SHOBNALL PRIMARY & NURSERY SCHOOL

APPROACH TO THE TEACHING OF SCIENCE

"Somewhere, something incredible is waiting to be known"

SEPTEMBER 2021
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INTRODUCTION

This document outlines the teaching, organisation and management of science taught and learnt at Shobnall Primary & Nursery School.

The document has been drawn up as a result of staff discussion and its implementation is the responsibility of all teaching staff. The responsibility for monitoring and review rests with the science subject leader.

The main purposes of this document are:

- To establish an entitlement for all pupils.
- To establish expectations for teachers of this subject.
- To promote continuity and coherence across the school.

VISION

"At Shobnall Primary & Nursery School, our vision is to provide a high-quality science education, which provides the foundations for understanding the world through the specific disciplines of biology, chemistry and physics. All pupils know essential aspects of the knowledge, methods, processes and used of science through building up a body of key foundational knowledge and concepts and are encouraged to recognise the power of rational explanation by developing a sense of excitement and curiosity about natural phenomena. Pupils are encouraged to understand how science can be used to explain what is occurring, predict how things will behave, and analyse causes. They display a passion for science and its application in past, present and future technologies."

PRINCIPLES

These are the 'Principles of Outstanding Science' at Shobnall Primary & Nursery School. They were devised and agreed by the children and staff in November 2021, informed by the way we feel that Science should be taught across the School.

Principle 1: Children are **excited and enthusiastic about Science** and have a desire to **explore** why things happen.

Principle 2: Children **lead their own learning,** asking and responding to their own **scientific questions**.

Principle 3: Children enjoy **learning through exploration.**

Principle 4: Teachers use a **range of effective assessment strategies** to inform the planning and teaching of Science.

Principle 5: Teachers introduce children to a range of age-appropriate **Scientific terminology** and they use this confidently.

Principle 6: Children and adults appreciate the **awe and wonder of** Science, making links to how, where and why it forms part of their everyday lives.

Principle 7: The **progression of Scientific subject content** is carefully planned for and clearly evident.

Principle 8: Teachers enable children to access **a range of enrichment opportunities,** both within and beyond the curriculum.

We believe our pupils should have the ability to think independently and raise questions about working scientifically and the knowledge and skills that it brings.

We ensure our children have the confidence in the full range of practical skills, taking the initiative in, for example, planning and carrying out scientific investigations. Pupils should have the ability to undertake practical work in a variety of contexts, including fieldwork.

We aim for our pupils to have excellent scientific knowledge and understanding which is demonstrated in written and verbal explanations, solving challenging problems and reporting scientific findings. They will display high levels of originality, imagination or innovation in the application of skills.

THEORY UNDERPINNING OUR PRACTICE AND PRINCIPLES

Children are naturally curious. We believe that science at primary school should nurture this curiosity and allow pupils to ask questions and develop the skills they need to answer those questions.

Science, as a discipline of formal study, got its place in school curriculum towards the last quarter of the 19th century. The founding fathers of science education attempted to teach it along with other subjects in schools in the same style. As science developed, and more science content was included in the curriculum, the science educators took cognizance of the developments in psychology. Twentieth-century educational psychologists came out with theories of learning that explained the way children acquired skills and knowledge. These theories have influenced the teaching of science significantly and are based on three main psychological paradigms – behaviourism (observable behaviours), cognitivism (making knowledge meaningful) and constructivism (constructing knowledge through personal experiences).

These three basic theories have influenced our intent for science and our approaches to teaching:

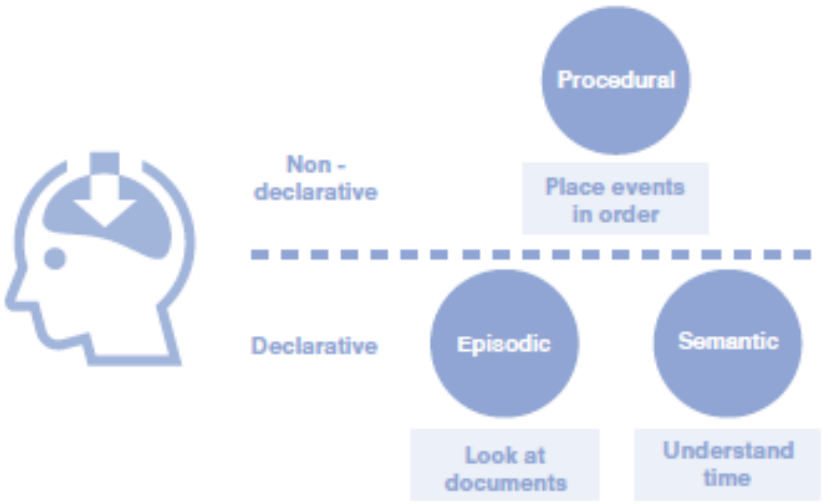
- **Behaviourism** focuses on observable behaviours. Behaviour theorists define learning as the acquisition of new behaviour based on environmental conditions.
- **Cognitive theories** emphasize making knowledge meaningful and helping learners organise new information in their cognitive schema.
- **Constructivism** paradigm believes that knowledge is constructed through personal experiences and interactions with the outside world. Thus, the learner takes up an active role in the construction of knowledge, and teachers facilitate this endeavour.

As a school we scrutinised the best research available and we have determined that our **definition of learning** is a **change to the long-term memory**. This means that the way we implement our curriculum maps involves repetitive teaching of the key concepts or the 'big' ideas. Each unit has built in practise, retrieval and reinforcement of the key concepts to ensure knowledge sticks in the long-term memory. For learning to stick in the **long-term memory** we teach historical knowledge in meaningful contexts and in a connected way.

Long-term memory involves three main areas:

1. Procedural memory where procedures such as placing events in order and other skills are stored. Procedures, once fluent, become automatic and are referred to as non-declarative.
2. Semantic memory where facts and their meaning is stored.
3. Episodic memory where the activities to learn the processes and facts are remembered and act as memory cues.

Both semantic and episodic memory involve conscious thought and are therefore referred to as declarative.



We have used the research around **cognitive load** and how children learn most effectively, to determine our approach to implementing the curriculum. Research has shown that If you teach children too many new concepts at once their short-term memory becomes overloaded and none of the knowledge will stick and move into the long term. We take an approach of **spacing** out new knowledge combined with interleaving and plenty of retrieval practise to ensure learning sticks. With **repetition, interleaving and retrieval**, research we use suggests that the more often children have to remember knowledge the more likely it just to be cemented into the long-term memory.

A useful framework for constructing science curriculums makes the distinction between the following:

- **substantive knowledge** (knowledge of the products of science, such as concepts, laws, theories and models). This is referred to as scientific knowledge and conceptual understanding in the national curriculum
- **disciplinary knowledge** (knowledge of how scientific knowledge is generated and grows): this is specified in the 'working scientifically' sections of the national curriculum and it includes knowing how to carry out practical procedures

There are at least 4 content areas through which pupils make progress when learning disciplinary knowledge:

1. **Knowledge of methods that scientists use to answer questions.** This covers the diverse methods that scientists use to generate knowledge, not just fair testing, which is often over emphasised in science classrooms and curriculums. For example, use of models, chemical synthesis, classification, description and the identification of correlations (pattern-seeking) have played important roles, alongside experimentation, in establishing scientific knowledge.
2. **Knowledge of apparatus and techniques, including measurement.** This covers how to carry out specific procedures and protocols safely and with proficiency in the laboratory

and field. This is a particularly important area for enabling progression on to science courses beyond GCSE and at university. It includes the accurate measurement and recording of data. Pupils learn that all measurement involves some error and scientists put steps in place to reduce this.

3. **Knowledge of data analysis.** This covers how to process and present scientific data in a variety of ways to explore relationships and communicate results to others. Pupils learn about different types of tables and graphs and how to identify correlations.
4. **Knowledge of how science uses evidence to develop explanations.** This covers how evidence is used, alongside substantive knowledge, to draw tentative but valid conclusions. It includes the distinction between correlation and causation and knowing that explanation is distinct from data and does not simply emerge from it.

Research shows that disciplinary knowledge is often framed as only 'skills' in school curriculums and pupils are assumed to pick up these skills by 'doing'. However, this assumption fails to recognise that disciplinary thinking and carrying out practical investigations skilfully are dependent on pupils having learned a domain of knowledge.

Science teachers and science education researchers have long noted the complex interplay between substantive knowledge and disciplinary knowledge. Deploying both substantive and disciplinary knowledge in combination is what gives pupils the capacity and skills to reason scientifically about phenomena with increasing sophistication and can use their knowledge to work scientifically with increasing expertise. This is because knowledge of the past must be shaped by disciplinary approaches in order to become scientific knowledge. Similarly, acquiring disciplinary knowledge 'working scientifically' is made purposeful and meaningful to pupils when it is related to scientific knowledge.

INTENT

Curriculum drivers shape our curriculum breadth. They are derived from an exploration of the backgrounds of our pupils, our beliefs about high-quality education and our values. They are used to ensure we give our pupils appropriate and ambitious curriculum opportunities:

- Diversity – We believe in developing pupils' understanding of British values and celebrating our unique and diverse community.
- Dreams – We promote ambition, high aspirations and foster pupils' capacity to see the possibilities within the world today.
- Decisions – We encourage our pupils to make the right choices in order to stay safe, healthy and happy.

Cultural capital gives our pupils the vital background knowledge required to be informed and thoughtful members of our community who understand and believe in British values.

Curriculum breadth is shaped by our curriculum drivers, cultural capital, subject topics and our ambition for pupils to study the best of what has been thought and said by many generations of academics and scholars.

Our curriculum distinguishes between subject topics- Science units of work and scientific enquiry skills. Subject topics are the specific aspects of subjects that are studied. Scientific enquiry skills tie together the units of work into meaningful schema. The same concepts are explored in a wide breadth of topics. Through this 'forwards-and-backwards engineering' of the curriculum, pupils return to the same concepts over and over, and gradually build understanding of them.

Scientific enquiry skills build up to provide a progression model. Knowledge categories in each unit give pupils a way of expressing their understanding of the threshold concepts.

Knowledge Organisers and KWL grids help pupils to relate each topic to previously studied topics and to form strong, meaningful schema. Cognitive science tells us that working memory is limited and that cognitive load is too high if pupils are rushed through content. This limits the acquisition of long-term memory. Cognitive science also tells us that in order for pupils to become creative thinkers, or have a greater depth of understanding, they must first master the basics, which takes time.

Scientific knowledge and skills build up in each year group through six units of work which consist of career opportunities linked to science which may be of interest to the children.

IMPLEMENTATION

Our curriculum design is based on evidence from cognitive science; three main principles underpin it:

- Learning is most effective with spaced repetition.
- Interleaving helps pupils to discriminate between topics and aids long-term retention.
- Retrieval of previously learned content is frequent and regular, which increases both storage and retrieval strength.

In addition to the three principles, we also understand that learning is invisible in the short term and that sustained mastery takes time.

Our Science Curriculum is taught through four additional principles:

- Working Scientifically
- Biology
- Chemistry
- Physics

IMPACT

Because learning is a change to long-term memory, it is impossible to see impact in the short term. We do, however, use probabilistic assessment based on deliberate practice. This means that we look at the practices taking place to determine whether they are appropriate, related to our goals and likely to produce results in the long run.

We use lesson observations to see if the pedagogical style matches our depth expectations.

Pupils attainment and progress in science is measured using teacher assessment and end of unit checks against the objectives set in the national curriculum and recorded by teachers using Classroom Monitor to inform parents and future teaching and learning activities.

EFFECTIVE TEACHING AND LEARNING IN SCIENCE

Effective teaching ensures that pupils retain knowledge they have learned in the long term. This is supported by opportunities to revisit and practise with prior knowledge. Pupils are more likely to retain knowledge when they have engaged analytically with the content they study. Teachers can support learning through clear exposition, which takes into account what pupils already know and understand. Disciplinary knowledge in science is highly distinctive and is likely to require distinctive teaching approaches. However, wider educational research offers a strong basis for a range of effective teaching approaches in science. These are often reflected in our lessons and will include:

- **Teaching for memory** – evidence suggests that teachers can support pupils' long-term learning by drawing attention to particularly important terms and expressions, precise phenomena and broader frameworks in their teaching.
- **Observation** – a fundamental skill that allows people to select the information via the use of all the senses.
- **Classification** – recognition, identification, sorting and ordering according to similarity and difference.
- **Hypothesis formation** – on the basis of consistent, general information from observations and other data, explication of those assumptions that can possibly explain a given occurrence or observation.
- **Prediction** – the formulation of the results of a study in advance.
- **Experimentation** – the testing of hypotheses via actual research using carefully controlled circumstances and methods.
- **Measurement** – determination of sizes, time, areas, speed, weights, temperature, volume etc.
- **Analysis** – the distinction of meaningful information.
- **Conclusion** – the drawing of conclusions on the basis of all the observations and data collected.
- **Interpretation** – attempts to understand the data collected and connect the conclusions.
- **Recall** - recalling previously taught content (retrieval practice) and revisiting content in lessons (spaced practice) have also been shown to be effective in securing pupils' knowledge over time.
- **Clear exposition that considers pupils' prior knowledge** - teachers' exposition is likely to be most effective when it is clear and carefully designed to account for pupils' existing knowledge.

SUPPORTING PUPILS IN SCIENCE, INCLUDING PUPILS WITH SPECIAL EDUCATIONAL NEEDS AND/OR DISABILITIES (SEND)

We recognise that in all classes children have a wide range of ability in science, and we seek to provide suitable learning opportunities for all children by matching the challenge of the task to the ability of the child. There is a lack of specific research on pupils with special educational needs and/or disability (SEND) and science education. However, findings into what makes an effective science curriculum provides some suggestions regarding effective support for pupils with SEND.

All pupils are entitled to a rich science curriculum. Any adaptations made to support pupils' learning in science usually should not be to the overall curriculum content but rather to how the content is taught. In the case of pupils with the most complex learning needs, there may be occasions when it is appropriate to modify the curriculum. However, this will be the exception.

Ensuring that all pupils otherwise encounter the same content is particularly important given the role that hinterland information has in facilitating learning in science. This suggests that significantly reducing content or complexity for some pupils might in fact limit their access to content or limit their ability to learn. It is likely that pupils will benefit most from support that combines extra attention to securing the most generative knowledge, while ensuring that all pupils are able to learn about events and periods in a rich context and through meaningful examples. This can be achieved by:

- setting tasks which are open-ended and can have a variety of responses;
- setting tasks of increasing difficulty, some children not completing all tasks;
- grouping children by ability in the room, and setting different tasks for each ability group;

- providing resources of different complexity, depending on the ability of the child;
- using teaching assistants to support children individually or in groups.

PROMOTING KEY SKILLS IN SCIENCE

The National Curriculum is followed in Key Stage 1 and Key Stage 2 and provides a full breakdown of the statutory content to be taught within each unit. Children in Nursery and Reception follow the Early Years Foundation Stage curriculum.

By the end of **Reception**, pupils will be able to:

- Explore the natural world around them, making observations and drawing pictures of animals and plants;
- Know some similarities and differences between the natural world around them and contrasting environments, drawing on their experiences and what has been read in class;
- Understand some important processes and changes in the natural world around them, including the seasons and changing states of matter.

During **years 1 and 2**, pupils will be taught to:

- Ask simple questions and recognise that they can be answered in different ways;
- Observe closely, using simple equipment;
- Perform simple tests;
- Identify and classify;
- Use their observations and ideas to suggest answers to questions.

During **years 3 and 4**, pupils will be taught to:

- Ask relevant questions and use different types of scientific enquiries to answer these questions, setting up simple practical enquiries, comparative and fair tests;
- Make systematic and careful observations and where appropriate, take accurate measurements using standard units and a range of equipment, including thermometers and data loggers;
- Gather, record, present and classify data in a variety of ways to help answer questions;
- Record findings using simple scientific language, drawings, labelled diagrams, keys, bar charts and tables;
- Report on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions;
- Use results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions;
- Identify differences, similarities or changes related to simple scientific ideas and processes;
- Use straightforward scientific evidence to answer questions or to support their findings.

During **years 5 and 6**, pupils will be taught to:

- Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary;

- Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate;
- Record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs;
- Use test results to make predictions to set up further comparative and fair tests;
- Report and present findings from enquiries, including conclusions, causal relationships and explanations of the results and the degree of trust in them. This should be in oral and written forms such as displays and other presentations;
- Identify scientific evidence that has been used to support or refute ideas/arguments.

EARLY YEARS FOUNDATION STAGE

Early years explore science themes and content through the 'Understanding of the World – People, Culture & Communities' strand of the EYFS curriculum. This involves guiding children to make sense of their physical world and their community through opportunities to explore, observe and find out about their natural environment. They are assessed according to the Progress Models determined by the school in accordance with the Statutory Framework for the Early Years Foundation Stage.

KEY STAGE 1

Pupils are taught different units of science throughout Key Stage 1 which include units of biology, chemistry and physics:

- Year 1: Everyday materials, Seasonal Changes, Animals Including humans and Plants.
- Year 2: Use of everyday materials, Animals including humans, Plants and Living things and their habitat.

Throughout these units of work, pupils are challenged through differentiated activities which includes at least one completed science investigation each term which progresses each year.

KEY STAGE 2

Pupils are taught different units of science throughout Key Stage 2 which include the following units:

- Year 3: Rocks, Light, Forces and Magnets, Plants and Animals Including humans.
- Year 4: Electricity, Animals including humans, States of Matter, Living things and their Habitats.
- Year 5: Properties and changes of materials, Earth and Space, living things and their habitats and Animals including humans.
- Year 6: Animals including humans, Light, Electricity and evolution and inheritance.

Throughout these units of work, pupils are challenged through differentiated activities which includes at least one completed science investigation each term which progresses each year.

Units which are repeated throughout the key stage are carefully planned so pupils build on their prior knowledge.

PLANNING AND RESOURCES

We use the National Curriculum and Developing Experts scheme of work as the basis for our planning in science. We ensure that there are opportunities for children of all abilities to develop their skills and knowledge in each unit, and we plan progression into the scheme of work, so that the children are increasingly challenged as they move through the school. We carry out curriculum planning in science in three phases (long term, medium term and short

term). The long-term plan maps the science topics studied in each term during each key stage. We teach the knowledge, skills and understanding set out in the National Curriculum through the corresponding programme of study through Developing Experts. The class teacher writes the lesson plans for each science lesson (short-term plans), often in the form of a flipchart of presentation. These plans list the specific learning objectives and expected outcomes for each lesson as well as the scientific vocabulary required for that lesson. The class teacher keeps these individual plans, although he or she and the subject leader often discuss them on an informal basis. Plans are stored on the staff shared drive for monitoring purposes and ease of access for the teachers and science subject leader.

There are sufficient resources for teaching all science units in the school. They are located in the shared resource area. The library contains a good supply of topic books and software and iPads are available to support children's individual research.

CROSS-CURRICULAR OPPORTUNITIES

Staff are encouraged to develop cross-curricular links with science and other subjects to provide a relevant and meaningful curriculum for pupils.

Mathematics
The teaching of science contributes to children's mathematical understanding in a variety of ways. Children use data, gained from scientific investigations and choose to present this in a variety of ways including tables and graphs. Children also learn to interpret information presented in graphical or diagrammatic form.

Spiritual, moral, social and cultural development (SMSC)
In our teaching of science, we also contribute to the development of the children's spiritual, moral, social and cultural understanding by looking at natural materials found in their environment. Children are therefore provided with many opportunities to discuss moral questions.

Computing
Wherever appropriate we use computing to enhance our teaching of science. The children use ICT in a variety of ways, such as word-processing, finding information on the Internet and presenting information through PowerPoint.

ASSESSMENT

Assessment for learning is continuous throughout the planning, teaching and learning cycle. Key scientific knowledge is taught to enable and promote the development of children's scientific enquiry skills. Assessment is supported by use of the following strategies:

- Observing children at work, individually, in pairs, in a group and in class during whole class teaching.
- Using differentiated, open-ended questions that require children to explain and unpick their understanding.
- Providing effective feedback, including interactive marking through green pen questions where appropriate, to engage children with their learning and to provide opportunities for self-assessment, consolidation, depth and target setting.
- Book moderation and monitoring of outcomes of work, to evaluate the range and balance of work and to ensure that tasks meet the needs of different learners, with the acquisition of the pre-identified key knowledge of each topic being evidenced through the outcomes.
- Rocket Word Quiz - Pupils' understanding of the Rocket Words are assessed during the lesson.

- Use of End of Unit Checks which have been designed to gain an understanding of what the children have retained.
- Science Floor Books are evidence of scientific investigations from each year group which shows the progression of skills throughout school.
- Use of KWL grids ('what I know already, what I want to know and what I have learnt') throughout a unit, alongside specific and measureable learning objectives for each lesson.

Pupils attainment and progress in science is recorded by teachers using Sonar Tracker to inform parents and future teaching and learning activities.

HEALTH AND SAFETY

We enable all pupils to have access to the full range of activities involved in learning science. Where children are to participate in activities outside the classroom, teachers should be aware of health and safety issues. Risk assessments are undertaken prior to activities, to ensure that they are safe and appropriate for all pupils. Before undertaking a field trip, teachers are encouraged to visit the proposed area of study and fill in a risk assessment form. Further information can be found in the Health and Safety and Wellbeing Document and Educational Visits Document.

SAFEGUARDING AND CHILD PROTECTION

We seek to safeguard children and young people by:

- valuing them, listening to them and respecting them;
- adopting child protection guidelines through procedures and a code of conduct for staff and volunteers;
- recruiting staff and volunteers safely, ensuring all necessary checks are made;
- sharing information about child protection and good practice with children, parents, staff and volunteers;
- sharing information about concerns, with agencies who need to know, and involving parents and children appropriately;
- providing effective management for staff and volunteers through supervision, support and training.

See JTMAT Safeguarding and Child Protection Policy and Shobnall Primary & Nursery School Safeguarding and Child Protection Procedures for further information.

MONITORING AND REVIEW

It is the responsibility of the science subject leader:

- supports colleagues in their teaching, by keeping informed about current developments in science and by providing a strategic lead and direction for this subject;
- to develop, implement and review an action plan for science;
- to monitor science throughout the school;
- to encourage staff to provide effective learning opportunities for all pupils;
- to develop valid activities, appropriate for children at different stages of development, which enable pupils to progress in the subject.

Monitoring of the standards of children's work and of the quality of teaching in science is the responsibility of the science subject leader. The work of the subject leader also involves supporting colleagues in their teaching, being informed about current developments in the subject, and providing a strategic lead and direction for the subject in the school.

This document will be reviewed at least every three years.