enquiry that was not addressed, although cross-curricular studies that include science would have been covered in this review, if they had been found during the search. The rapid review focused on literature spanning the last ten years. Therefore, some older studies, such as those involving concept cartoons, were not included. Updating resources from some longstanding projects, so that they support the current/future iteration of curricula, could provide another avenue for STEM organisations to support practice.

7. Opportunities for the Royal Society

Champion oracy and scientific literacy in the curriculum

There is a significant opportunity for the Royal Society to promote oracy and scientific literacy in curricula reviews. These terms are missing or have a low profile in most curricula guidance, with the effect that oracy-rich primary science is less likely to happen in practice. The Royal Society should promote the purposeful use of oracy to support scientific literacy, by, for instance, authoring a statement to advise policy and future curriculum development regarding the benefits of oracy for primary science learning.

Communication is part of scientific literacy, with children developing scientific thinking through discussion and application of scientific ideas. Thus, there is much potential for the development of scientific literacy alongside oracy, when oracy is seen as a process rather merely an outcome. The current professional interest in oracy in the UK suggests that it could be used as a driver to support primary science, were the link to be made explicit.

Exemplify oracy and scientific literacy in primary science

The Royal Society can lead the field in clarifying and exemplifying what oracy-rich primary science looks like in practice. Sections of this report could serve to clarify the definition of primary-phase scientific literacy and the purpose of oracy in science, specifically for practitioners. Exemplification is needed to demonstrate oracy-supported scientific literacy practices, for example, through case studies developed in collaboration with schools via the Partnership Grants. Any exemplification produced should show a range of different contexts and age groups, including examples of how the use of talk can be promoted in practical work, how it can aid inclusivity and what it potentially looks like in bilingual contexts. Current resources could be repackaged to emphasise oracy-rich primary science (e.g. highlighted examples within the current Brian Cox experiments or utilising the British Sign Language resources). Further, new resources could be created that, for example, populate the Oracy Skills Framework with primary science-oriented cases. Any new resources or updates should be collated into one space, for both ease of access and to make the link between oracy and scientific literacy more explicit. For instance, resource links could be collated to list examples that help to scaffold talk, sample questions to stimulate dialogue and examples of how to support science thinking with oral activities.

Promote oracy and scientific literacy across the sector

The Royal Society can provide strategic direction by bringing together STEM organisations to discuss how to support oracy in primary science. Making oracy more explicit in current resources and high profile in professional development should be an agreed target for all organisations that are engaged in supporting primary science. Supporting dissemination of this review’s findings and any updated resources are prerequisite to helping teachers and teacher educators guiding pre- and in-service teachers.

The Royal Society can raise the profile of oracy-rich primary science across the sector, for example, by creating a new emphasis in current projects/collaborations or a new campaign that addresses both dialogue and the application of scientific thinking. To this end, some suggestions are offered: linking with other STEM organisation campaigns; launching a new debating/presentation/persuasive video project or competition for primary-aged children; curating resources to assist teachers to discuss current scientific issues with their class, including climate anxiety. Promoting the inter-relation and mutual benefit of oracy and scientific literacy provides an opportunity for raising the profile of inclusive science for primary schools.

8. Key recommendations

The key recommendations arising from this report are to:

- Promote **oracy-rich primary science** as a means to develop and apply science thinking, by making this more explicit in guidance, resources and curricula.

- Demonstrate the value of oracy-rich primary science by **exemplifying** what this looks like for different ages and across topics, so that teachers and schools have clear examples to apply to their own context.
- Provide an age-appropriate definition and associated examples of **scientific literacy** for primary schools to underscore the importance of applying science ideas and thinking.

Table 2: Recommendations for different stakeholders

Stakeholders	**Recommendations**
Teachers	Plan oracy opportunities into primary science lessons, to enable the children to explain and develop their scientific thinking. Consider how children are applying their science ideas and relating these to real life, helping them to see that science is 'for them' on their path to scientific literacy.
Science leads and school leaders	Consider how to support oracy-rich primary science e.g. select a focus for children's drawing and writing (rather than a full investigation write-up), promote talk partners, sentence stems, collaborative group work, practical prompts for thinking…
Pre/in-service teacher educators and STEM organisations	Make oracy and scientific literacy more explicit in sessions, resources and examples. Be clear about the rationale for developing science thinking *through* oracy.
Policy-makers and curriculum reviewers	Be more explicit about oracy and scientific literacy in guidance, raising their profile and explaining the benefits of dialogue in primary science.

Oracy-rich primary science is currently a missed opportunity. There appears to be great potential in being more explicit about the power of oracy to support scientific literacy, as a process to support scientific thinking in primary science.

Appendices

Resources

Table 3: Resources that could be used to support oracy in primary science

Organisations and weblinks	Details
Association for Science Education https://www.ase.org.uk/	Some resources could support discussion, for example: Mary Anning, Why not catch smallpox, Primary Upd8.
Centre for Industry Education Collaboration (CIEC) https://www.york.ac.uk/ciec/school-support/	Range of resources to support primary science, linking activities to science jobs/real world, some could support oracy.
Chartered College of Teaching https://my.chartered.college/research-hub/rethinking-curriculum-oracy-toolkit/	Oracy toolkit contains links to range of articles and toolkit, plus case studies.
Explorify https://www.stem.org.uk/explorify	800+ activities to support class discussions, mapped to the curriculum, plus guidance.
Great Science Share for Schools https://www.greatscienceshare.org/	Annual campaign spotlighting young people's scientific questions, culminating in a celebratory event each June: ‘ask, investigate, share’. Resources to support enquiries and sharing could support oracy.
Institute of Physics https://www.iop.org/education	Some activities/guidance for 5-11, Marvin and Milo practicals could support discussion.
Oracy Cambridge https://oracycambridge.org/	Pupil talk prompts and talk guidelines that could be applied to primary science.
Ogden Trust https://www.ogdentrust.com/resources/	Range of resources to support primary physics, some could support oracy.
Royal Society https://royalsociety.org/news-resources/resources-for-schools/	Some resources could support discussion, for example: your planet, your questions video clips; global challenges resources; Brian Cox example videos.
Royal Society of Biology https://www.rsb.org.uk/activity-resources.html	Some activities that could be used to support discussion, including biology week each October.
Royal Society of Chemistry https://edu.rsc.org/primary-science	Resources that could be used to support discussion include: some RSC sponsored concept cartoons, kitchen science podcasts.
Primary Science Teaching Trust https://pstt.org.uk/resources/	Resources could support discussion, for example: Scientist like me, Science dice, Pictures for talk, Let's talk plants & environment/Health, Bright ideas (plus pay for resources: I can explain, Science trails).
STEM Learning https://www.stem.org.uk/primary/resources	Wide range of resources to support science teaching, searchable by topic, some could support oracy.

NB. Most resources are not yet explicit about their potential for developing oracy and scientific literacy.

Strategies

Table 4: Pedagogical strategies for developing scientific literacy and oracy

Study/project	Sample	Pedagogical strategies
Creating a class environment conducive to talk		
Dialogic Teaching: UK Jay et al. (2017) Alexander (2018)	Teachers of Year 5 pupils (Key Stage 2) from 72 schools	Justifications: understanding why talk is important. Principles: dialogic teaching should be collective, reciprocal, supportive, cumulative and purposeful. **Repertoires:** 1. **Interactive settings:** organising talk between the class, groups and individuals. 2. **Everyday talk:** supporting children to engage in a range of interactions with others. 3. **Learning talk:** e.g. enabling children to listen, think about what they hear, explain, analyse, evaluate, question, discuss… 4. **Teaching talk:** ensuring range of instruction, exposition, discussion and dialogue. 5. **Questioning:** considering wait/thinking time, feedback and participation structures and cues. 6. **Extending:** moves to expand thinking, listen carefully, deepen reasoning and think with others.
Chen (2020) USA	1 teacher of a fifth-grade class (equivalent Year 6)	The uncertainty is not deficit but rather, is a resource to develop students' knowledge and understanding through productive disciplinary engagement. Engagement steps taken in the lesson are: 1. Problematizing content 2. Giving students authority 3. Holding students accountable to others and to disciplinary norms 4. Providing resources to solve problems
France (2021) Australia	4 teachers and children aged 5-9 years from these teachers' classes	Teachers supporting dialogue: 1. Teachers constructing a **conducive environment** in the classroom. 2. Teacher **questioning to scaffold** students' learning 3. **Extended talk turns** to give time for students' higher level thinking responses
Promoting talk in science		
SOLID start: USA Wright and Gotwals (2017) Anderson et al. (2023)	8 early elementary teachers	Science, Oral Language, and Literacy Development from the Start of School (SOLID Start) frame uses five instructional steps to promote students' science talk. 1. Teachers asking **driving questions** regarding scientific phenomena 2. Children talking about exploring what they need to do to answer the driving questions 3. Children talking through participation in interactive reading 4. Children talking through writing and drawing to help them answer the driving questions 5. Children discussing what they have learned about the question so as to scaffold learning.
Larrain et al. (2018) Chile	18 teachers and 538 fifth-grade	For fostering dialogic and argumentative talk, needs lessons organised around **problems and activities in which different views were explicit.**

	pupils (aged 10-11 years)	**Small group collaboration** included hypothesis testing and discussion of ideas to reach an agreement. **Metacognition**: reflection on shared science learning experiences with an emphasis on thought processes, e.g. 'metalanguage think alouds'. **Scaffolds:** structured, often temporary, language supports designed to support engagement.
Deehan & MacDonald (2024) Australia	40 primary school teachers	Consistent use and modelling of scientific vocabulary, taught explicitly and connected to regular classroom dialogue. Importance of **questioning**: dialogic exchanges e.g. asking open questions and then questioning the answers.
Chang & Hsin (2021) Taiwan	104 fifth-grade pupils	The Self-explain–Discuss–Re-explain (SDR) strategy enables students to learn science concepts and develop independent thinking. 1. **Self-explain:** Students write personal responses to the questions on the worksheet and the rationale for their responses, without any discussion. Then, each student shares these personal notes with another student 2. **Discuss:** Within-group discussion takes place. This is followed by a pre-designated member of each small group sharing highlights of their group discussion on the whiteboard. Then group presentations, discussion, and communication between groups take place 3. **Re-explain:** Students return to review their previously written personal responses/rationales (Self-explain step) and decide whether to modify them.
Thinking Doing Talking Science: UK Hanley et al. (2015) Hanley et al. (2020)	Year 5 pupils (Key Stage 2) aged 9-10 years from 42 schools	**Bright Ideas Time:** a short discussion slot (5-10 minutes) within a primary science lesson that can be used to stimulate pupil talk e.g. **Odd One Out** (select from 3 or 4 animals etc and justify, no right answer), **PMI** (discuss Positive Minus and Interesting features of a possible scenario such as a world without electricity), **Big Question** (discuss big ideas such as how we know the Earth is a sphere). **Practical Prompts for Thinking:** short practical teacher demonstrations that prompt discussion, for example, because the outcome is unexpected such as a can rolling uphill. **Teacher questioning:** to extend pupils' thinking about scientific ideas and encourage pupils' own questioning. **'Minds-on' investigations:** open enquiries with elements of challenge, such as pupils choosing the equipment to test shoe grip.
Explorify (CFE Research, 2020) UK	Teachers at 3 primary schools in London	Large bank of **image and video-based prompts** to stimulate dialogue, including strategies including: 'Zoom In Zoom out' pictures for discussion, 'What's going on?' videos, 'Have you ever?' questions... Also includes TDTScience-inspired strategies (e.g., odd one out).
EEF primary science guidance: UK Luxton and Pritchard (2023)	31 teachers from 21 schools	1. Develop pupils' **scientific vocabulary**: Identify science-specific vocabulary. Explicitly teach new vocabulary and its meaning, creating opportunities for repeated engagement and use over time. 2. Encourage pupils to **explain their thinking**, whether verbally or in written form: Create a collaborative learning environment. Capitalise on the power of dialogue. Cultivate reasoning and justification. 3. Guide pupils to **work scientifically**: Explicitly teach the knowledge and skills required to work

		scientifically, guiding pupils to apply this in practice, with opportunities for discussion and reflection.
Chen (2019)	Not applicable	Science Talk-Writing Heuristic (STWH) strategy engages students in scientific literacy practices through using talking and writing in practical work. 1. Exploring big ideas – using talking and writing to generate **questions** that students would like to explore 2. Designing the test and observation for gathering data – group work and **discussion to design and run** an experiment 3. Engaging in **social negotiation to debate** claims and evidence by sharing ideas and findings with the class, to allow for debate and evidence-informed challenge 4. Reading to compare arguments with expert views as students evaluate their arguments by comparing them with scientific experts/textbooks 5. Reflecting through argumentative writing.
Talk with enquiry		
Dunlop et al. (2015) UK	19 teachers and 364 primary school pupils (8-11 years)	Community of Scientific Enquiry (CoSE) promotes teaching and learning science through enquiry, driven by students' own questions which are explored through dialogue. Origins lie in the Philosophy for Children (P4C) movement that advocates progress towards dialogue. 1. Preparation for the enquiry 2. Stimulus 3. Thinking time 4. Question making 4. Question airing 5. Question choosing 6. First thoughts in the dialogue 7. Building dialogue 8. Last thoughts in the dialogue 9. Review for reflecting on the process of enquiry.
Hackling and Sherriff (2016) Australia	One teacher of Year 3 and Year 4 class pupils	Science talk needs to be supported by explanations and evidence. The Five E (5E) inquiry strategy follows these steps. 1. Engage 2. Explore 3. Explain 4. Elaborate 5. Evaluate The prompts are key: WILF (What I am looking for…) and TIB (This is because…).
Soysal (2023) Turkey	One teacher and their class of 16 pupils (11-12 years)	Argument-Based Inquiry (ABI) strategy for teaching that guides students to collect, analyse and interpret data to achieve evidence-based arguments.
Rees and Roth (2019) Canada	Two teachers and 17 children (6-7 years)	Steps to Inquiry (S to I) is adopted as a base for organizing class activities. 1. Making observations 2. Developing wonderings 3. Brainstorming variables 4. Choosing variables 5. Phrasing a testable question 6. Conducting an experiment to find an answer.

Gerde and Wasik (2022) US	Not applicable	How talk can be implemented within science practical work: 1. Talk about observations 2. Focus on inquiry, not answers 3. Promote new vocabulary 4. Provide feedback.

References

Alexander, R. (2018). Developing dialogic teaching: genesis, process, trial. Research Papers in Education, 33(5), 561–598. https://doi.org/10.1080/02671522.2018.1481140

Amodia-Bidakowska, A., Hennessy, S., & Warwick, P. (2023). Disciplinary dialogues: Exploring the association between classroom dialogue and learning outcomes within and between subjects in English primary schools. Learning, Culture and Social Interaction, 43, 100742. https://doi.org/10.1016/j.lcsi.2023.100742

Anderson, B. E., Wright, T. S., & Gotwals, A. W. (2023). Teachers' Vocabulary Talk in Early-Elementary Science Instruction. Journal of Literacy Research, 55(1), 75-100. https://doi.org/10.1177/1086296X231163117

Bennett, J., Dunlop, L., Atkinson, L., Compton, S., Glasspoole-Bird, H., Lubben, F., Reiss, M., & Turkenburg-van Diepen, M. (2023). A systematic review of approaches to primary science education. Education Endowment Foundation.

Bianchi, L., Whittaker, C., & Poole, A. (2021). The 10 Key Issues with Children's Learning in Primary Science in England. The University of Manchester & The Ogden Trust.

Cambridge Assessment. (2022). Education brief - oracy. https://www.cambridgeinternational.org/Images/661428-education-brief-oracy-.pdf

CCEA (Council for the Curriculum Examinations and Assessment). (2019). Science and Technology within the World Around Us: Progression Guidance. CCEA.

CFE Research. (2020). Evaluation of the Primary Science Campaign A report for the Wellcome Trust. https://cms.wellcome.org/sites/default/files/evaluation-of-the-primary-science-campaign-2020.pdf

Chang, T. L., & Hsin, H. T. (2021). The effect of the Self-explain–Discuss–Re-explain (SDR) learning strategy on high- and low-achieving fifth-grade students' achievement in science. Research in Science & Technological Education, 39(4), 461–488. https://doi.org/10.1080/02635143.2020.1772223

Chartered College of Teaching. (2024). Oracy evaluation framework. https://my.chartered.college/wp-content/uploads/2024/06/Final-ORACY-Evaluation-Framework-v09_2024.pdf

Chen, Y. C. (2020). Dialogic Pathways to Manage Uncertainty for Productive Engagement in Scientific Argumentation. Science & Education, 29, 331–375. https://doi.org/10.1007/s11191-020-00111-z

Chen, Y.-C. (2019) Using the science talk–writing heuristic to build a new era of scientific literacy. Reading Teacher, 73, 1, 51-64. https://ila.onlinelibrary.wiley.com/doi/abs/10.1002/trtr.1808

Curriculum for Wales. (2020). Curriculum for Wales: Science and Technology. https://hwb.gov.wales/curriculum-for-wales/science-and-technology/

Deehan, J., & MacDonald, A. (2024). Communicating in primary science: exploring the reported language practices of Australian primary teachers. Teachers and Teaching, 30(5), 652–667. https://doi.org/10.1080/13540602.2024.2320805

Deehan, J., MacDonald, A., & Morris, C. (2022). A scoping review of interventions in primary science education. Studies in Science Education, 60(1), 1–43. https://doi.org/10.1080/03057267.2022.2154997

DfE (Department for Education). (2013). National curriculum in England: science programmes of study. https://www.gov.uk/government/publications/national-curriculum-in-england-science-programmes-of-study

Dunlop, L., Compton, K., Clarke, L., & McKelvey-Martin, V. (2013). Child-led enquiry in primary science. Education 3-13, 43(5), 462–481. https://doi.org/10.1080/03004279.2013.822013

Earle, S., Read, S., Bianchi, L., & Jordan, J. (2025). Purposeful practical work in primary science. Bath Spa University & The University of Manchester. https://doi.org/10.17870/bathspa.28615676.v1

Education Scotland. (2009). Curriculum for excellence: sciences experiences and outcomes. Education Scotland. https://education.gov.scot/media/jcxpmwd5/sciences-eo.pdf
Education Scotland. (2017). Benchmarks: Sciences. Education Scotland.
France, A. (2021). Teachers Using Dialogue to Support Science Learning in the Primary Classroom. Research in Science Education, 51, 845–859. https://doi.org/10.1007/s11165-019-09863-3
Fung, D. (2024). The synergy of peer collaboration and mind mapping in cultivating primary students' science understanding: an integrative pedagogy to enhance science concept acquisition. International Journal of Science Education, 46(2), 131–154. https://doi.org/10.1080/09500693.2023.2222549
Gerde, H. K., & Wasik, B. A. (2022). Developing Language Through Science. The Reading Teacher, 75, 5, 535-544. https://research.ebsco.com/c/3sefaz/viewer/pdf/ng2adj3dvr
Gillies, R. M., Nichols, K., & Khan, A. (2015). The effects of scientific representations on primary students' development of scientific discourse and conceptual understandings during cooperative contemporary inquiry-science. Cambridge Journal of Education, 45(4), 427–449. https://doi.org/10.1080/0305764X.2014.988681
Gotwals, A. W., Wright, T. S., Domke, L., & Anderson, B. E. (2022). Science Talk in Elementary Classrooms. The Elementary School Journal, 122, 4. https://doi.org/10.1086/719410
Hackling, M., & Sheriff, B. (2015). Language-based reasoning in primary science. Teaching Science, 61, 2, 14-25. https://eric.ed.gov/?id=EJ1077354
Hanley, P., Slavin, R., & Elliott, L. (2015). TDTS 1st trial evaluation report. EEF. https://educationendowmentfoundation.org.uk/projects-and-evaluation/projects/thinking-doing-talking-science
Hanley, P., Wilson, H., Holligan, B., & Elliott, L. (2020). Thinking, doing, talking science: the effect on attainment and attitudes of a professional development programme to provide cognitively challenging primary science lessons. International Journal of Science Education, 42(15), 2554–2573. https://doi.org/10.1080/09500693.2020.1821931
Jay, T., Willis, B., Thomas, P., Taylor, R., Moore, N., Burnett, C., Merchant, G., & Steve, A. (2017). Dialogic Teaching evaluation report. EEF. https://educationendowmentfoundation.org.uk/projects-and-evaluation/promising-programmes/dialogic-teaching
Kitmitto, S., González, R., Mezzanote, J., & Chen, Y. (2018). TDTS 2nd trial evaluation report. EEF. https://educationendowmentfoundation.org.uk/projects-and-evaluation/projects/thinking-doing-talking-science-effectiveness-trial
Larrain, A., Howe, C., & Freire, P. (2017). 'More is not necessarily better': curriculum materials support the impact of classroom argumentative dialogue in science teaching on content knowledge. Research in Science & Technological Education, 36(3), 282–301. https://doi.org/10.1080/02635143.2017.1408581
Luxton, K., & Pritchard, B. (2023). Improving Primary Science: Guidance report. London: Education Endowment Foundation.
Mercer, N., & Mannion, J. (2018). Oracy across the Welsh curriculum. Oracy Cambridge. https://oracycambridge.org/wp-content/uploads/2018/07/Oracy-across-the-Welsh-curriculum-July-2018.pdf
Millard, W., & Menzies, L. (2016). The State of Speaking in Our Schools. Voice21. https://voice21.org/wp-content/uploads/2019/10/Voice-21-State-of-speaking-in-our-schools.pdf
Millard, W., & Gaunt, A. (2018) Speaking up: The importance of oracy in teaching and learning. https://my.chartered.college/impact_article/speaking-up-the-importance-of-oracy-in-teaching-and-learning/
Nag Chowdhuri, M., King, H., & Archer, L. (2021). The Primary Science Capital Teaching Approach: teacher handbook. London: University College London.
Northern Ireland Curriculum. (2007). The Northern Ireland Curriculum: Primary. Belfast: Council for the Curriculum Examinations and Assessment (CCEA).
OECD. (2017). PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematic, Financial Literacy and Collaborative Problem Solving, revised edition, PISA, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264281820-en
OCED website. https://www.oecd.org/en/topics/sub-issues/science-literacy.html {Last accessed 2.5.25].

Ofsted. (2021). Research review series: science. Ofsted.
Ofsted. (2023). Finding the optimum: the science subject report. Ofsted. https://www.gov.uk/government/publications/subject-report-series-science/finding-the-optimum-the-science-subject-report--2
Oracy All-Party Parliamentary Group. (2021). Speak for change report. https://voice21.org/wp-content/uploads/2024/01/Oracy_APPG_FinalReport_28_04-4.pdf
Oracy Cambridge & Voice21. (2019). The Oracy skills framework and glossary. https://oracycambridge.org/wp-content/uploads/2020/06/The-Oracy-Skills-Framework-and-Glossary.pdf
Oracy Education Commission. (2024). We need to talk: The report of the Commission on the Future of Oracy Education in England. https://oracyeducationcommission.co.uk/wp-content/uploads/2024/10/Future-of-Oracy-v23-web-13.pdf
Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D, et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *British Medical Journal*, *372*(71). https://doi.org/10.1136/bmj.n71
PCAG (Primary Curriculum Advisory Group). (2023). Framework for a Future Primary Science Curriculum: Recommendations from the Primary Curriculum Advisory Group to the Royal Society of Biology, the Royal Society of Chemistry, the Institute of Physics, and the Association for Science Education. PCAG.
Rees, C. A. B., & Roth, W. M. (2019). Discourse forms in a classroom transitioning to student-centred scientific inquiry through co-teaching. International Journal of Science Education, 41(5), 586–606. https://doi.org/10.1080/09500693.2019.1571649
Royal Society. (2010). Science and mathematics education: 5–14 A 'state of the nation' report. The Royal Society.
Soysal, Y. (2023). Understanding linkage between teacher talk moves, discourse contexts and students' talk productivity. Research in Science & Technological Education, 41(4), 1452–1479. https://doi.org/10.1080/02635143.2021.2012648
Vieira, R.M., & Tenreiro-Vieira, C. (2016). Fostering Scientific Literacy and Critical Thinking in Elementary Science Education. International Journal of Science and Mathematics Education, 14, 659–680. https://doi.org/10.1007/s10763-014-9605-2
Voice 21 website. https://voice21.org/what-is-oracy/ [Last accessed 2.5.25].
Woods-McConney, A., Wosnitza, M., & Sturrock, K. L. (2016). Inquiry and groups: student interactions in cooperative inquiry-based science. International Journal of Science Education, 38(5), 842–860. https://doi.org/10.1080/09500693.2016.1169454
Wright, T. S., & Gotwals, A. W. (2017). Supporting Disciplinary Talk From the Start of School: Teaching Students to Think and Talk Like Scientists. The Reading Teacher, 71, 2, 189-197. https://doi.org/10.1002/trtr.1602

Contact

For queries regarding this report, please contact Prof Sarah Earle at: primary.science@bathspa.ac.uk

How to cite this report:
Earle, S., Parfitt, A., & Read, S. (2025). Review of scientific literacy and oracy in primary school education. Bath Spa University.