The National Strategies
Secondary

Assessment for Learning in science

Unit 1: Lesson scaffolding: structuring learning to develop Quality First teaching in science

department for
children, schools and families

Assessment for Learning in science

Unit 1: Lesson scaffolding: structuring learning to develop Quality First teaching in science

First published in 2009
Ref: 00932-2009PDF-EN-01

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Please check all website references carefully to see if they have changed and substitute other references where appropriate.

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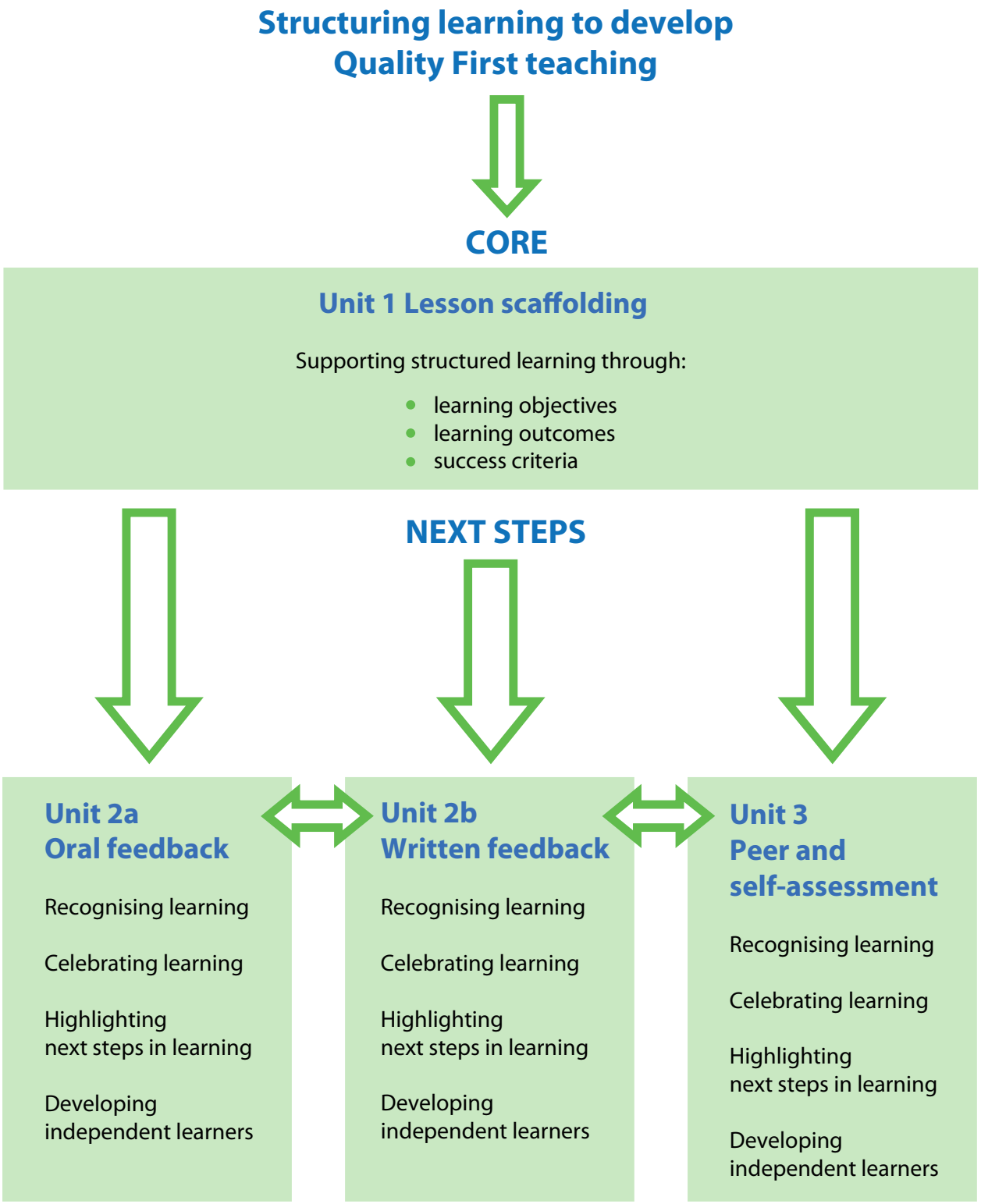

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Unit 1: Lesson scaffolding: structuring learning to develop Quality First teaching in science

This is the core unit in a series of support materials to strengthen Assessment for Learning (AfL) in science. These materials link closely with the following quality standards developed for AfL.

AfL quality standards

2.1. All teachers have a secure and shared understanding of AfL and how it impacts on learning and standards.

2.2. All teachers have a good understanding of progression in the key concepts and skills in their subject.

2.5. In lessons, all pupils have a clear understanding of what they are trying to learn (learning objectives), how they can recognise achievement (learning outcomes), what 'good' looks like (success criteria) and why they are learning this (big picture).

Purpose of these materials

- To define what is meant by learning objectives and how learning outcomes can provide assessment opportunities linked to Assessing Pupils' Progress (APP)
- To consider strategies for constructing learning objectives that provide the appropriate level of challenge
- To illustrate the purpose and importance of using a learning objective that has a focus on *How Science Works* (*HSW*)

Reference material

All materials referred to are listed at the end of this document and are available to download from **www.standards.dcsf.gov.uk/nationalstrategies**.

Key messages

- Learning objectives and intended learning outcomes should be the starting point in lesson planning; appropriate activities that drive different parts of the lesson should be chosen to support the achievement of the objectives.
- Using stems (*Discuss, Present, Explain why*, etc.) helps to ensure that learning objectives focus on learning rather than on classroom activities.
- Effective learning takes place when learners understand what they are trying to achieve. Sharing objectives with pupils ensures they are aware of what they are learning and why. Sharing the learning objectives enables teachers and pupils to review progress during and at the end of the lesson.

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- What the teacher intends the pupils to learn is called the learning objective, and how achievement will be demonstrated by pupils is called the learning outcome.
- Pupils' progress is accelerated when they are clear about the success criteria for the intended outcomes and are able to judge the quality of their work and know how to improve it. This requires teachers having a good understanding of progression in the key concepts and skills in science. (The APP assessment guidelines can support this understanding of progression in *HSW).*
- In stating the learning objective in a lesson, it is common practice to link to past and future lessons, so that pupils can appreciate how this links to the big picture of their learning, and day-to-day and periodic assessment.
- In science, learning objectives should have a *HSW* focus and the context of the learning derived from an appropriate part of the range and content. This will ensure opportunities for assessment against the APP assessment guidelines. A good starting point for this is the Framework.

In summary, Quality First teaching in science will feature:

- learning objectives as the starting point for planning the lesson. In science these have a *HSW* focus
- learning outcomes that are an integral part of the planning and delivery of Quality First teaching where it is clear what aspect of *HSW* is being developed
- learning objectives and learning outcomes, skilfully crafted to guide teachers and advise pupils of the goal of the lesson, giving focus, meaning and purpose to the tasks performed; teachers personalising learning; pupils judging the quality of their work and identifying their next steps; all helping pupils to become independent learners.

There is a wealth of support for developing aspects of *HSW* in the Framework for secondary science section of the National Strategies web area: **www.standards.dcsf.gov.uk/nationalstrategies**.

Support materials for *'Progressing to Level 6 and beyond in science with added How Science Works'* can also be accessed by searching for this title on the National Strategies web area, becoming a registered user and joining the course of the same name.

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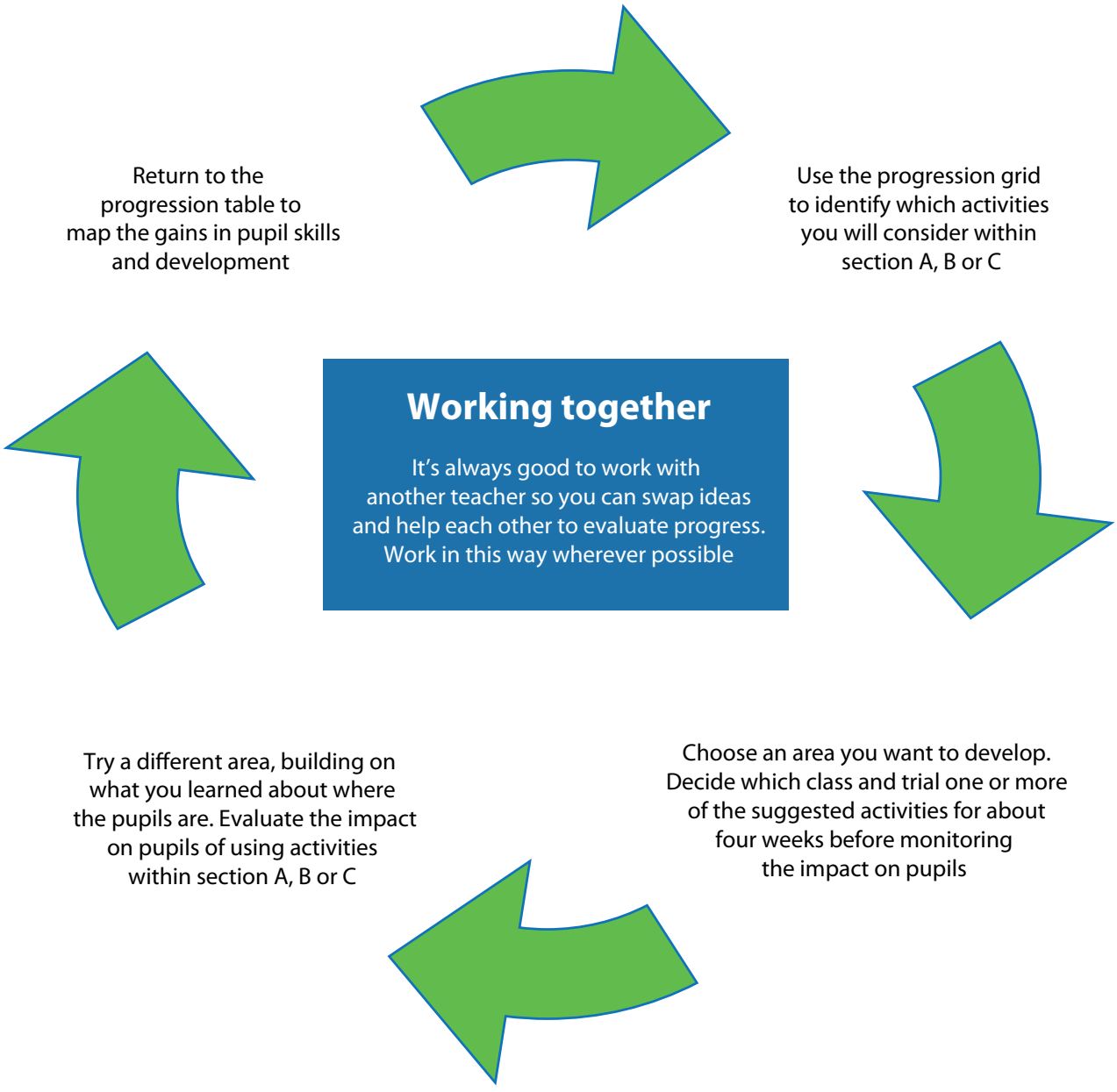
Cycle of professional development

The diagram explains how to use the progression table and take the next steps to develop your expertise in scaffolding learning.



Reviewing existing practice in Lesson scaffolding: structuring learning to develop Quality First teaching in science

The following progression table provides a tool for a department or an individual to review their current practice and to identify the next steps in professional development.

Start with what pupils can do in lessons, then look at what the teachers are doing. Pupils' development often lags behind that of the teacher.

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Progression table: reviewing existing practice in lesson scaffolding

Highlight the table to show which column (Focusing, Developing, Establishing or Enhancing) best describes practice in your classroom or department. Look at the pupils then the teachers. This should be based on evidence from lesson observations or pupil and teacher voice.

In that column identify which row(s) are in need of most development, e.g. D3 to Es3. Find this box in the supporting activities and try with your identified class.

	Focusing	Developing	Establishing	Enhancing
Pupils	Pupils can state in a limited way what they are trying to learn and the purpose of the task F1	Pupils can state what they are trying to learn and are beginning to use the language of *How Science Works* (*HSW*) to explain this D1	Pupils can state specific aspects of *HSW* they are learning about, can recognise their achievements and what they need to do to improve Es1	Pupils recognise the skills of *HSW* that are being used to engage with content, e.g. by exploring the strengths and weaknesses of models. There is an awareness of a range of possible learning outcomes and as a result they are able to improve their achievements in relation to success criteria En1
	Pupils enjoy practical work but learn little from it F2	Pupils have limited choice in the investigations and often rely on planning frames D2	Pupils can state the aspect of *HSW* they are engaged with in their investigative work Es2	Pupils explain how they are using aspects of *HSW* in their investigative work En2
	Significant amounts of time are spent on low-level tasks which occupy their time but add little to skill development F3	*HSW* skills relating to developing explanations or argumentation are gained in a haphazard or accidental way D3	A choice of which aspects of *HSW* skills to develop in lessons is beginning to be made by pupils and they are supported to articulate what 'good' looks like in terms of their learning (success criteria) Es3	A range of skills is used independently to explain, evaluate, develop arguments and ideas, and identify success criteria they have agreed collaboratively En3

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Teachers	Learning objectives and outcomes often have a focus on range and content. Planning is mainly task driven rather than based on what the pupils will learn F4	Some lessons have dual learning objectives: a range and content objective and a *HSW* objective. There is limited exemplification of the learning outcomes. The *HSW* 'big picture' is beginning to be communicated but there is uncertainty as to how to phrase learning objectives and learning outcomes that link the range and content to *HSW* D4	An explicit *HSW* learning objective is shared and an appropriate context to develop *HSW* is chosen from the range and content. This is made clear to pupils APP criteria are used to support understanding of progression in skills and to differentiate the outcomes for specific classes, resulting in learning objectives and outcomes that are at an appropriate level of challenge Es4	*HSW* learning objectives and outcomes are personalised for pupils in response to their progress Review of learning against the APP criteria is used to identify next steps and plan future lessons. When periodic assessments have taken place, learning targets are identified and used to drive the planning for the next term En4
	Practical skills are expected to be taught but are not specifically planned for F5	*HSW* activities are completed in an ad hoc fashion. These are chosen by individual teachers and there is inconsistency across the department D5	*HSW* objectives are planned into the scheme of learning so that all skills are represented but there is no clear progression across the key stages Es5	*HSW* objectives and outcomes are mapped progressively across all schemes of learning in Key Stage 3 and Key Stage 4 En5
	HSW is considered to be the same as practical work. This practical work is 'recipe driven' with the assumption that pupils will pick up skills with practice F6	Practical work is used because pupils are engaged and enjoy the experience. It is used to illustrate ideas from range and content, but this purpose is not made explicit D6	The purpose of practical work and where it fits in the 'big picture' of *HSW* is made explicit to pupils through the learning objectives, e.g. to illustrate a piece of science knowledge, to develop a practical skill or to develop non-practical skills such as argumentation Es6	There is a good understanding of progression in *HSW* and this is used to drive planning at all levels En6

	There is no agreed departmental approach to sharing learning objectives in lessons F7	Learning objectives that are difficult to assess are often used, e.g. beginning with the following stems: 'know', 'understand', 'become familiar with' D7	In lessons, the learning objectives and outcomes are at an appropriate level of challenge, and pupils are supported to articulate what 'good' looks like in terms of learning (success criteria) Es7	Differentiated outcomes and agreed success criteria are driven by the pupils; these relate to the full range of *HSW* En7
	A: Go to these activities to move from Focusing to Developing beginning on page 11	**B: Go to these activities to move from Developing to Establishing beginning on page 15**	**C: Go to these activities to move from Establishing to Enhancing beginning on page 18**	

A: Activities to move from Focusing to Developing

Choose the box that you have identified from the review of the progression grid.

Moving from F1 to D1	Pupils can state in a limited way what they are trying to learn and the purpose of the task F1	Pupils can state what they are trying to learn and are beginning to use the language of *How Science Works* (*HSW*) to explain this D1

You could try to:

- use suggested practical strategies to help frame learning objectives and learning outcomes. Notice the increasing demand and challenge as you go down the page
- use the *HSW* 'big picture' animation in the *Progressing to level 6 and beyond in science* course or poster to help write learning objectives that link to *HSW*
- use the poster and supporting resources to illustrate the language of the *HSW* learning objective
- find out what pupils know about *HSW* by giving them a questionnaire and analysing the results
- check that pupils understand what they are trying to learn by using a starter activity or questions that link to the learning objectives before moving on to the main part of the lesson.

Moving from F2 to D2	Pupils enjoy practical work but learn little from it F2	Pupils have limited choice in the investigations and often rely on planning frames D2

You could try to:

- increase the challenge by substituting an open-ended investigation for a practical task
- use a copy of the planning posters for groups of pupils to identify variables and choose the range for the independent variable
- link the processes used to the *HSW* 'big picture' animation in the *Progressing to level 6 and beyond in science* course or poster
- model the use of the language of investigations, e.g. evidence, independent variable, range of data. For information on the type of activity to support this development see *Literacy in science*.

Moving from F3 to D3	Significant amounts of time are spent on low-level tasks which occupy their time but add little to skill development F3	*HSW* skills relating to developing explanations or argumentation are gained in a haphazard or accidental way D3

You could try to:

- in the four-week period of trialling to improve learning objectives, look ahead to identify a context that would help you include the following objectives: 'Distinguish between opinion and scientific evidence' and similarly 'Use evidence rather than opinion to construct an argument'. These link to the Framework yearly learning objectives for 1.1a3: Scientific thinking; developing argument
- plan lessons that explicitly teach these skills; check progress by having a plenary to inform your next lesson(s). Some ideas for plenaries can be found in Appendix 3 of *Creating a progress culture*.

Moving from F4 to D4	Learning objectives and outcomes often have a focus on range and content. Planning is mainly task driven rather than based on what the pupils will learn F4	Some lessons have dual learning objectives; a range and content objective and a *HSW* objective. There is limited exemplification of the learning outcomes The *HSW* 'big picture' is beginning to be communicated but there is uncertainty as to how to phrase learning objectives and learning outcomes that link the range and content to *HSW* D4

You could try to:

- construct two learning objectives for every lesson: one that has a range and content focus, the other that has a *HSW* focus. Remember to use the helpful words to phrase the objectives.

Moving from F5 to D5	Practical skills are expected to be taught but are not specifically planned for F5	*HSW* activities are completed in an ad hoc fashion. These are chosen by individual teachers and there is inconsistency across the department D5

You could try to:

- at a departmental meeting, listen to how everyone uses learning objectives that incorporate *HSW* and shares them with a class; agree a common approach. Teachers should choose one teaching group and trial for four weeks
- select a series of lessons to be taught in the next few weeks. Identify opportunities for practical work from the scheme of learning. Look at the yearly learning objectives in the Framework for 1.2 Practical and enquiry skills (there are six different aspects). Choose a learning objective that you want to develop with your class, e.g. from Using investigative approaches: selecting and managing variables
- plan lessons that explicitly teach the skills; check progress by having a plenary to inform your planning for your next lesson. Some ideas for plenaries can be found in Appendix 3, pages 47 and 48 of *Creating a progress culture*.

Moving from F6 to D6	*HSW* is considered to be the same as practical work. This practical work is 'recipe driven' with the assumption that pupils will pick up skills with practice F6	Practical work is used because pupils are engaged and enjoy the experience. It is used to illustrate ideas from range and content, but this purpose is not made explicit D6

You could try to:

- ensure all practical work is used to enhance understanding of a scientific idea. If it doesn't, then stop doing it and choose a different approach, e.g. use a demonstration where pupils get confused by the complexity of the apparatus and so do not focus on the scientific ideas. Ideas can be found within the document *Effective demonstrations*.

Moving from F7 to D7	There is no agreed departmental approach to sharing learning objectives in lessons F7	Learning objectives that are difficult to assess are often used, e.g. beginning with the following stems: 'know', 'understand', 'become familiar with' D7

You could try to:

- at a departmental meeting, listen to how everyone uses learning objectives and shares them with a class; agree a common approach. Teachers should choose one teaching group and trial for four weeks
- at a future meeting, bring a selection of your learning objectives, make a tally of the frequency of different word stems across the department and discuss which are easiest to assess in order to confirm that pupils have made progress towards them. Agree to reduce the frequency of the less-helpful stems.

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Evaluation of impact

Use these activities over a period of about four weeks. Monitor the impact by reflecting on learning gains, talking to pupils, teaching assistants and other teachers about the impact. Look at progress with periodic assessments, using APP.

Check the progression grid to see if you have moved forward in your practice.

You could also ask a colleague to watch a lesson with a focus on the area you are trying to improve, and ask them for feedback.

To continue your development, adjust what you do in the next four weeks by identifying your next steps from the progression grid and moving on to the activities in section B or C.

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B: Activities to move from Developing to Establishing

Choose the box that you have identified from the review of the progression grid.

Moving from D1 to Es1	Pupils can state what they are trying to learn and are beginning to use the language of *HSW* to explain this. D1	Pupils can state specific aspects of *HSW* they are learning about, can recognise their achievements and what they need to do to improve Es1

You could try to:

- use the amplification statements in the Framework for secondary science to exemplify the learning objectives into outcomes, e.g. from Using investigative approaches: obtaining and presenting primary evidence. You might want to check the associated assessment focuses of this aspect of investigations from APP to link the learning to an assessment opportunity
- plan your lesson to ensure pupils can achieve the learning objectives and have opportunities to make progress by the challenge of the outcomes
- plan a plenary where pupils discuss with each other, and sometimes the teacher, what they have learned and what their next steps are
- at the end of each week ask pupils to fill in a learning journal where they can reflect on what they have learned and what they need to do to improve.

Moving from D2 to Es2	Pupils have limited choice in the investigations and often rely on planning frames D2	Pupils can state the aspect of *HSW* they are engaged with in their investigative work Es2

You could try to:

- ask pupils working in small groups to use the *HSW* 'big picture' animation in the *Progressing to level 6 and beyond in science* course or poster to decide how they will approach an investigation independent of the teacher. Ask them to explain their approach to each other or the class and what aspects of *HSW* they have learned more about
- ask pupils to identify with their peers those areas in which they feel confident and those that need development, and record this in their learning journals
- check pupils' self-assessment and plan a series of lessons to address their needs.

Moving from D3 to Es3	*HSW* skills relating to developing explanations or argumentation are gained in a haphazard or accidental way D3	A choice of which aspects of *HSW* skills to develop in lessons is beginning to be made by pupils and they are supported to articulate what 'good' looks like in terms of their learning (success criteria) Es3

You could try to:

- ask pupils to use the *HSW* 'big picture' animation in the *Progressing to level 6 and beyond in science* course or poster to identify weaknesses around developing explanations. Use the Framework yearly learning objectives and the amplification statements to plan a lesson to address weaknesses in developing explanations. In later lessons use the same resources but this time focus on developing arguments
- use the pupil sheets from the *Progressing to level 6 and beyond in science* materials for pupils to identify success criteria and next steps in aspects of investigative science.

Moving from D4 to Es4	Some lessons have dual learning objectives: a range and content objective and a *HSW* objective. There is limited exemplification of the learning outcomes The *HSW* 'big picture' is beginning to be communicated but there is uncertainty as to how to phrase learning objectives and learning outcomes that link the range and content to *HSW* D4	An explicit *HSW* learning objective is shared and an appropriate context to develop *HSW* is chosen from the range and content. This is made clear to pupils APP criteria are used to support understanding of progression in skills and to differentiate the outcomes for specific classes, resulting in learning objectives and outcomes that are at an appropriate level of challenge Es4

You could try to:

- use the Framework yearly learning objectives for *HSW* to identify opportunities to use an aspect of the range and content to develop a *HSW* skill. Choose the Scientific thinking: developing explanations using models learning objective and an appropriate range and content learning objective to develop a combined learning objective for a lesson, e.g. use the idea of particles to describe or explain transfer of heat by conduction (convection and radiation)
- check out opportunities for assessment by referring to the associated assessment focuses within APP. Ensure your planning has sufficient challenge to enable all pupils to make progress.

Moving from D5 to Es5	*HSW* activities are completed in an ad hoc fashion. These are chosen by individual teachers and there is inconsistency across the department D5	*HSW* objectives are planned into the scheme of learning so that all skills are represented but there is no clear progression across the key stages Es5

You could try to:

- with other colleagues from the department, check that there are opportunities in the scheme of learning to address the *HSW* learning objectives
- map coverage across Key Stage 3, identify any gaps and insert additional opportunities into the scheme of learning. Depending on the size of this task, this would be a good opportunity to check for progression and move towards En5. The *HSW* mapping grids would support this activity.

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Moving from D6 to Es6	Practical work is used because pupils are engaged and enjoy the experience. It is used to illustrate ideas from range and content, but this purpose is not made explicit D6	The purpose of practical work and where it fits in the 'big picture' of *HSW* is made explicit to pupils through the learning objectives, e.g. to illustrate a piece of science knowledge, to develop a practical skill or to develop non-practical skills such as argumentation Es6

You could try to:

- be explicit about the purpose of practical work. Make sure the learning objectives and outcomes of the lesson reflect the purpose
- ask pupils to use the *HSW* 'big picture' in the *Progressing to level 6 and beyond in science* course or poster to identify where practical work fits into the ideas about *HSW*
- use some of the activities in the unit *Interactive practicals*.

Moving from D7 to Es7	Learning objectives that are difficult to assess are often used, e.g. beginning with the following stems: 'know', 'understand', 'become familiar with' D7	In lessons, the learning objectives and outcomes are at an appropriate level of challenge, and pupils are supported to articulate what 'good' looks like (success criteria) Es7

You could try to:

- develop the phrasing of learning objectives. Use the grids in Appendices 1 and 2, pages 1–46 of *Creating a progress culture* to assess your use of these words when phrasing learning objectives and outcomes
- consider the levels/grades of the pupils in your class, and check that the learning objectives are at an appropriate level for the class. If there is insufficient challenge, move up a level on the grids
- use the APP assessment guidelines to check that the target levels match those of your learning objectives and outcomes. Use these to develop a set of success criteria for a particular context so that pupils can judge the quality of their work and that of others, and identify the next steps.

Evaluation of impact

Use these activities over a period of about four weeks. Monitor the impact by reflecting on learning gains, talking to pupils, teaching assistants and other teachers about the impact. Look at progress with periodic assessments, using APP.

Check the progression grid to see if you have moved forward in your practice.

You could also ask a colleague to watch a lesson with a focus on the area you are trying to improve, and ask them for feedback.

To continue your development, adjust what you do in the next four weeks by identifying your next steps from the progression grid and moving on to the activities in section C.

C: Activities to move from Establishing to Enhancing

Choose the box that you have identified from the review of the progression grid.

Moving from Es1 to En1	Pupils can state specific aspects of *HSW* they are learning about, can recognise their achievements and what they need to do to improve Es1	Pupils recognise the skills of *HSW* that are being used to engage with content, e.g. by exploring the strengths and weaknesses of models. There is an awareness of a range of possible learning outcomes and as a result they are able to improve their achievements in relation to success criteria En1

You could try to:

- develop the phrasing of learning objectives. Use the grids in Appendices 1 and 2 on pages 41–46 of *Creating a progress culture* to assess your use of these words when phrasing learning objectives and outcomes
- consider the levels/grades of the pupils in your class, and check that the learning objectives are at an appropriate level for the class. If there is insufficient challenge, move up a level on the grids
- support pupils by modelling how to identify any success criteria linked to the particular context. Organise discussion groups to develop success criteria that are then agreed by the rest of the class
- support pupils to use success criteria to peer and self-assess their work and identify next steps.

Moving from Es2 to En2	Pupils can state the aspect of *HSW* they are engaged with in their investigative work Es2	Pupils explain how they are using aspects of *HSW* in their investigative work En2

You could try to:

- ask pupils to explain to each other or the class their approach and what aspects of *HSW* they have learned more about
- ask pupils to identify with their peers those areas in which they feel confident and those that need development, and record this in their learning journals
- encourage and plan oral feedback (teacher and peer) on the quality of their explanation
- check pupils' self-assessment and plan a series of lessons to address their needs.

Moving from Es3 to En3	A choice of which aspects of *HSW* skills to develop in lessons is beginning to be made by pupils and they are supported to articulate what 'good' looks like in terms of their learning (success criteria) Es3	A range of skills is used independently to explain, evaluate, develop arguments and ideas, and identify success criteria they have agreed collaboratively En3

You could try to:

- develop the phrasing of learning objectives. Use the grids in Appendices 1 and 2 on pages 41–46 of *Creating a progress culture* to assess your use of these words when phrasing learning objectives and outcomes
- consider the levels/grades of the pupils in your class, and check that the learning objectives are at an appropriate level for the class. If there is insufficient challenge, move up a level on the grids.
- support pupils by modelling how to identify any success criteria linked to the particular context. Organise discussion groups to develop success criteria that are then agreed by the rest of the class
- provide opportunities for pupils to use success criteria to self-assess their work and identify next steps.

Moving from Es4 to En4	An explicit *HSW* learning objective is shared and an appropriate context to develop *HSW* is chosen from the range and content. This is made clear to pupils APP criteria are used to support understanding of progression in skills and to differentiate the outcomes for specific classes, resulting in learning objectives and outcomes that are at an appropriate level of challenge Es4	*HSW* learning objectives and outcomes are personalised for pupils in response to their progress Review of learning against the APP criteria is used to identify next steps and plan future lessons. When periodic assessments have taken place, curricular targets are identified and used to drive the planning for the next term En4

You could try to:

- meet as a department to review pupils' progress after the next round of periodic assessments. Take a sample of work to the meeting to illustrate the different levels of pupils in your group. Agree standards across the department and share ideas about successes and barriers for pupils. Identify any curricular targets across the whole year group, across classes and for certain individuals, and agree intervention processes in the department
- Use the yearly learning objectives for *HSW* to identify those learning objectives that need Quality First teaching and focus on these for the next term. After this time, meet again to evaluate progress.

Moving from Es5 to En5	*HSW* objectives are planned into the scheme of learning so that all skills are represented but there is no clear progression across the key stages Es5	*HSW* objectives and outcomes are mapped progressively across all schemes of learning in Key Stage 3 and Key Stage 4 En5

You could try to:

- if the department has not already done so in the section B activities, use the mapping grids to check for progression in *HSW* (rather than just coverage) in your scheme of learning. Progression may be in place at Key Stage 3 but more dependent on the specification at Key Stage 4. Progression can be checked across all the secondary years by using the Framework yearly learning objectives.

Moving from Es6 to En6	The purpose of practical work and where it fits in the 'big picture' of *HSW* is made explicit to pupils through the learning objectives, e.g. to illustrate a piece of science knowledge, to develop a practical skill or to develop non-practical skills such as argumentation Es6	There is a good understanding of progression in *HSW* and this is used to drive planning at all levels En6

You could try to:

- meet as a department to review pupils' progress after the next round of periodic assessments. Take a sample of work to the meeting to illustrate the different levels of pupils in your group. Agree standards across the department by comparing your work with the APP standards files, and share ideas about successes and barriers for pupils. Identify any learning targets across the whole year group, across classes and for certain individuals, and agree intervention processes in the department
- Use the yearly learning objectives for *HSW* to identify those learning objectives that need Quality First teaching and focus on these for the next term. After this time, meet again to evaluate progress.

Moving from Es7 to En7	In lessons, the learning objectives and outcomes are at an appropriate level of challenge, and pupils are supported to articulate what 'good' looks like (success criteria) Es7	Differentiated outcomes and agreed success criteria are driven by the pupils; these relate to the full range of *HSW* En7

You could try to:

- support pupils by modelling how to identify any *HSW* success criteria linked to the particular context. Use the *HSW* road map in the *Progressing to level 6 and beyond in science* course and associated resources to develop further understanding of aspects of *HSW*, e.g. descriptions for buildings in the pupil or teacher map
- organise discussion groups to develop success criteria that are then agreed by the rest of the class
- provide opportunities for pupils to use these success criteria to self-assess their work and identify next steps.

Evaluation of impact

Use these activities over a period of about four weeks. Monitor the impact by reflecting on learning gains, talking to pupils, teaching assistants and other teachers about the impact. Look at progress with periodic assessments, using APP.

Check the progression grid to see if you have moved forward in your practice.

You could also ask a colleague to watch a lesson with a focus on the area you are trying to improve, and ask them for feedback.

To continue your development, volunteer to coach another member of the department who is also interested in developing their practice.

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Further information

The Framework for secondary science can be accessed at: **www.standards.dcsf.gov.uk/nationalstrategies**. The following related documents can be found on the same website by searching using the document name or reference number.

1. *AfL with APP: developing collaborative school-based approaches – Guidance for senior leaders* – Ref: 00824-2009PDF-EN-01
2. *Assessing Pupils' Progress in science* – Ref: 00036-2009
3. *Progressing to level 6 and beyond in science* – Ref: 00013-2009
4. *Practical strategies to support learning objectives* – Ref: 0932-2009PDF-EN-10
5. *How science works road map* – Ref: 00013-2009POS-EN
6. *How science works questionnaire and survey* – Ref: 00013-2009
7. *Science planning posters – posters to support planning investigations* – Ref: 0367-2002
8. *Literacy in science* – Ref: 0563-2002
9. *Creating a progress culture* – Ref: 0054-2008
10. *Effective demonstrations*, found within the *Developing our future scientists in your school pack* – Ref: 00097-2008PCK-EN
11. *Science learning journal* – Ref: 00932-2009
12. *How science works mapping grids* – Years 7, 8 and 9 – Refs: 00932-2009
13. *Interactive practicals*, found within the *Developing our future scientists in your school pack* – Ref: 00097-2008PCK-EN
14. *How science works pupil speak sheet* – Ref: 00932-2009
15. *Assessment for Learning in science: Supporting APP* – Ref: 00932-2009

Supporting resources

How science works questionnaire

Pupil questionnaire: Please fill in the questionnaire so that we have an idea about how we can help you perform better in your lessons.

For each statement tick the box to show:

a. How often this happens in your lessons **b.** How much it helps you do your work

Subject ..... Set/Group ..... Sex .....

This happens...				It helps me...		
Very often	Sometimes	Rarely or never		Learn a lot	Learn a little	Learn nothing
☺	😐	☹	**1.** You focus on developing skills in science and not just learn about science facts	☺	😐	☹
☺	😐	☹	**2.** The skills that you are developing in science are included in the lesson objectives and outcomes	☺	😐	☹
☺	😐	☹	**3.** You use and develop models to help explain ideas in science	☺	😐	☹
☺	😐	☹	**4.** Lessons include opportunities to ask questions about science	☺	😐	☹
☺	😐	☹	**5.** You talk about and share your opinions about how science impacts on our environment	☺	😐	☹
☺	😐	☹	**6.** You use examples from real-life situations and link these to your learning in school	☺	😐	☹
☺	😐	☹	**7.** Science lessons include opportunities to learn about scientists and how they work	☺	😐	☹
☺	😐	☹	**8.** You are presented with questions or problems in science that you then investigate	☺	😐	☹
☺	😐	☹	**9.** You consider scientific evidence when planning an investigation	☺	😐	☹
☺	😐	☹	**10.** You explain to others what you think you found out from an investigation	☺	😐	☹
☺	😐	☹	**11.** You discuss with others how an investigation might be improved	☺	😐	☹
☺	😐	☹	**12.** you make choices of which type of graph to use to present your results	☺	😐	☹

How science works survey - An example of a spreadsheet to analyse pupil responses in the questionnaire

Sex (B/G)	This happens											
	Skills	L Ob/Outs	Models	Questions	Environment	Real life	Scientists	Inv solve problems	Inv evidence	Inv explain	Inv improve	Graphs & tables
	1	2	3	4	5	6	7	8	9	10	11	12
b	2	2	1	1	3	2	1	1	1	2	2	2
g	3	3	2	3	1	1	1	2	3	2	2	2
g	3	3	3	3	2	2	2	2	2	2	2	2
b	3	3	2	3	1	1	1	2	2	3	3	2
Average	**2.8**	**2.8**	**2.0**	**2.5**	**1.8**	**1.5**	**1.3**	**1.8**	**2.0**	**2.3**	**2.3**	**2.0**
g	1	3	3	3	2	1	2	1	2	3	3	3
g	1	2	2	2	3	2	1	2	1	3	3	2
b	1	1	1	1	1	1	1	1	2	2	2	2
b	2	3	2	1	1	1	1	1	2	3	3	3
Average	**1.3**	**2.3**	**2.0**	**1.8**	**1.3**	**1.3**	**1.3**	**1.3**	**1.8**	**2.8**	**2.8**	**2.5**
b	2	3	1	2	2	2	1	1	3	3	3	1
g	3	2	2	3	1	1	2	1	2	1	2	2
b	3	2	1	2	2	2	1	1	2	1	1	1
g	2	2	1	2	1	1	1	1	2	1	2	1
Average	**2.5**	**2.3**	**1.3**	**2.3**	**1.5**	**1.5**	**1.3**	**1.0**	**2.3**	**1.5**	**2.0**	**1.3**
g	3	3	1	2	2	2	1	3	3	3	3	3
g	3	3	2	2	2	2	1	1	3	3	3	3
b	3	3	2	2	3	2	2	2	3	3	3	3
b	3	3	3	2	3	2	1	3	3	3	3	3
Average	**3.0**	**3.0**	**2.0**	**2.0**	**2.5**	**2.0**	**1.3**	**2.3**	**3.0**	**3.0**	**3.0**	**3.0**

This helps me											
Skills	L Ob/Outs	Models	Questions	Environment	Real life	Scientists	Inv solve problems	Inv evidence	Inv explain	Inv improve	Graphs & tables
1	2	3	4	5	6	7	8	9	10	11	12
2	2	1	2	3	2	1	2	3	2	2	2
3	3	2	3	3	2	1	2	3	2	2	2
3	3	3	3	2	2	2	2	2	2	2	2
3	3	2	3	1	3	1	2	2	3	2	2
2.8	**2.8**	**2.0**	**2.8**	**2.3**	**2.3**	**1.3**	**2.0**	**2.5**	**2.3**	**2.0**	**2.0**
1	3	3	3	2	1	2	1	2	3	3	3
2	2	2	2	3	2	1	2	1	3	3	2
1	1	1	1	1	2	1	3	2	2	2	2
1	3	2	2	1	3	3	2	2	4	3	3
1.3	**2.3**	**2.0**	**2.0**	**1.8**	**2.0**	**1.8**	**2.0**	**1.8**	**3.0**	**2.8**	**2.5**
2	3	1	2	3	2	1	1	2	1	1	1
3	2	1	2	3	1	1	2	2	1	2	2
3	2	1	3	2	2	1	2	2	1	1	2
2	2	2	3	2	1	1	2	2	1	2	1
2.5	**2.3**	**1.3**	**2.5**	**2.5**	**1.5**	**1.0**	**1.8**	**2.0**	**1.0**	**1.5**	**1.5**
3	3	1	2	2	2	2	3	3	2	3	3
3	3	2	2	2	2	1	1	3	3	2	3
3	3	2	2	3	2	1	2	2	2	3	3
3	2	3	2	2	2	1	3	3	2	2	3
3.0	**2.8**	**2.0**	**2.0**	**2.3**	**2.0**	**1.3**	**2.3**	**2.8**	**2.3**	**2.5**	**3.0**

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Science learning journal

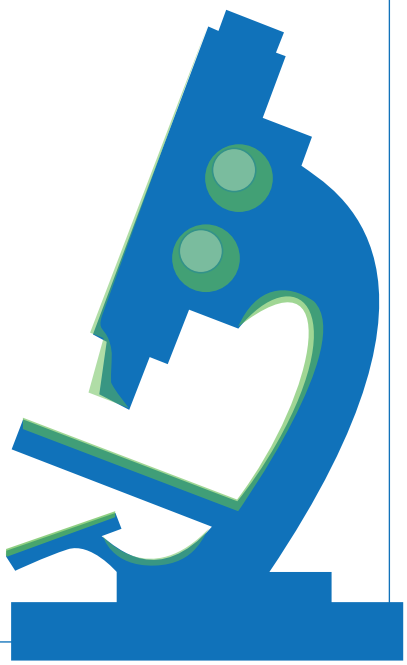
How Science Works focus:	Date:

This week's key words in science were:

The important ideas we have covered this week in science are:

Things I need to improve are:

The question I'd like to ask is:



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How science works pupil speak sheet

I am just starting *How science works*:

- I can draw line graphs, but sometimes I find it hard to get the scale right.
- If someone helps me, I can explain what the shape of the graph shows.
- In practical work, I am usually confident at using the equipment.
- I can make a simple plan for a practical.
- I can choose which measuring instruments to use for a practical.
- I can draw conclusions that match with the evidence I have collected.
- I can look at someone else's evidence and draw a conclusion.
- I can sometimes spot patterns in data.

Where I am

Top tips to improve:

- Practise talking through the 'story of the line' on pre-drawn graphs.
- Break line graphs into sections and see if you can describe each section separately, then put them together to tell the story of the line.
- Practise describing the pattern on a graph (including some with a negative scale) by using '-er, -er' statements such as, the high**er** the temperature, the fast**er** the substance melts).
- When planning, think about the plan, then talk someone else through it, and only then write it down.
- Make sure you know the names and spellings for common pieces of science equipment (for example, measuring cylinder, Bunsen burner, beaker, tripod, gauze, test tube).
- Remember that the **D**ependent variable is usually the one you **D**o not know. The **I**ndependent variable is the one that you (**I**) have decided to measure.

I am improving at *How science works*:

- I can choose scales to show the data clearly on graphs.
- I can explain what the shape of a graph represents.
- I understand graphs with negative scales.
- I can draw conclusions based on evidence and use science to explain my conclusions.
- I know what dependent and independent variables are and I can identify them in experiments.
- I can choose appropriate ranges for variables in my experiments.
- I know that I need to make repeat measurements to increase the reliability of my results.
- I can measure precisely, using several different measuring instruments.
- With some help, I can carry out data analysis that involves calculations.

Top tips to improve:

- Practise drawing graphs with appropriate scales, including negative scales.
- Make sure you understand what a line of best fit is and how to draw one.
- Look for and talk about patterns in data and graphs.
- Know the difference between these three sorts of variable:
  - **Categoric** – variables are sorted into categories, such as colour of eyes, or male and female. There is no particular order.
  - **Ordered** variables such as shoe size or age may be sorted into order. There is an obvious sequence to this sort of variable.
  - **Continuous** variables have a large possible range of values, and a clear sequence; for example, height in cm, mass in g, amount of gas given off in cm^3.
- Always ask yourself if an experiment is 'valid' – does it answer the question it sets out to ask?

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I am taking *How science works* further:

- I know what the line of best fit is and I use it correctly.
- I can identify anomalous results in my own and other people's graphs.
- I can say what the independent and dependent variables are in investigations.
- When I plan experiments, I choose equipment carefully to increase accuracy, for example choosing a graduated pipette rather than a measuring cylinder for small quantities of liquids.
- I can evaluate my experimental planning and identify and explain possible causes of error.
- I understand that sometimes I do not have enough data or evidence to draw a conclusion; in these situations I can say this and suggest what further information needs to be collected.
- I do calculations on my data to find out information such as the rate of reaction, or an average.

Top tips to improve:

- Understand and use these two tricky terms: Interpolate – using a graph, find out information from a data point that lies between two of the points on the graph. Extrapolate: draw the line of best fit beyond the top point to find out a data point that lies beyond the range of data you collected during the experiment.
- Always look at graphs critically – do the points lie close to the line of best fit? If they do not you might wonder if the experiment was carried out accurately. When repeat results have been carried out, are the results close to each other for every trial of the experiment? If not, you might wonder how reliable the results are.
- Try explaining to a friend how to extrapolate or interpolate data points from a graph.
- When planning, consider what possible equipment there is to measure with, then try to choose the equipment that allows you to measure with the highest degree of accuracy.

I am confident and skilled in *How science works:*

- I can interpolate and extrapolate data points from graphs.
- I can suggest reasons for anomalous points on graphs.
- I can identify the variables in an experiment, identify the dependent and independent variable, and suggest which variables should be changed and which should stay the same in order to collect valid data.
- I plan to make my results as accurate and reliable as possible.
- I can look critically at someone else's experimental method and data and suggest improvements to the method to increase reliability and accuracy.

Top tips to improve:

- Always look for ways to comment on how you could improve the accuracy (how close to the true value your results are) or reliability (how sure you are that you would get the same result if you did the experiment over again) of an experiment and make sure you know the difference between these two.
- Be critical of your own and others' experimental procedures; evaluation is often poorly dealt with and yet it is the path to improvement.
- Look for clues in graphs and tables that help you to see where mistakes have been made. Try to work out what in the experimental method could have happened to cause each anomaly.

How science works mapping grids – Years 7, 8 and 9

	HSW mapping grid Year 7	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
1.1 Explanations, argumentation and decisions	**1.1a1** Scientific thinking: developing explanations using models ● Use an existing model or analogy to explain a phenomenon. ● Recognise and explain the value of using models and analogies to clarify explanations.						
	1.1a1 Scientific thinking: challenge and collaboration in the development of explanations ● Recognise that scientists of all disciplines and nationalities often work together to develop explanations. ● Recognise that science cannot yet explain everything.						
	1.1a3 Scientific thinking: developing argument ● Identify a range of scientific data and other evidence to back an argument and the counterclaim in less complex and/or familiar contexts, e.g. establishing a wind farm. ● Recognise that scientific evidence can be used to support or disprove theories.						
	1.1b Applications, implications and cultural understanding ● Describe some of the benefits and drawbacks of scientific developments with which they are familiar. ● Recognise that decisions about the use and application of science and technology are influenced by society and individuals.						
	1.1c Communication for audience and with purpose ● Use key scientific vocabulary and terminology in discussions and written work. ● Identify and use the conventions of various genres for different audiences and purposes in scientific writing.						

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1.2 Practical and enquiry skills	**1.2a** Using investigative approaches: planning an approach ● Describe an appropriate approach to answer a scientific question using a limited range of information and making relevant observations or measurements.						
	1.2b Using investigative approaches: selecting and managing variables ● Recognise the range of variables involved in an investigation and decide which to control.						
	1.2c Using investigative approaches: assessing risk and working safely ● Explain how action has been taken to control obvious risk and how methods are adequate for the task.						
	1.2d Using investigative approaches: obtaining and presenting primary evidence ● Describe and record observations and evidence systematically. ● Recognise that the presentation of experimental results through the routine use of tables, bar charts and simple graphs makes it easier to see patterns and trends.						
	1.2e Working critically with primary evidence ● Describe patterns and trends in results and link this evidence to any prediction made. ● Describe and suggest how planning and implementation could be improved.						
	1.2f Working critically with secondary evidence ● Describe patterns and trends in secondary evidence and link these to the prediction or conclusion drawn. ● Recognise that different conclusions may be drawn from secondary data.						

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	HSW mapping grid Year 8	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
1.1 Explanations, argumentation and decisions	**1.1a1** Scientific thinking: developing explanations using models • Describe more than one model to explain the same phenomenon and discuss the strengths and weaknesses of each model. • Describe how the use of a particular model or analogy supports an explanation.						
	1.1a2 Scientific thinking: challenge and collaboration in the development of explanations • Recognise that science is a communal, and therefore fallible, human activity and that different explanations can arise from individual bias. • Recognise questions that the scientific process cannot yet answer.						
	1.1a3 Scientific thinking: developing argument • Identify a range of scientific data and other evidence to back an argument and the counterclaim in more complex and/or less familiar contexts, e.g. use of antibiotics. • Describe how scientific evidence from different sources carries different weight in supporting or disproving theories.						
	1.1b Applications, implications and cultural understanding • Explain some issues, benefits and drawbacks of scientific developments with which they are familiar. • Recognise that decisions about the use and application of science and technology are influenced by society and individuals, and how these could impact on people and the environment.						
	1.1c Communication for audience and with purpose • Use a range of scientific vocabulary and terminology consistently in discussions and written work. • Adapt the stylistic conventions of a range of genres for different audiences and purposes in scientific writing.						

1.2 Practical and enquiry skills	**1.2a** Using investigative approaches: planning an approach ● Describe an appropriate approach to answer a scientific question using sources of evidence and, where appropriate, making relevant observations or measurements using appropriate apparatus.						
	1.2b Using investigative approaches: selecting and managing variables ● Describe and identify key variables in an investigation and assign appropriate values to these.						
	1.2c Using investigative approaches: assessing risk and working safely ● Explain how to take action to control the risks to themselves and others, and demonstrate competence in their practical techniques.						
	1.2d Using investigative approaches: obtaining and presenting primary evidence ● Explain how the observation and the recording methods are appropriate to the task. ● Describe ways in which the presentation of experimental results through the routine use of tables, charts and line graphs makes it easier to see patterns and trends.						
	1.2e Working critically with primary evidence ● Describe how the patterns and trends in the results link to the conclusions drawn and whether the evidence is sufficient. ● Describe and suggest, with reasons, how planning and implementation could be improved.						
	1.2f Working critically with secondary evidence ● Describe what needs to be considered in the collection and manipulation of simple secondary evidence to evaluate the conclusion or interpretation made. ● Recognise that the selection, ordering or rejection of secondary data could lead to different conclusions.						

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	HSW mapping grid Year 9	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
1.1 Explanations, argumentation and decisions	**1.1a1** Scientific thinking: developing explanations using models ● Describe the strengths and weaknesses of a range of available models and select the most appropriate. ● Explain why the manipulation of a model or analogy might be needed to clarify an explanation.						
	1.1a2 Scientific thinking: challenge and collaboration in the development of explanations ● Describe how a bias, a lack of evidence or misconceptions can give rise to inappropriate theories and the role of scientists in questioning these. ● Identify some questions that the scientific process cannot yet completely answer but can contribute to.						
	1.1a3 Scientific thinking: developing argument ● Use criteria to select relevant scientific data and other sources of evidence to support or negate an argument. ● Explain how scientific evidence from a range of sources can be used to support or disprove theories.						
	1.1b Applications, implications and cultural understanding ● Evaluate the issues, benefits and drawbacks of scientific developments with which they are familiar. ● Recognise that different decisions on the use and application of scientific and technological developments may be made in different economic, cultural and social contexts.						
	1.1c Communication for audience and with purpose ● Communicate effectively and use appropriate scientific terminology and conventions in discussion and written work. ● Adapt the stylistic conventions of a wider range of genres for different audiences and purposes in scientific writing.						

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1.2 Practical and enquiry skills	**1.2a** Using investigative approaches: planning an approach • Explain how the planned approach to answer a scientific question was informed by scientific knowledge, understanding or other sources of evidence.						
	1.2b Using investigative approaches: selecting and managing variables • Use and apply independent and dependant variables in an investigation by choosing an appropriate range, number and value for each one.						
	1.2c Using investigative approaches: assessing risk and working safely • Explain how approaches to practical work were adapted to control risk.						
	1.2d Using investigative approaches: obtaining and presenting primary evidence • Use and apply qualitative and quantitative methods to obtain and record sufficient data systematically. • Explain how the presentation of experimental results through the routine use of tables, charts and line graphs makes it easier to see patterns and trends.						
	1.2e Working critically with primary evidence • Explain how patterns and trends in results can be manipulated to be consistent with the evidence gathered and the predictions made. • Explain how improvements to the planning and implementation would have led to the collection of more valid and reliable evidence and a more secure conclusion.						
	1.2f Working critically with secondary evidence • Explain whether the collection and manipulation of secondary evidence is sufficient or insufficient to support the conclusion or interpretation made. • Explain how secondary numerical data has been manipulated to support a particular conclusion or viewpoint.						

Acknowledgements

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00932-2009PDF-EN-01

Audience: Science leaders and teachers
Date of issue: 10-2009
Ref: **00932-2009PDF-EN-01**

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