

**How To Guide – Building Booklets**

Astrea Academy Trust is moving to booklet-led learning in every subject; in 2023/24 we will complete KS4 booklets. In time, this move will reduce workload and enable teachers to focus on the more impactful aspects of planning.

**The Nature of the Curriculum**

Science is a hierarchical subject with many links between topics; it is important that each stage of learning is secure and appropriate links are made.

We can broadly divide the content of the curriculum into two types:

* Procedural: Knowledge that is learnt as a process (e.g. risk assessments; calculations).
* Declarative: Knowledge that includes the facts and information related to science.

Each type of knowledge is built in different ways that need to be considered when writing booklets.

**Key considerations**

* The activities that you include when you build your subtopics reflect the type of knowledge.
* We aim to build expertise in novices. The learning journey must reflect starting points and ambitious end points but not to overwhelm working memories.
* Students should be challenged. Desirable difficulties (Bjork, 1994) can be built into lessons through varying practice, spacing and interleaving.
* Students need to understand where new content fits into their existing schema.

**What it looks like – procedural knowledge**

Students need to understand where the knowledge fits into their existing knowledge, learn a process and then apply it in increasingly challenging contexts.

**Guided reading** is a powerful strategy that is particularly important in our context; a reading activity needs to be included that:

1. Refers to prior learning to enable links to existing schema.
2. Contains tier 2 and tier 3 terminology.
3. Is 400 – 600 words in length.

 **Worked examples** are particularly powerful when used with novices who self-explain. A worked example should be included.

**Faded application questions** build proficiency by removing scaffolding at a pace that works for the student.

At Astrea Dearne we use I do, we do, and you do. Typically one question is used for the ‘I do’, one for ‘we do’ and several examples are used for ‘you do’.

Difficulty of ‘you do’ should be increased incrementally.

**Examples: Dotted lines for writing answers on have been removed for clarity.**

**Example 1: Relative formula mass**

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The formulae used increase the challenge as the set of questions is descended.

**Example 2: Natural Selection**

All of the questions can be answered using the following procedure:

1. Identify the variation.
2. Identify the advantage (e.g. camouflage).
3. Refer to those with one type of variation being more likely to survive.
4. Refer to favourable genes being passed on to offspring.



Q4.

Requires processing of large amounts of information.

Format of the question (in bold) might confuse students.

Q3.

Advantage requires a link to be made to SA: volume ratio or layers of fat. This needs to be explained in terms of heat loss. This is more challenging than previous examples.

Q2.

Increased challenge because more information must be processed.

Students need to identify mimicry as an advantage; students will be less familiar with this than camouflage.

Q1.

Simple format reflecting the I DO, and We DO.

Familiar advantage (camouflage).

**What it looks like – procedural knowledge (equations)**

Use of calculations is an example of procedural knowledge. However, the difficulty is increased because the equation may need to be rearranged. In this situation, blocking and interleaving is used.

**Key considerations:**

* Each section of questions should contain ten or more questions.
* Increase the difficulty of questions by, for example, changing the wording incremental, requiring students to convert units or removing scaffolding.

**Example – momentum, mass and velocity.**

**Block 1 – calculating momentum Block 2 – calculating mass**

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In both cases, the challenge has been increased by removing scaffolding. This would also be the case for block 3 (calculating velocity).

**Example continued.**

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With interleaved content, challenge comes from students having to discriminate between similar questions.

In this case, all of the questions have a similar format.

For questions 6 and beyond, additional challenge could be added by requiring students to convert units etc.

**What it looks like – declarative knowledge**

When we teach declarative content, we need to ensure that students have understood the content and have opportunity to use the content alongside their existing knowledge.

**Guided reading** is used as part of the teacher explanation.

**Practising declarative content**

As with procedural knowledge, declarative knowledge needs to be practised. Adam Boxer gives several examples of how to do this in his book ‘Teaching Secondary Science – A Complete Guide’.

**Technique 1 – Spacing and slightly varied repeat**

This is a straight-forward technique to plan that should be in every lesson.

**Example:**

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The format is changed again. This time they have to name the organelle; in previous questions they were given the name.

Questions are repeated. For example, ‘e’ is a repeat of ‘a’. However, the wording is changed; this adds a small amount of difficulty.

The first four questions have the same direct format.

**It is anticipated that two of the following techniques will be built into sub-topics.**

**The techniques that are most relevant to the content should be chosen.**

**Technique 2 – Contrasting concepts**

Thinking about the content is provoked by asking students to compare related concepts. For example:

1. Compare mitosis and meiosis.
2. Compare plant cells and animal cells.
3. Compare prokaryotic cells and animal cells.
4. Compare the structure of lithium to the structure of sodium.
5. Compare an object with a lot of energy in its thermal energy store to one that has a lot of energy in its kinetic energy store.
6. Compare longitudinal waves and transverse waves.
7. *Give two differences between muscle cells and nerve cells.*
8. *The digestion of proteins and the combustion of fuel are both chemical reactions. What are the differences between them?*
9. *What are the differences and similarities between ammeters and voltmeters.*
10. *What are the similarities between a particle diagram of a solid and a particle diagram of a liquid.?*

Questions 7 – 10 were taken from page 259 of Teaching Secondary Science: A Complete Guide.

**Technique 3 – If it didn’t…**

Structure – function and structure – properties relationships are common in Science. Thinking about these can be promoted using ‘If it didn’t…’.

Examples from page 260 of Teaching Secondary Science – A Complete Guide include:

1. If a sperm cell did not have a tail, how would it affect its ability to carry out its function?
2. If the stomach did not have acid in it, how would this affect digestion?
3. If metals were not malleable, how would this affect the way that we use electrical devices?
4. If water was not a liquid, how would this affect how plants could grow?

**Technique 4 – Wrong answers**

Students correct answers that are incorrect. For example:

1. A student is asked ‘name a property of solids’ and answers: The particles are all touching.

**Explain why the student is incorrect.**

1. A student is asked ‘name two non-contact forces’ and answers: Weight and air resistance.

**Explain why the student is incorrect.**

1. A student is asked ‘Why do root hair cells not have any chloroplasts in them?’ and answers: Because they are not green.

**Explain why the student is incorrect.**

**Explain why the student thought the answer was correct.**

1. A student says: A substances boiling point is when it boils.

**Explain why the student is incorrect.**

**Rephrase the student’s statement to make it correct.**

Difficulty increases down the list.

Questions were taken from pages 260 and 261 of Teaching Secondary Science: A Complete Guide.

**Interleaving**

Difficulty can be increased further through interleaving new content with prior learning. This content might come from the current topic or from other topics.

**Example: The muscle cell.**

*Students have previously studied particles and cells. They are currently studying energy, and following introduction to stores and pathways, they practise their new knowledge before attempting the question set below:*

*This question is about a muscle cell.*

1. *What is the function of a muscle cell?*
2. *How is the muscle cell adapted to its function?*
3. *What is the name of the process that releases energy in the muscle cell?*
4. *In which organelle does this take place?*
5. *The muscle cell uses glucose to release energy in a chemical reaction. Which energy store is involved with the glucose in this store?*
6. *Muscle cells work together to bring about movement. What is the name for something made of many cells working together?*
7. *When a person moves their muscles move, they start to feel warm. Which energy store is filling up?*
8. *A person who has just exercised touches a cold object and warms it up a bit. What energy transfer is involved?*
9. *The object they touched was an ice-cube. What happens to it if they hold it for a long time?*
10. *Draw a particle diagram of an ice cube.*
11. *Explain why the ice cube cannot flow.*

**Exam questions** can be valuable when used in lessons. However, they are usually overused because they are used as a substitute for activities that scaffold or promote deeper thinking (e.g., techniques 1 – 4).

A maximum of three well chosen exam questions should be included.