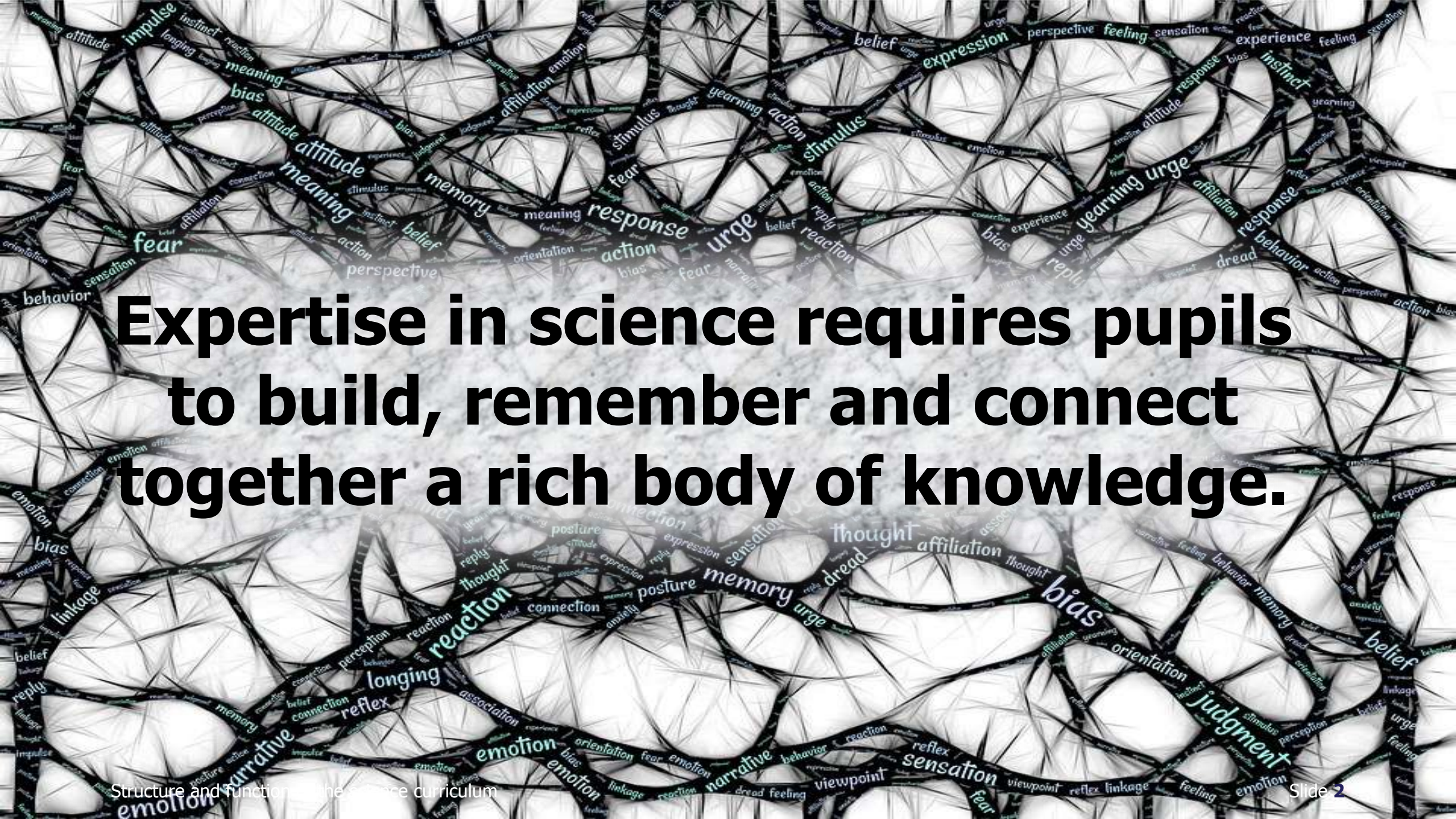
Structure and function of the science curriculum: key insights from Ofsted's research review

Dr Jasper Green, HMI
Curriculum Unit


Expertise in science requires pupils to build, remember and connect together a rich body of knowledge.

The 'quality of education' judgement

Quality of education

Intent

- Does the curriculum identify **what** pupils need to know? Is it logically sequenced? Ambitious? Meet the needs of all pupils?

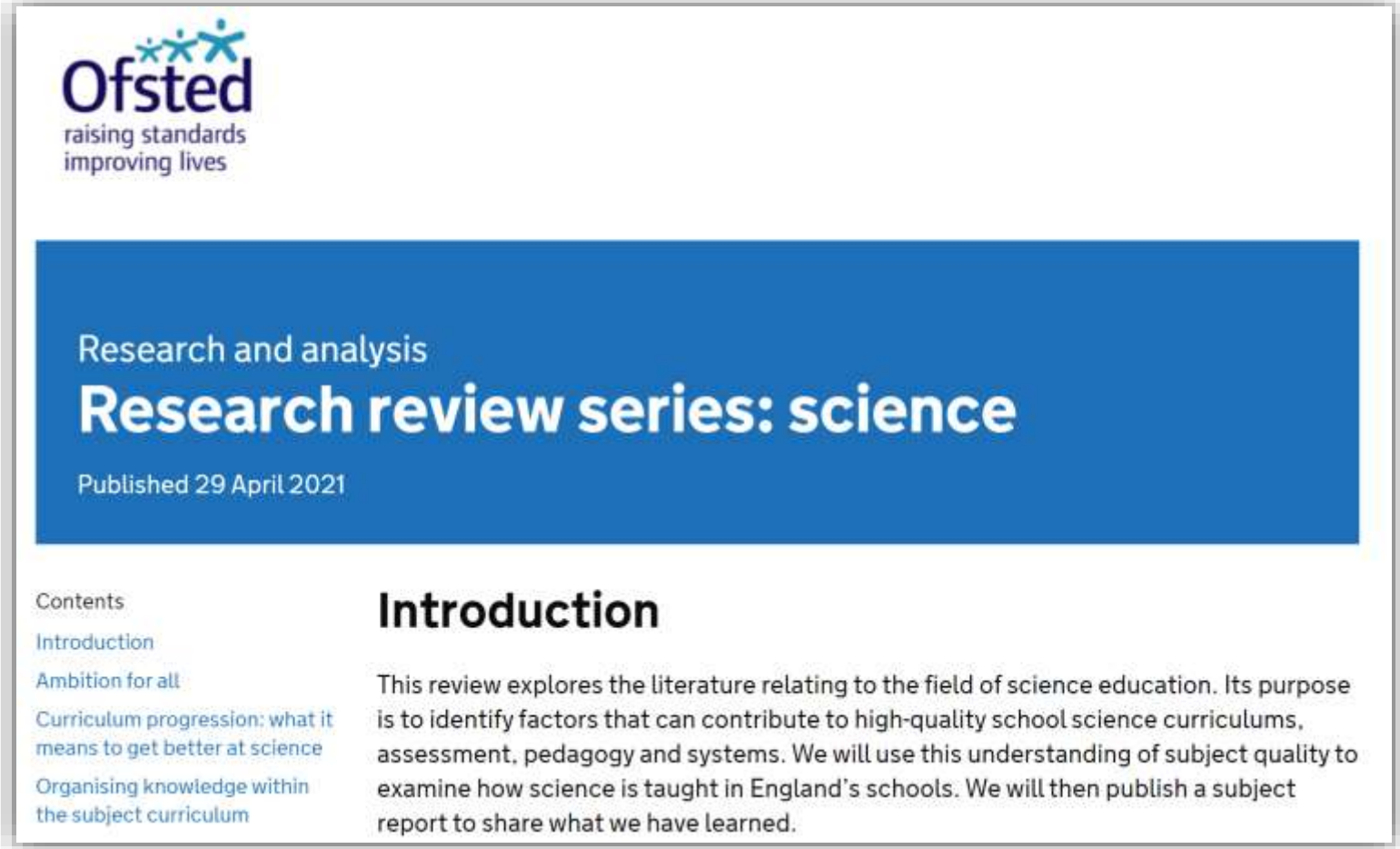
Implementation

- Do teachers have good subject knowledge and present subject matter clearly?
- Do teaching materials support the intent?
- Is assessment (formative and summative) used well, and not overly burdensome on staff?

Impact

- Do pupils know more, remember more and are able to do more?

The science research review



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Research and analysis

Research review series: science

Published 29 April 2021

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Introduction

This review explores the literature relating to the field of science education. Its purpose is to identify factors that can contribute to high-quality school science curriculums, assessment, pedagogy and systems. We will use this understanding of subject quality to examine how science is taught in England's schools. We will then publish a subject report to share what we have learned.

Contents

The research review is **NOT:**

- a checklist of things inspectors look for
- a second framework
- a document that covers all areas of science education e.g. we did not look at science clubs, careers etc. This does not mean they are not important.

The research review **does**:

- identify features associated with high-quality science education
- recognise that there is not just one way of achieving high-quality
- identify a number of principles that guide **how inspectors look at what they see.**

An example

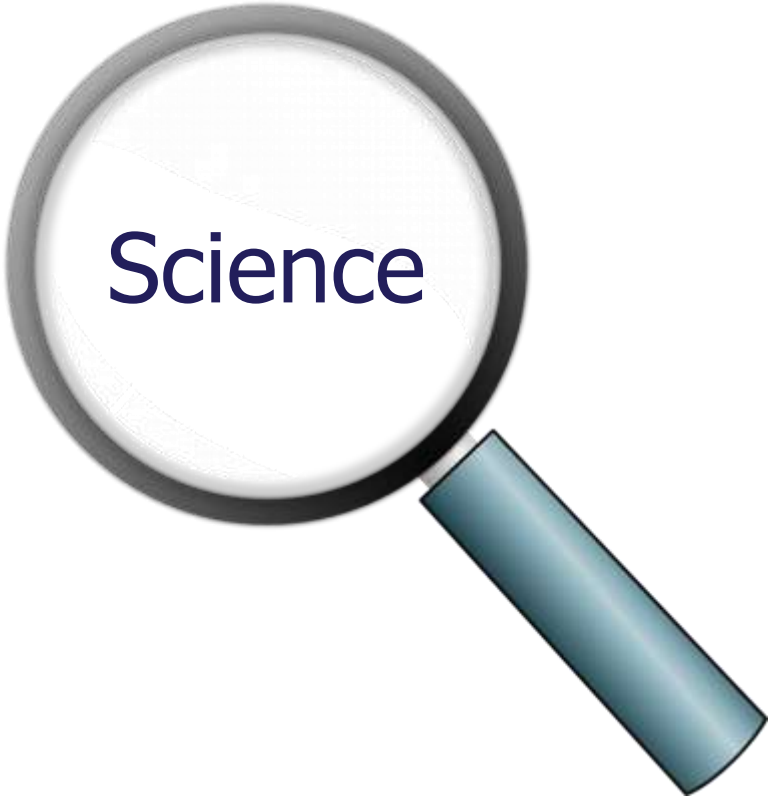
- An inspector visits a practical lesson. What questions might she be thinking about?
- What is the purpose of the practical in relation to curriculum content?
- Can pupils connect the theory to what they are doing?
- What do pupils know and can do?
- What came before/after the practical?

School inspection handbook (para. 218)

- Pupils are making progress in that they **know more, remember more and are able to do more**. They are learning what is intended in the curriculum.

- 'The curriculum is the progression model'.

So, what does it mean to make progress **in science**?



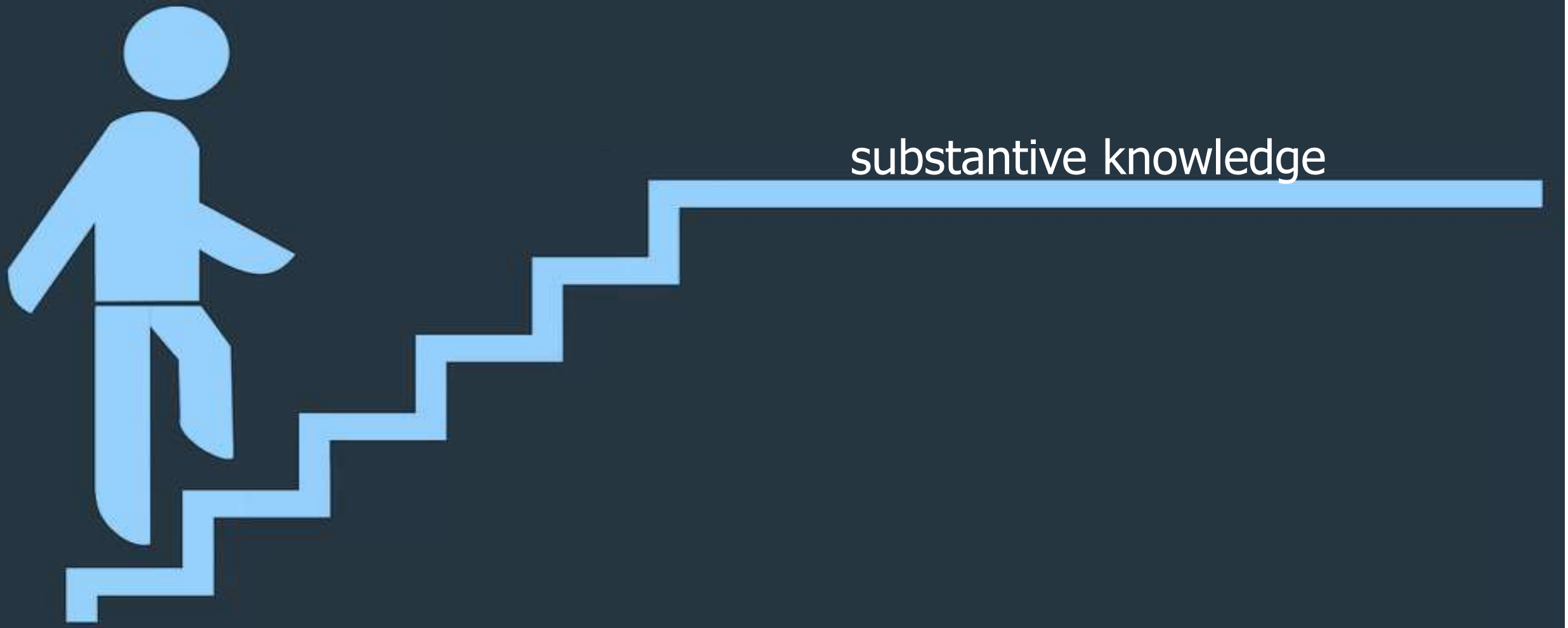
So, making progress in science involves…

Pupils knowing more and remembering more about:

- **substantive knowledge** e.g. the concept of a plant, the theory of evolution or the heliocentric model of our solar system.

- **disciplinary knowledge** refers to what pupils need to know about how science establishes and refines scientific knowledge e.g. knowledge of biological classification, variables, and measurement.

‘The curriculum as the progression model’



Substantive knowledge

- Pupils building knowledge of key concepts* over time

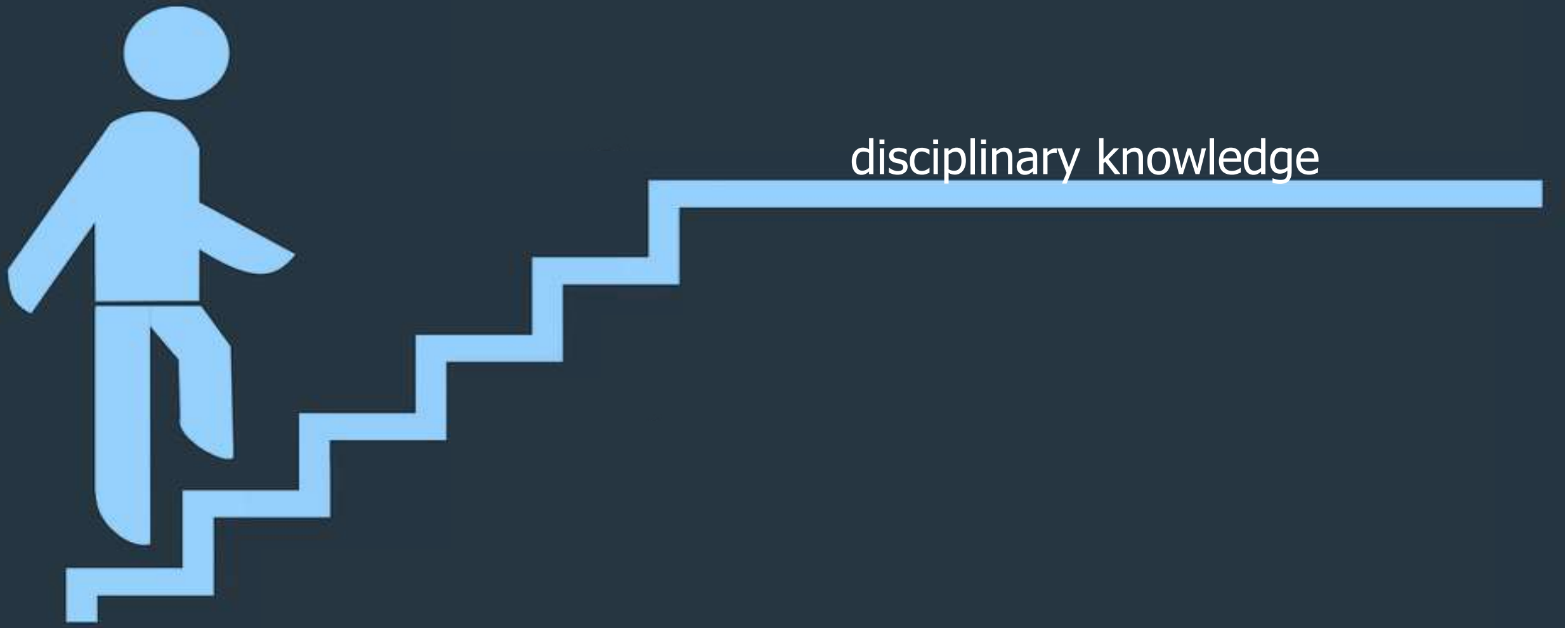
* there is no definitive list of scientific concepts

Progression in terms of…

Extent – knowing more about that concept.

Organisation – knowing how concepts are related.

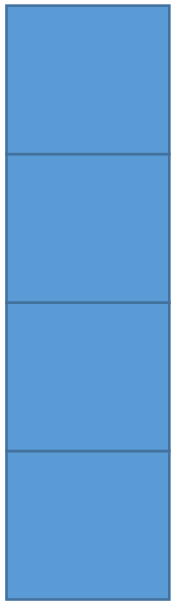
‘The curriculum as the progression model’



Why disciplinary knowledge and not scientific skills?

Disciplinary knowledge

Scientific skill



The ‘skill’ of using a thermometer

Make a list of all of the knowledge pupils should know to be able to use a thermometer.

The ‘skill’ of using a thermometer

- How to hold it i.e. not at the bulb
- How to rest it
- How to read the scale (including negative numbers)
- How to record data in a table

- Measurement
- Variable
- Standard units e.g. °C
- Repeatability
- Calibration
- Linear relationships e.g. volume and temperature
- Uncertainty ±0.5 °C
- Significant figures e.g. 20 or 20.0

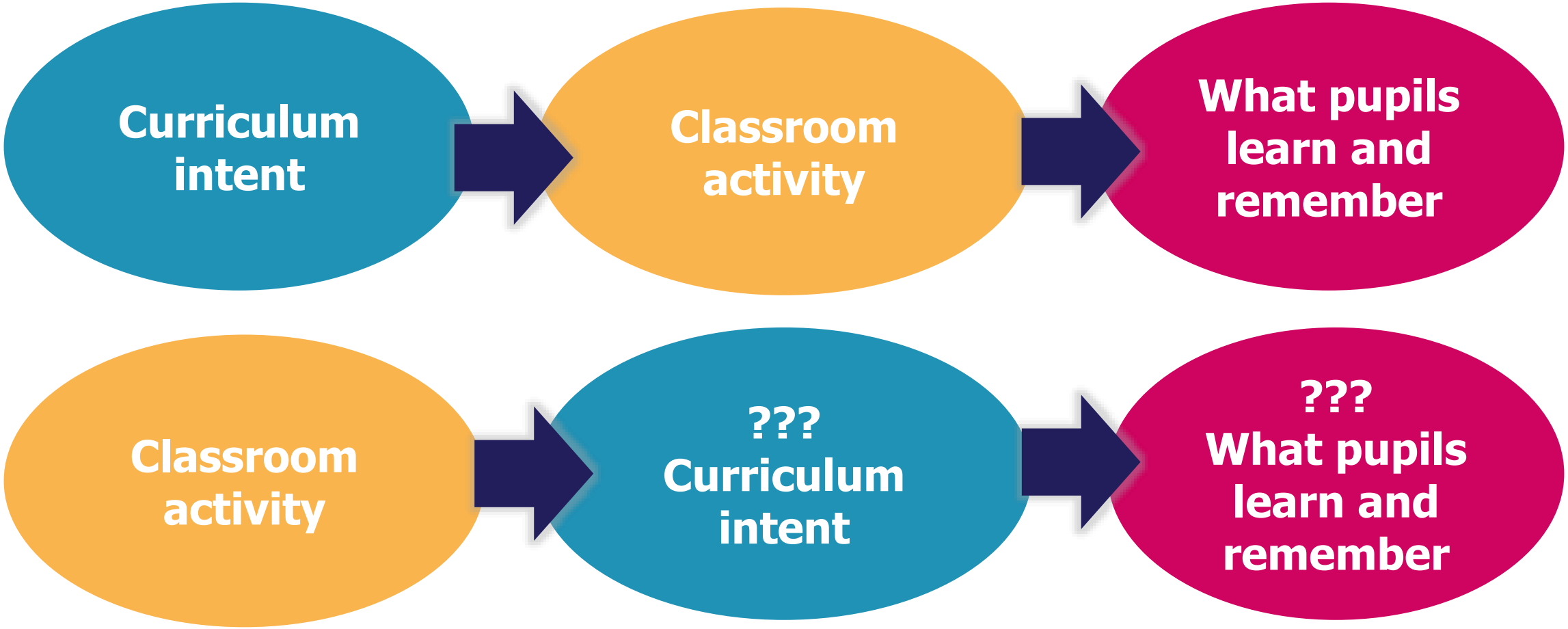
Possible aspects of disciplinary knowledge

Knowledge of scientific methods.	Knowledge of apparatus and techniques, including measurement.	Knowledge of data analysis and presentation.	Knowledge of how science uses evidence to develop explanations.
▪ Models ▪ Classification ▪ Pattern-seeking ▪ Fair tests	▪ Apparatus ▪ Safety ▪ Procedures	▪ Graphs ▪ Tables ▪ Drawings	▪ Evidence ▪ Validity ▪ Conclusions ▪ Peer review

Pedagogy

- Clear teacher explanations.
- Importance of practical work:
  - enough prior knowledge to learn
  - purpose in relation to curriculum intent
  - forms part of a wider instructional sequence.
- High-quality textbooks can be a valuable resource for learning and teaching science.
- Disciplinary knowledge is explicitly taught.
- Learning about scientific enquiry is **not** confused with enquiry-based teaching approaches.

Being clear on intent



Systems

- Regular access to high-quality subject-specific CPD.
- Dedicated time for subject leadership.
- SLT support science and maths leaders to work together.
- Timetables support teachers to develop expertise in their subject.
- Time in the timetable to teach an ambitious science curriculum.
- Sufficient practical resources.

Assessment

- Clarity around purpose: as learning, for learning, of learning.
- Feedback focused on the science content – not on generic features.
- Not overly burdensome on teachers' time.
- Overuse of external assessment items e.g. GCSE questions is avoided.
- Assessment checks that pupils are remembering what they previously learned.

To recap

- The science research review identifies features associated with high-quality science education. A subject report will follow.

1. Does the curriculum plan for all pupils to build their knowledge of key substantive concepts over time?

2. Does the curriculum plan for pupils to build their disciplinary knowledge over time inc. concepts? Is this connected to substantive knowledge?

3. Are activities carefully chosen to help pupils learn specific curriculum content?

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