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SECOND EDITION

The Primary Science Leaders' Survival Guide

WRITTEN FOR PRIMARY SCIENCE SUBJECT LEADERS BY FELLOW PROFESSIONALS

The Association for Science Education
Promoting Excellence in Science Teaching and Learning

The ASE Primary Science Leaders' Survival Guide contains practical advice from fellow professionals on all aspects of delivering science in primary schools and comprises of eight sections.

The publication may be downloaded by primary members of The Association for Science Education at www.ase.org.uk

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The Association for Science Education

Promoting Excellence in Science Teaching and Learning

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These new chapters will be available in the next version of the guide.

INTRODUCTION

Start here...

How to use the Primary Science Leaders' Survival Guide

Author and Hub Editor: Lois Kelly

Purpose of the Subject Leader Guide

Whether you are a newly appointed or an established science subject leader, the role can feel quite overwhelming at times. There is a well know saying "How do you eat an elephant? One bit at a time".

The purpose of this guide is to help you develop your subject leadership role and science in your school by tackling one bit at a time, or to paraphrase David Brailsford, the boss of British Cycling, it is a number of small gains that brings success.

How to use the Subject Leader Guide

Being a science subject leader is just one of several different roles you undertake primary teacher. Each article in this resource has been written as a stand alone document.

Depending on your experience and the context of your school each of you will have different priorities. It is intended that you choose an aspect of your own leadership or an aspect of science that you wish to develop in your school, read and act on the guidance given for that focus. It is not expected that you work through this resource in any particular sequence. It has been divided into sections for ease of use.

The sections are:

Section 1	Developing your school's vision for science
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SECTION 1

Developing your school's vision for science

How to develop a vision for science learning and teaching

Authors: Wendy Precious, Entrust Education and Mary Darby, Keele and North Staffordshire SCITT

Why develop a vision?

Any team that works together for some purpose needs to have a clear vision and understanding of what it is it is trying to achieve if it is to be effective, and in a rapidly changing environment such as education, a clear sense of direction is important to avoid being pulled one way or another by short term crises and other demands.

A vision is a way of communicating to staff, pupils, governors, parents and other adults what the school or subject area stands for and what it is trying to achieve.

A vision for a subject or area provides a focus for action and all effort should be channelled into the realisation of that vision. This is as much about having a long term vision for the future as it is about dealing with immediate obligations. It looks at the current position, but it also takes into account a range of influences that will affect children's education in the future.

How do we develop our vision for science learning and teaching?

Ask staff in pairs consider the following questions and answer each on the coloured card suggested using a marker pen:

- Why is the subject important to you? **[Yellow]**
- What do you believe it offers the children? **[Green]**
- Describe 2 or 3 teaching methods you think are an essential part of teaching science well. **[Blue]**
- What do you want to see happen in this subject over the next three years? **[Lilac]**
- What is the main aim for you as a subject leader with regard to this subject? **[Orange]**

Use the coloured cards to share views and experiences, so that you can create a vision statement that covers these elements/questions.

In conjunction with developing your vision for science learning and teaching you should develop your principles of science teaching which show how the vision will be put into practice in the classroom.

Credit: *We are grateful to Wendy Precious of Entrust and to PSQM for permission to use this guidance www.PSQM.org.uk*

How to develop principles of science teaching

Author: Jane Turner, Primary Science Quality Mark

Why develop principles of science teaching?

- To create a framework for science learning and teaching
- To make explicit what the school values for science learning and teaching are
- To make explicit the expectations for both children and teachers.

The Science Principles should be developed in conjunction with the whole school vision for science learning and teaching. As explained in "How to develop a vision for science learning and teaching" your vision statement is strategic and gives clear sense of direction for science. The science principles show how the vision will be put into practice in the classroom.

How do we develop our principles of science teaching?

Prepare a stack of cards (roughly A6 size) with the heading 'Science teaching at our school is good when…..'

About one week ahead of a staff discussion session place a ballot box in central location. Place a stack of the cards by the box. Place an instruction card on box with following instructions:

"Over the next week please complete as many of these cards as you wish. Complete the sentence 'Science teaching at our school is good when…' Please use one card for each idea."

The day before the discussion session, empty the box & review the responses. You should hopefully have around 15-20 ideas. If there are strange ones, leave them out, you are creating a list of the most common responses. If necessary add ideas you believe should be there.

At the start of the discussion session either give out the list or ask pairs to rank them from 1 upwards or have the ideas on cards (one idea per card) and ask the staff to create a diamond rank of importance or produce a continuum line in order to rank the cards. Photographs can be taken as future reference as well as recording the ranking score (the lower the number the more important the idea is) when amalgamating the different pairs/groups ordering. It is important to allow plenty of discussion time for the ranking, and for the addition of further ideas if necessary. Aim for no more than 10 principles agreed by the staff.

These collectively produced ideas need to be actioned in order to achieve the desired outcome. Use them as part the School Development Plan, as well as a focus for monitoring during the year.

You need to consider how you will share these principles with the whole school and the wider community so that they are seen as underpinning science in the school.

You can also invite children to complete "Science is good when…." cards and compare these with the staff's principles of science teaching. How similar are the two sets of principles? Consider if any of the children's ideas should be adopted and become part of the whole school principles of science teaching.

Review the principles of science teaching regularly throughout the year. This will help you monitor progress towards the outcomes for science identified in the School Development Plan.

Credit: *This guide is taken from the PSQM Principles of Science criteria activity. (www.psqm.org.uk)*

How to raise the profile of science

Author: Rachael Webb

Introduction

Raising the profile of science across your school has benefits not only for science but also for other subjects including English and Maths. Studies with older pupils have shown links between raising attainment in science and improved results in Maths and English. In his commentary for May 2016 Ofsted's Chief Inspector Sir Michael Wilshaw noted that "Inspectors found that the best primary schools are capable of providing effective teaching in science, foreign languages and all other subjects, without undermining pupils' progress in literacy and numeracy. The best primary schools recognise that providing excellent teaching in subjects like foreign languages and science promotes good literacy and numeracy skills. This complements, rather than detracts from, the focus on English and mathematics" It should not be an either/or situation.

Strategies to support raising the profile of science across school

A brief overview of strategies which help to raise the profile of science is given here and are developed more fully throughout this resource .The strategies outlined below can be used in isolation but consider implementing 2 or 3 each year and build on these to ensure the profile of science continues to grow within in your setting.

Effective science displays making science visible around school

Encourage staff to have a science display in their classroom. You could have this as a target for each half term/unit.

A science display must: Be visually appealing, include essential vocabulary and everyday language, include questions generated by children and include questions to get children thinking like a scientist. Ideally it will be interactive.

Children can be asked to photograph their classroom display and these can be shared at a staff meeting and added to a corridor display showing 'Science in our School'.

Encourage staff to add one other photograph to the corridor display each half term of something exciting they have done in their science lessons.

Once classroom displays and the 'Science in our School' corridor display have been established progress teachers on to turning their displays into 'Learning Walls'.(Put hyperlink to Working Walls here)

Encourage a discussion by teachers of the different examples of display across the school – either, visit each other's classes during a staff meeting or share photographs of each other's science walls. What positive feedback can they share? What could they try next in their own classroom?

Visits and visitors encouraged in each classroom

Encourage staff to plan a visit out of school or visitor to their class for every science unit they plan (or at least twice in the year). This will encourage children to see how science is relevant to their everyday life, can help to engage children about careers/jobs that involve science and makes the learning experience more engaging and memorable – we all remember, with fondness, a trip out of school from our younger days.

As a staff, brainstorm all the potential opportunities;

- in your immediate locality (e.g. florists, garden centres, dentist, park, meadow, woodland, supermarket, etc.)
- further afield (museums, science centres, zoos, etc.)
- inks with business
- expertise within your parents / grandparents

Ask parents if they might be prepared to share their interest, job or experience with children during a topic or science event. You never know how many budding astronomers, chefs, nurses, engineers, etc. that you might have. Even a hobby such as making soap or candles can be a wonderful experience to share with the children.

"Engage parents and children by encouraging them to take part in science at home either through a science competition"

Image Credit: © ASE - CLEAPSS Competition winners as the ASE Annual Conference

Make a calendar for each half term

Encourage use of a calendar on a display board in the staffroom or shared area and ask staff to add their planned visit or visitor to the grid. Photographs from the events can be added by the children to enhance the 'Science In Our School' display. Alternatively, images can be added to a television screen in the entrance scrolling through photographs of exciting science opportunities from across the age phases. Why not try a Science theatre group to come and run a show for the whole school too?

Science appears in the school newsletter more frequently

Have a 'Science Corner' included in the school newsletter once per half term (or build this up to once per week). This can include information about an interesting science experience from a specific class, a science experiment to try at home, a new resource linked to science, a science fact researched by some pupils, a link to science in the news, a request for volunteers to help with the class allotments or indeed anything linked to the wonderful world of science.

A science day, week or event planned across the school[1]

A special science event can raise the profile of science as a subject and can engage and motivate the children and adults. Why not teach Science for a whole day and do some exciting experiments to get everyone switched on to science? You are bound to get some cross-curricular mathematics and English in there too!

A science after school club is set up to support keen scientists

A science club can be used to provide extra-curricular opportunities with a science theme. A club can be run in various ways, either;

- Engaging practical science ideas planned by the teacher using some of the ideas from the websites (Planning a science week) or
- Run by a teacher using the CREST awards scheme (Creativity in Engineering, Science and Technology). The award scheme is free to join and can support the club with free downloadable ideas and projects and for a small charge certificates and badges for completion of the 3 different award levels (Star, SuperStar and MegaStar Packs available). By using CREST star resources teachers will be getting children involved in a national initiative which is often extended at high school.[2]

1 British Science Week is an annual event that take places every March. Find out more www.britishscienceweek.org/

2 For more information visit www.crestawards.org/run-crest-awards/crest-star/

- A club can be run by an outside agent such as MadScience however this can be a little expensive for some parents thus not making it as accessible as the previous two options.

Home and school science projects

Encourage practical science based homework across the age phases. Engage parents and children by encouraging them to take part in science at home either through a science competition, science homework or a practical science activity.

Involve parents in science events or arrange a parent science workshop

Links with local secondary school for science support and transition projects

To add to children's experiences and to support visits and visitors linked to science why not make links with the local high school(s) to see how they can raise the profile of science amongst your pupils. It might be a visit to their science department, a link to a science careers day or they might even be planning a gifted and talented science day for primary aged children (quite a few science specialist high schools run events such as this).

Make links with the wider science community

Can children bring science into their local community and run some community events linked to healthy eating, gardening projects (try guerrilla gardening), community cooking, etc.

Consider getting children involved in National initiatives / competitions e.g. RSPB Birdwatch, RHS Campaign for School Gardening, British Science Week, STEM projects, The Big Bang, Great Bug Hunt, Eco Schools/Flag, etc. (start by involving science club participants then include others).

Have a 'sharing good practice' section in staff meetings

Either every term or half term, this will encourage positive comments linked to good practice science that is occurring across the school.

Ask staff to share an example of something that went well in their science lesson. As a subject leader you may need to exemplify this over the first few sessions then begin to ask others to contribute. Your positivity will be infectious, lead by example.

Have a science section on your school website

Have a gallery of photographs to represent engaging science across the school as well as a section of children's work exemplifying standards in science. These samples can be built up over time from monitoring activities linked to sharing children's work.

Set up a science blog or a school science twitter account

For inspiration, visit 'Lab13 Network' blog on the internet to see how some primary children report the exciting science in their school. Even if you do not start your own blog it is full of useful ideas and projects to use in your own school or classroom.

Pupil Voice activities

To ensure children's views on science are voiced and acted upon wherever possible. Include questions such as 'What would you like to see more of in science?' and 'What would make the perfect science lesson?' After asking to see more explosions in the first few pupil voice sessions, the children begin to get even more imaginative especially if they know their ideas will be acted upon – within reason!

> *Teacher: "What would be the perfect science lesson?"*
>
> *Y5 pupil: "Go to Las Vegas to learn about electricity and an aquarium to study fish"*

Well nearly everything is possible!

References

Ofsted (2016) HMCI'S monthly commentary May 2016. Available at www.gov.uk/government/speeches/hmcis-monthly-commentary-may-2016

We are grateful to Rachael Webb of Lancashire Grid for Learning for permission to use this guide.

How to write a science policy

Author: Tara Livesley

Why do we need a Science Policy?

What is it for?

In short a science policy, in fact any policy, is a statement of 'how things are done in our place'. It is intended to be a reference document for those that are new to the establishment to ensure that they follow the same procedures and protocols as the rest of the staff. It doesn't have to be long: a couple of sentences may be all that some procedures in the policy may take.

Unlike an 'action plan' this is not a living document, although over time revisions will need to be made. However instead of annotating the policy, it is reviewed on a regular basis, normally every 2-3 years to ensure that any new practices are incorporated.

The school's principles and vision statements complement the policy and can be included in appendices but they stand alone as overarching statements of the purpose and practice of science in your school and will not include the detail of a policy document (see *How to develop a vision* statement and *How to develop science principles*).

What should a Science Policy include?

These are some headings and questions you might like to think about when writing a policy for science.

Rationale

- What is the school's belief about the subject?
- Include how and when the policy originated, as well as review date (usually about 2 or 3 years)
- This could be extracted from the NC, Ofsted or even PSQM.
- How does it fit in with the school and subject development plans?

Aims, Objectives and Expectations

- What are the expectations for the end of significant milestones along the primary age range, e.g. Y2; Y6 in England; P4; P7 in Scotland

Progression

- What Scheme of Work do you follow in each stage?
- What is the premise behind it? e.g. creativity; development of skills; knowledge and understanding being developed etc?
- How do you ensure that it is progressive and continuous?

Learning and Teaching

- How much timetable time is allocated? Is this a percentage of the timetable or a set number of hours per week or half-term?
- How is it taught – themed, standalone etc?
- Do you use a pro-forma for planning? What level of detail do you expect?
- What cross curricular links are made?
- What recording methods will you use e.g. Floor Book; Mind/Concept Maps; Rough books etc

Inclusion

- How does it relate to the school's equal opportunities policies?
- What arrangements do you work in – set/ whole class/small groups/ability run etc?
- How do you support less able/more able? How do you recognise them?
- How do you ensure children with disabilities can access the curriculum?
- What arrangements do you have for supporting those with EAL?

Learning Environment

- What is the display like? How often should it be changed? What should it include?
- Are there any things that should always be displayed?

Monitoring

- How do you set out the monitoring?
- What do you monitor and how often? Is it a rolling programme?

Assessment

- What kinds of assessment do you use? Is it formative/summative/teacher/test etc.?
- What do you do with the information? How often do you do review this? Why?

Marking and Feedback

- How often do you mark work? What does feedback look like? How do the pupils respond?

Resourcing

- Where are resources located and how are they organised?
- What is your spend per year? What about ICT?

Health and Safety

- How do you risk assess? What support do you use for this, e.g. ASE *Be Safe!* and CLEAPSS?
- How is it related to the whole school's policy on health and safety?

Appendices

- Other useful documents that might help the subject might be included in a 'handbook'. E.g. the science principles for your school; suggestions for visits and visitors to enhance science experiences; organisations and websites that support teachers' CPD

Review

- When will you review this policy?

What do you do first?

Dig out your old policy and see if it does cover these points. You could also contact a colleague in a local school, to go through your policies together. This may be an opportunity for networking, especially if this is missing in your local area. Contact your ASE field officer or your local PSQM hubleader if you are part of these networks for links to other schools.

Useful Reading

CLEAPSS guide to being a co-ordinator, available to download from: www.cleapss.org.uk

SECTION 2

Leading science in your school

- Self-evaluation and monitoring
- Moving forward

How to carry out a 'book' scrutiny

Authors: Wendy Precious, Entrust Education and Mary Darby, Keele and North Staffordshire SCITT

Purpose

The purpose of a 'book' scrutiny is to support building up a picture of the profile and quality of science teaching in the school by looking at what and how children have recorded and communicated their science learning. 'The word 'book' is used in its widest sense as the scrutiny could include floor books and electronic devices such as ipads'.

Recording in Science is often much debated and reflecting on the evidence in books in terms of how what the children recorded added to learning can be a really valuable discussion. We recommend that you focus on the quality of what is recorded in the books not the quantity of written work. You should consider:

- Is the recording purposeful and linked to the Learning Objective?
- Do the books record what was learned or what was done?

How many books?

It is important to get a good spread of achievement in the sample of books, whilst at the same time being realistic about how many books can be looked at in the time available. Your school may have a policy about how to choose your sample. You may ask for books from specific children, or for one or two books from higher, middle and lower achievers. If you use floor books these can form the focus of a book scrutiny.

Who?

You might want to involve staff, governors and even pupils in looking at the books. It needs to be realised that not all science learning will be present in the books. This is why it is often advantageous for staff to be involved in scrutinising their own books as they can discuss the learning which has not been captured in the books.

Focus?

Prior to the book scrutiny you will want to make sure everyone knows the purpose and what is expected. You might decide to do a termly check to make sure certain things that have been agreed are happening (i.e. maintenance) e.g. whether the long term plan is followed. At other times you might want to do more focused book scrutinies with staff involvement on specific areas that are being developed.

Example book scrutiny checklist

The following table is an example of what might be looked for. This way reflective discussion allows strengths and ideas to be shared and issues to be resolved.

Curriculum	Long term plan is followed. There is continuity and progression between topics and year groups		Teacher name and year group:
	Children are learning from their own starting points (AfL)		
	Appropriate levels of challenge are being set		Improvements since last scrutiny:
	Links to ICT, literacy and mathematical skills		
Learning gains	Development of scientific vocabulary		Strengths to share:
	Opportunities to apply learn in different contexts		
	Working scientifically skills/ understanding of concepts are developed progressively for different groups		
	Approaches to teaching and learning support breadth and depth of understanding		Areas to develop further:
Teaching Approaches	Feedback is appropriate and manageable Identifies misunderstandings, strengths Promotes critical reflection, checks / challenges understanding		
Feedback	Children respond to feedback		

How to carry out a lesson observation

Author: Caroline Galpin

Effective Lesson Observations by supporting self-review

One of the most important and challenging requirements of your role as Science Leader is to know about the teaching and learning of Science across the school. Monitoring can take many forms, but classroom observations are one of the most purposeful and effect ways of doing this, especially if approached in the way suggested here. This document, therefore offers an approach to lesson observations which is non-judgmental, does not involve grades and helps teachers to be self-reflective.

Why supported self-review?

Lesson observations can be extremely stressful for teachers, but they need not be so. Supporting them plan, deliver and review a science lesson not only helps teachers identify a specific area for their own development and guides them through the process, it also results in deeper thinking about strategies and approaches for improving practice. Targets can be integrated with Performance Management or not, as appropriate.

The process will also help you, as Science leader, understand teaching and learning in a way that planning and book scrutinies, learning walks and drop-ins will not.

What will it tell me?

- About the range of teaching and learning across the school - approaches and quality
- How resources are being used as well as their availability and quality
- How teachers plan, including their confidence/ ability within Science. (If further support /CPD is needed)
- Assessment approaches and how teachers make and act on judgments.
- If children enjoy their science lessons

How could I do it?

- Ask teachers to complete a personal self-review for Science including confidence with their own subject knowledge and understanding, planning/carrying out effective/ dynamic lessons (working scientifically/child-led) and making accurate and informative assessments.
- Help teachers identify an area for improvement and use this to agree a focus for the lesson observation.
- Support planning by reminding teachers of the key ingredients of an outstanding lesson.
- Observe the agreed lesson focus and give the teacher quality feedback
- Encourage the teacher to reflect on the lesson

Feedback

This is an important aspect of the process and should support the teacher to reflect on the lesson against the agreed focus. Here are some ideas about how you could do it.

- Talk me through the lesson from your perspective. Did it go as you expected? Did you achieve your goals?
- What told you that it was going well?
- How well did the children attain and progress?
- I observed the following …….
- I have questions about ….
- What will you do next?
- What further support would you like?

The impact on teaching and learning

- Enables and supports teachers to reflect on their own practice – the catalyst for improvement
- Teachers will be better informed about their own strengths and weaknesses so they can raise standards
- Learners have appropriate challenge and make relevant progress during lessons
- Science leaders are informed about the provision of Science throughout the school and have a tool for improvement
- Science leaders have an evidence base for reports to SMT, Governors, Ofsted etc

Supporting self-review can be time consuming as it involves pre and post lesson discussions, but these are the very factors that make it so effective. They can be kept manageable by concentrating on the agreed focus.

School policy on lesson observations must be observed and agreed with SMT to endorse this approach.

How to carry out a learning walk

Authors: Wendy Precious and Mary Darby

Purpose

You can use learning walks to gain an overview of science in the school, identifying areas of strength to share and areas to develop, they can also be a quick check to see if agreed developments are in place. Learning walks can include aspects such as the learning environment right through to aspects of teaching and classroom management. To build up a truer picture you might want to link this with a more in depth look at pupils' books, planning and pupils' voice.

Who?

You might decide to do the learning walk paired up with someone from a different phase or role in school, a governor or even with a pupil! Paired walks give a great opportunity for discussion on what was seen, heard and felt.

Prior to the learning walk you will want to make sure everyone knows the purpose and what is expected of them. You may want to ensure that science is being taught as you do the learning walk, that books are available and that you can talk to pupils. Making the science principles a focus for a learning walk with a governor is a good way to share the school's vision for science with the governing body. As science develops you might want to make the focus more specific. A clear vision and what this vision might look like in practice will help everyone, staff, pupils, parents, governors to know what is being looked for and to strive to improve science teaching and learning.

Carrying out the learning walk

You might want to take an ipad or camera to record what you see. Photograph the environment, examples of children's learning i.e. drawings, writing and examples of them 'doing' science. This can then provide a good focus for reflection and discussion with staff.

See the checklist overleaf.

This is not an exhaustive list and you may choose to look for other aspects which support science teaching and learning.

Checklist for carrying out a learning walk

Focus	Examples	Questions	Next steps
Does the learning environment support learning?	Evidence of Science vision / Examples of what is expected at the end of the year / Examples of displays - Are any displays interactive? Examples of what success looks like? Aid memoirs e.g. vocabulary, model predictions/ conclusions/scaffolds,labels to encourage independence Foster curiosity e.g. wonder wall, question table, science role play area, interactive area, learning walls in use, room set out for easy access to resources.	What helps you learn well in science? How well are you doing in Science? How do you know? What will you do to get even better at Science?	
Who is doing the talking?	Do pupils get the opportunity to get actively involved?	Do you get chance to ask your own questions, investigate your own ideas in Science?	
Is there opportunity for independence/ interaction?	Can the pupils work independently, together in pairs, groups etc?	Do you get chance to work on your own or in groups in Science?	
Is the setting appropriate for that style of lesson?	Are pupils sitting in groups/working in pairs? Can they all see what is going on?	How do you like to work in science? How does working this way help you to learn? Do you work in different ways for different science activities?	
Are all pupils on task?	Are they engaged and actively involved in the task? Does the activity foster curiosity? Are there sufficient resources to enable all children to learn?	When do you find science most exciting? What helps you when you are stuck in science?	
Do the pupils know what they are learning as opposed to what they are doing?	Can they say what they are learning and why?	What are you learning about today? Why might it be useful to learn that? What skills are you developing? How do you think you are learning to work like a scientist? How do you use your literacy and maths skills in science?	
How does feedback and questioning support learning?	Does the teacher use questions and statements that support and challenge all pupils? What kinds of questions/statements are being used? Are they appropriately pitched? Is any time given for reflection?	How does the teacher help you to think about your science learning?	
How does the teacher use modelling and demonstrating to support learning?	Do the pupils know the final picture? Does the teacher model and promote the use of scientific vocabulary Does the teacher demonstrate how to get there in clear easy steps?	How do you know how to be successful in science? What kinds of things does the teacher do to help you?	
Problem-solving	Are the pupils given opportunities that challenge their own thinking? Can they work together to develop solutions?	What kinds of problems do you get to solve in Science? Do you do them together or on your own?	
Planning	How does the lesson fit into the learning sequence? Does the teacher audit previous learning? How is it adapted in the light of children's responses? Evidence of challenge for deeper learning? How do mini plenaries support addressing alternate ideas, deepening learning?	Do you get to investigate your own questions? What kinds of investigations do you use? What ways do you use to find answers to your questions?	
How do support staff promote learning?	How are they deployed?	Who does the teaching assistant work with and why?	
How is assessment used to support learning?	Who is with the target group and what are they focussing on? Are they engaged? Are the pupils involved in their own assessments? Do they know what they have to do next to be successful and develop further?	Can you tell me some of the things you have done in Science? Show me some science you were proud of? What are you dissatisfied with? Do you sometimes get chance to look back at what you have learned and see how well you did? Do you sometimes give other children your opinions on their learning? Do you get chance to discuss your learning?	

How to write a development (action) plan

Author: Carol Sampey and Rachael Webb

Introduction

Once you have carried out an audit of science provision in your school and identified areas of development, you will need an action plan to ensure that you achieve your goals within the coming year. As a school, you may want to start on something new, build on existing strengths or work on scientific skills in need of improvement.

What does a good action plan look like?

Targets	Tips to help you write your action plan
Specfic	**What** actions/changes do you want to occur? - Be clear about both the objective and the impact on the children's learning in Science that you want to achieve. - Ensure that the objectives are clearly worded
Measurable	**How** will you track/measure the progress you are making? - Identify your Success Criteria before deciding on the actions to be taken.
Agreed	**Who** will carry out the changes? **What** resources (eg. money, staff) are needed? - Make sure that you have agreed the objectives with SLT before sharing them with the rest of the staff, (teachers and teaching assistants), governors and children, if appropriate.
Realistic	Targets should be stretching but try not to plan to do too much – keep it manageable!
Time scale	**When** will the changes take place? - Give dates the targets should be achieved and reviewed by.

Creating an effective action plan is a skill in itself! The key to success is to make sure that your objectives are SMART (Smart, Measurable, Agreed, Realistic and Time Bound). In reality, this means determining the important Who/What/How/When steps to help make your vision a reality.

Potential focus for development:

New Subject Leader

- Effective displays visible around school (Essential vocabulary and everyday language, questions generated by children, etc.)
- Visits / visitors encouraged in each classroom (incl. parents' database of jobs/skills) – calendar of events
- Have a science section on school website
- Development of outdoor learning (esp. for plants initially) – RHS Campaign for School Gardening

Developing subject leader

- ICT resources purchased for use in Science
- Science day/week/event planned
- Science after school club e.g. CREST awards
- Learning walls - a display board in the classroom that is used to document the development of a topic for the whole class, using children's drawing, writing and photographs, annotated by the teachers for younger children.
- Home / school science project or practical Science based homework
- Science appears in the school newsletter more frequently
- Links with local secondary school for Science support and transition projects

Experienced subject leader

- Links with wider community
- Involve parents in science events or arrange a parent science workshop
- Involvement in National initiatives / competitions e.g. RSPB Birdwatch, National Science Week, STEM projects, Big Bang, Great Bug Hunt, etc. (start by involving science club participants then include others)
- Set up a science blog / science twitter
- Share experiences with other schools and support the development of Science within a cluster / network.

When you have collated your ideas together, review your completed action plan and ask yourself are my action points clear and SMART?

Formats for Action Plans vary and will depend on how your headteacher has set out the overall school development plan. Below are examples of two different formats:

Example 1

Action points arising from:	Action to be taken	By Whom and when?	What will success look like?
Current standards	Lead a staff meeting on the changes in the new curriculum and expectations Continue to improve the children's Working Scientifically skills so that they are clear what makes a good scientist.	SL to lead staff meeting Re. changes in Term 1 (during September) All staff to focus on skills supported by SL as necessary. (in a team teach/ coaching role)	Teachers are clear about changes to year group expectations in terms of: • knowledge and understanding • the progression of Scientific skills (Working Scientifically) At least 95% of children have met end of milestone standards in KS1, Lower KS2 and Upper KS2 in both Knowledge and Understanding and Working Scientifically.
Curriculum and policy	Review and Update Science policy	SL By March	Science Policy updated to take account of changes in the new curriculum.
Planning	SL to support classes as necessary – plan/ teach alongside/ coach	SL through terms 3-6	Teachers are confident to plan a wide range of experiences and to develop targeted Working Scientifically skills. Lesson Observations show that all teaching is at least good in Science.
The children's experience	All Teachers to involve children in their own self -assessment of Science Skills - make greater use of "Science Stars" to give verbal feedback during lessons and through AfL marking eg. ask further questions to clarify or deepen learning. - give reflection time next lesson to ensure that children read and respond.	All staff from T2.	Science monitoring in June (observations/Book Scrutiny and talking to children) reveals that children: • are aware of the "Science Star" skills. • have a secure understanding of how to improve their learning and make good progress in the Scientific skills. • there is evidence of "green for growth" marking and pupil response
Resource needs	Develop a "Tinkering Table" in FS2 classroom to encourage scientific exploration and questioning.	FS2 teacher to research and source resources to be paid for from Science budget	Children in FS2 are able to explore and ask own questions about a range of materials related to the world around them thereby developing their observation, dexterity and communication skills.
Staff Development Needs	Train 2 new teachers in use of "Science stars"	SL to hold a meeting with teachers concerned and give support with planning/ in class as needed.	As a result of training Staff report (and demonstrate in lessons) an increased confidence with the "Science Star" system to help them plan and deliver effective Science lessons.

This may look like a lot to achieve during one year, but when you look closely, the major changes which the school wishes to improve are developing effective assessment for learning and the involvement of the children in self – assessment. Two areas on this plan (Curriculum Policy/Resource needs) will be quicker and more straight forward to achieve, therefore making the complete Action Plan more manageable.

Example 2					
Action point					
Continue to monitor lessons and moderate work • Science leader to plan/ work alongside staff in new age groups. (model the teaching of investigative skills /formative questioning and techniques of ongoing assessment) • SLT to observe a sample of lessons in all Key stages/monitor marking in books	Nov.	Jul.	SL release time/ out of school planning time	Supply Costs	Teachers have a greater awareness of science skills and how to use formative assessment in the classroom to move the learning on. Interviews with children reveal that pupils are aware of the scientific skills and how to improve their own performance. Standards achieved continue to be maintained or improved in KS1 and KS2.
Organise a science week – November • Book a Science show to come in to school. • Provide staff with planning resources/ideas and give staff time in staff meetings to plan activities • Sharing assembly at end of week to celebrate work produced • SL to upload some "Try this at home" ideas on the website	Jun.	Nov.	SL release time to research and organise/plan • a staff meeting • resources for science week	Cost of Science Show £500 approx.	Sharing assembly at end of Science week provides evidence of children's enjoyment as well as their learning. Children are keen to share their learning to parents - reported by Parent Voice/ children bringing in some of the things they have tried at home. Teacher observation reveals that children can explore/question and investigate in a systematic way.
Continue to develop the focus on Outdoor Learning • Allocate an area of the grounds to each year group. • SL to provide support/ideas to help focus Outdoor Learning and ensure children are aware of the variety of life, life cycles and seasonal changes. • Consider teaching strategies to incorporate Darwin inspired learning for developing knowledge and understanding. • SL and parent team have cleaned and prepared The "Exploratory" Classroom ready for use by classes.	Oct.	Jun.	Release time for SL to: • collate Teaching ideas (2 days) • prepare "Exploratory" classroom (1 day) SL to take advice from Parent re. further planting on Darwin Walk SL to attend Darwin Inspired Learning Course	£400 approx £100 approx	Pupils develop science enquiry skills through outdoor learning. Interviews with children reveal that they have an improved knowledge of the plant and animal life in our grounds. (compared to last year). The "Exploratory" classroom is being used regularly by classes and contains displays of children's work.

This example is from a school which has already committed to raising the profile of Science. It contains 3 distinct action points, one of which is continuing to monitor/moderate standards whilst the organising of a science week and developing outdoor learning will require greater financial commitment to make the plan manageable for both Subject Leader and staff to implement.

How to implement and monitor the action plan

Author: Carol Sampey

The Action Plan is complete but what is the best way of achieving success?

1. Keep everyone informed

The Action Plan should be shared with the staff in a staff meeting: it is important to keep everyone informed about what the actions and changes the school is trying to bring about and WHY. Some of the actions may involve only yourself, but where actions require whole staff involvement, you will need to outline HOW the staff will be supported, especially if changes to teaching approaches are required.

2. Plan your time over the year

Look at your plan and map out when you will begin on various actions across the year to make sure that it is manageable. Which actions should be ongoing across the whole year and which can be done more quickly?

Book the release time that you will need so that your SL role doesn't get forgotten in amongst all of the other jobs you have!

Be aware of time pressures at certain times of the school year which may affect the success of your plan so that you can maximise the effects of your efforts.

3. Keep track of what you have done

Ideally do this termly, but certainly review what you have managed to achieve at your half year performance review meeting with a Senior Leader.

Keep several questions in mind for both yourself and others:

- Are we doing what we said we would do?
- Are we doing it well?
- Do we need more time/support to achieve success or change the strategies used?

You can address these questions informally (ask yourself, chat with colleagues/children) as well as using more formal methods eg. surveys.

Informal chats work well as it keeps staff (and or Governors/Children as appropriate) up dated and reminds them of the key actions agreed.

4. Celebrate success with your colleagues and children

Celebration will keep everyone excited and interested in continuing to develop good Science Teaching and Learning next year.

Do not expect to have achieved success in all areas! If you aim for 80% success and 20% to carry over into next year's Action Plan you will have done well!

At the end of the year, you will need to carry out another subject audit. Which success criteria have been met?

You will now be ready to repeat the cycle and begin to plan the Action Plan for next year, thereby building upon your success.

SECTION 3

Developing as a subject leader

How to identify and meet your own CPD needs

Author: Claire Seeley

Why is CPD important?

All primary teachers need to continually reflect on and refine their practice. Continuing professional development extends to any reflective activity with the objective of improving the quality of teaching and learning in schools. It can involve working with peers, further reading, staff meetings, courses, online web discussions and skill sharing. The teaching profession evolves at a rapid pace, good quality CPD enables us to keep abreast of changes and helps us to consider how best to respond.

CPD can have impact on our practice at numerous levels: affecting teachers, children and more widely, organisational change and school improvement. In order to achieve this, good CPD needs to be relevant to teacher's needs and be transferable to the classroom, so that it can become embedded into everyday practice.

How can I identify my own CPD needs?

You may wish to consider:

- What CPD needs have arisen as a result of monitoring and evaluation?
- How could CPD be used to support the school development plan for science?
- Are there any areas of subject knowledge that you need support with?
- Which areas of primary science pedagogy do you need support with?
- If you are a subject leader, what are the needs of your colleagues in terms of CPD?

In order to identify primary science CPD needs, the Subject Leader Audit provides a useful tool for flagging up areas for future development. How about RAG rating your school against each criteria?

Where can I meet my CPD needs?

Sometimes CPD needs can be met 'in house' through skill sharing strategies such as peer coaching and lesson study. Local high schools can often support teachers with training on how to use specific resources or subject knowledge. However it is good to look further afield for new

"How could CPD be used to support the school development plan for science? Which areas of primary science pedagogy do you need support with?"

Image Credit: © ASE - CPD Workshop at the ASE Annual Conference

ideas for primary specific pedagogy and subject knowledge.

Here is a list of CPD providers to get you started:

www.ase.org.uk

In addition to the packed primary programme at the ASE Annual Conference. ASE hold regular regional conferences for primary teachers bringing speakers from across the UK to lead CPD on current issues.

Weekly twitter chats - This is a weekly online science education discussion group open to everyone. Search on twitter for #ASEchat from 8pm on Mondays. This is a great forum, staffed by ASE Primary Science enthusiasts and is a great place to ask questions and receive sound advice.

www.stem.org.uk

The National Stem Centre and Science learning partnerships across the UK run a range of courses enabling teachers to Early Years and Primary settings. These courses can often be funded by Enthuse Awards or Intensive bursaries.

www.pstt.org.uk

The Primary Science Teaching Trust has numerous online CPD units covering topics as varied as Talking Science to Early Years. These units are suitable for individual study or to be used as a basis for staff meetings.

www.reachoutcpd.com

Reach Out CPD is a free online resource to help primary school teachers with the science curriculum. The site has been developed by a team from Imperial College London and Tigtag. Modules cover every area of primary science and draw upon good practice from across the UK.

www.rsc.org/learn-chemistry

The Royal Society of Chemistry has in its primary area a range of video resources exploring Talk for Science through stimuli such as Stories, Puppets and concept cartoons. These films can be used to support your own CPD at home or as part of a staff meeting.

Questions to ask yourself following CPD:

- How will you link your learning back to your work in schools?
- How will this learning impact your children?
- How could this CPD enable you to support the aims of your school development plan for science?
- How will you share your learning with the wider school community?
- What obstacles exist to prevent you from applying your learning? What can you do to remove these obstacles?
- What impact could this CPD have on your school cluster or local area

How to manage your time as Science Subject Leader

Author: Claire Seeley

Whilst the opportunity to lead a subject, to take the strategic lead on something within a school can be a fantastic opportunity; the reality can be that time is in limited supply and it can at times feel like a burden. The most essential task is to manage your time, to prioritise so that you spend your time leading the subject not getting bogged down in organising resources and tidying cupboards.

Before you can lead your subject you need to know the basics about science in your school:

- What is pupil achievement like in science? How do you know?
- Are there any underachieving groups of children?
- What is staff confidence and subject knowledge like?
- What do the pupils think about science?

You also need to establish your levels of support:

- How much time will I be given for subject leadership?
- Do I have a subject governor / parent helpers?
- Do I have dedicated teaching assistant time?
- Do I have a budget for science?
- Are there local people I can call for support?
- What tasks could I ask someone else to help me with?

Once you have established the basics, you need to have a discussion with your senior leadership and work out the priorities for your school. You need to ask if science is on the school development plan and what level of priority is science going to receive from senior leadership. School improvement is a team sport.

The next step is to develop a short action plan. Choose an area for development and break it down:

- What needs developing? Why? How will this impact on children's learning? What changes are you hoping for?
- What CPD and resources are needed to facilitate this improvement?
- How will you monitor the impact of this initiative?

You need to be realistic about subject leadership, ensure you work systematically and steadily, try and achieve something each term. The pace of what you can achieve will be affected by the time you have available. So make your action plan SMART. Set targets for yourself that are:

- Specific
- Measurable
- Attainable
- Relevant
- Ttimely

Here is a list of possible subject leadership tasks. It is important to look after yourself. Subject leadership is a marathon not a sprint, so you will need to prioritise the essential tasks and fit in the other tasks as time allows or share them with other staff members.

Essential Leadership Tasks	Less urgent tasks
Provide a good role model for the teaching of science / trialling new ideas Analyse and evaluate pupil attainment and progress Establish and manage assessment procedures Identify, plan and deliver training for staff - in house or using external specialists Read about latest developments in primary science education Draw up or revise subject policy Monitoring science teaching and learning	Setting up science displays Catalogue resources and order new items Encourage and manage parent helpers Enhance the science curriculum through extra-curricular provision Develop cross curricular links Establish and maintain links with local secondary school and neighbouring primary schools

How to work with other schools and Science Subject Leaders

Author: Peter Sainsbury, Winterbourne Earls CE Primary School

Why work with other schools and Subject Leaders?

Working in a group or network is vital to us if, as Subject Leaders, we are to have the greatest impact on science and in our schools. A successful, collaborative group will enhance the individual, leading to greater impact upon your school and achieving more than you would be able to do on your own.

The role of subject leader is very rewarding, however at any stage in one's career, it can seem daunting to be responsible for the school's development and ultimately performance. Having others with the same subject responsibility and shared curriculum interest gives the support necessary to make the role successful and provides an important, out of school, perspective.

What are the Benefits of Working with other Schools?

You and your School:

- A science group divides the workload; not only making the whole role manageable, but also improving the outcomes of each task and the quality of practice.
- We learn so much with sharing ideas. This is one of the easiest, most exciting and effectively efficient CPD opportunities.
- Engaging with others outside your own school fosters an outward view and keeps you fresh. It is harder to survive in the insular environment of one school.
- It is good to realise you are not alone and there is support. Equally, it is rewarding to offer support and develop others; there are mutual benefits.

The Science Subject Leader Group - what it can achieve?

- Professional development within meetings (sharing good practice, ideas and heads together) and between schools – involvement, buddy work, monitoring / scrutiny.
- The group has ownership of the agenda, and can hold fast to good practice; it is empowering and exciting to be in control of what you do and decide your priorities.
- There is something positive about the collective responsibility, challenging thinking and the holding of each other to account (in a meaningful, friendly way) that motivates and gets things done.
- Sharing development tasks, working in a subject team to feed back and purchasing shared resources all bring financial efficiency; saving money, making it go further and enabling you to do more.
- A number of schools getting together and approaching other organisations is much more attractive than a single school; 'collective clout' opens doors.
- Group CPD gives the ability to target needs and put in appropriate development, or pull in outside providers (and more cheaply). Specific short term CPD projects or longer term projects such as linking with a University to engage in action research or working with a learned society are possible.

You'll know you are there when…

- There is a collective view that what you are doing as a group is worthwhile for you as subject leaders and for your schools. The group, its ideas and above all science are valued and the profile raised.
- Others are ready to take a leadership role, whether it be for a specific science project or overall leadership for a period.
- One sign of a truly established group is that it continues when you aren't able to attend or would be sustainable even if you were to move on.
- The group is proactive and not just reactive. The group is mutually supportive and developmental in a changing world and helps its member leaders and schools to be current and implement policy. However, it also has ideas of its own and matures into having its own agenda for what good science is.

How to: Advice and Guidance

- There are a number of ways in which to engage with other schools; working on a

specific project can be a short term, focussed approach or a means of progressing to establishing a long-term group. By using an existing group MAT to generate the link. A group of schools that already work together for different purposes other than Science such as a local cluster.

- Have a joint event to start things off and gel people and schools together.
- Have a purpose / clear tangible reasons to meet. Either backed by the school in release time within 'working' day or importance is recognised as part of a teacher's additional time and performance management.
- It is good to recognise that there are stages of growing a group or network:
    1. Initiation
    2. Formation and performing
    3. Sustainability
- Be prepared for the odd false start. Patience and tenacity may well be needed but it will be worth it in the end.
- It is important to have one or two people to take overall responsibility and co-ordinate the work of the group (to be the 'science champion/s') otherwise the organisation and initiatives will falter.
- Encouraging and enabling others to contribute, initiate and be active are crucial. Tasking others to take responsibility and following this up is a good way to achieve this.
- Have shared projects that the whole group works on but also general themes that each schools is able to develop individually and feedback.
- Be realistic about how much the group and each individual can do. Having a balance of projects
    a. Some relatively easy to work on and others that will take more work
    b. Some short-term mixed with some long-term ones that will need revisiting to establish good practice.
- Be adventurous and ambitious, try something and, if it doesn't work, decide to move on
- Although this guide's central premise is to meet and work together, social media shouldn't be discounted either as a useful addition or an alternative, whether through necessity or preference.
- If possible some financial input from member schools into a collective pot will help. In addition, groups of schools can look beyond themselves and seek other mean of financial support.

Actions to take now

- Approach your Head or SMT and get them on board. If you are already in an established group your Head will be key to making contact and extending the group's collaboration to science.
- Try to find another person in your area who shares the vision; not essential but very helpful.
- You will need to make a key decision on how to go about ensuring the support and enthusiasm of both Subject Leaders and Head teachers – whether you approach Heads or Subject leaders first will depend upon your circumstances, however, they all need to be engaged and brought on board.
- Locate and invite other Subject Leaders to an initial meeting. If you can, have an initial focus, a positive CPD input or a short sharing of science practice ideas, i.e. a purpose.
- Give schools the option and time to buy into the idea, however, there comes a point when you've encouraged and offered as much as you can and it's time to let them go; not everyone has to join even in an existing group or cluster.

Go for it – there's very little to lose and so much to gain.

Further reading that may be of interest:

'Leading Curriculum Innovation in Primary Schools project: a final report', Mark Brundrett and Diane Duncan, 10 Nov. 2014 Education 3 – 13 (Association for the Study of Primary Education)

'Subject Leadership in Primary Schools – Towards Distributed Practice', Linda Hammersley-Fletcher, 30 July 2007 Education 3 – 13.

'The development of leadership capacity through collaboration in small schools', Jeffery Jones, 30 April 2009 School Leadership and Management.

Although discussing collaboration of children, there are useful, relevant parallels to be found in – 'Developing Advanced Primary Teaching Skills', Denis Hayes, 2012, Routledge.

SECTION 4

Managing and developing science resources

How to audit and manage resources

Authors: Hellen Ward, Canterbury Christ Church University

Introduction

Having high quality resources, which are well managed, is essential to support effective science teaching and learning. Learning how to use science equipment, make mistakes and learn from these mistakes is an important aspect of children's science education.

Having poorly organised and maintained resources is a barrier to good science education. If teachers cannot readily find the resources needed for science investigations and if they cannot rely on them working then they are less likely to provide children with opportunities to carry out practical work themselves. Whilst there is no one way to organise science resources, successful systems generally have the following characteristics:

- resources have been audited;
- there is an up-to-date resource list with pictures and numbers of items;
- there is a method of communicating shortages between teaching staff and the co-ordinator

It is also helpful to have any advice about using the resources included with them e.g. safety guidance on heating with candles.

Auditing and Maintaining resources

What resources do you have?

- Carry out an audit of science resources annually. If it has been a while since they were checked, hold an amnesty and ask for all science equipment to be returned to a central location.

What resources do you need?

- Once audited, it is helpful to compare what is available in your school against the national benchmark produced by SCORE.[1] This was produced in consultation with teachers and indicates whether items are essential or desirable and recommends the quantity needed. This will help you identify what items are needed and help you plan a budget for science. The resources are specified by science themes.
- Whilst a list of essential, desirable and additional items is a useful starting point it shouldn't be left just to the subject leader to make the decisions about resources. Choices should include teachers. In some schools this involvement has promoted more active science lessons as staff are more willing to use equipment, games and activities they have selected. Choice is valuable in all areas of learning and motivation is known to be linked with this. Systems need to be in place for teachers to request resources or make agreed purchases from budgets devolved to classes or year groups.
- Checking the science equipment (resources) is part of this process. Ensure that items that have come to the end of their useful life have been disposed of and, importantly replaced. Develop a system, which works for your school, that allows your colleagues to let you know what needs replacing. Acting on this information in a timely manner makes the difference between effective and ineffective science teaching.

Organisation of Resources

How will you group resources?

- When making this decision remember that some pieces of equipment will be common to a number of science topics, or even subjects, so some flexibility is needed to avoid unnecessary duplication.
- If equipment is not easy to access, or replaced promptly, then within months less enthusiastic teachers will be using this as an excuse for non-practical science lessons.
- Some storage ideas seem to make it easier for the pupils to use and replace the equipment in the classroom before it is returned to a central storage area.

1 www.ase.org.uk/resources/primary/

1. A good starting point for the storage of science equipment and the collection of it by teachers is the colour coding of the boxes and trays. Some schools also use a picture of the item on the side of the box alongside its name to enable teaching and non-teaching staff to identify the resources that they are looking for.
2. Placing all the equipment in the right areas and colour coding them enables equipment to be found and placed back far easier.
3. Having a resource file in each class also enables the children to select their equipment, which is a requirement for the National Curriculum, and also helps younger children learn the names of the items.

- Having a team of 'helpers' is a useful strategy to help you manage the science resources. A number of schools use pupil science ambassadors or pupil technicians in this role, in other schools a teaching assistant may have responsibility for science resources.

Managing Shared Resources

This requires forward planning, an awareness of the needs of the wider curriculum across the school and where appropriate liaison with other subject leaders. For example batteries and motors are both a science resource and a D&T resource. How does your school ensure that if these are used in a D&T project there are still batteries and motors for use in science investgations? Who is responsible for replacing them?

- It is helpful to be clear who is responsible for any IT equipment that is required for science e.g dataloggers and computer microscopes. Is this equipment budgeted for in the IT budget or the science budget?
- Science can often provide a context for studying some genres in English and discussions with the English subject leader about suitable texts will lead to more effective cross-curricular links being developed.

Liaising with other subject leaders to ensure that resources are used effectively to support teaching and learning in both subjects shows the importance of science in many aspects of our lives.

Obtaining free resources

Local secondary schools can be a useful source of science equipment. Liaising with a local secondary school may mean that you are able to borrow resources that are not used frequently e.g. a full size skeleton.

Some organisations make loans of specialised resources e.g. the Royal Microscopical Society, The Linnean Society, the Royal Horticultural Society.

Parents can also be a good source. Send out requests for specific items in the science newsletter, but be sure to check that what you receive is suitable and safe.

How will you find out about new resources?

Keeping informed of new resources is important. ASE's Primary Science journal is a useful source of information as are science subject leader network meetings, CPD courses and ASE conferences both regional and national.

Get feedback from staff after they have taught a unit of work to find out about resources that would have been useful.

Next Steps

- Check the science resources and organise these so they are easily accessible to both staff and pupils
- Use your science ambassadors to help keep science resources well organised
- Set up a system for staff to let you know what needs replacing
- Keep up to date with developments in science resources

How to audit and develop your outdoor provision

Authors: Leigh Hoath and Lois Kelly

Introduction

Working outside is a far more dynamic setting than the classroom – the children are far less likely to discover insects, birds or other jewels within the school building. Auditing the outdoor provision in your school enables you to identify the range of opportunities for teaching science and identify opportunities to develop this. It also highlights those aspects of the science curriculum which will be enhanced by visits to specific sites. For example many schools do not have a school pond, so alternative arrangements need to be made for children to investigate a pond habitat.

Auditing the outdoor provision

Take a learning walk around the outdoor provision with a colleague, a member of the SLT or your link governor. Using your long term science plan / map as a starting point identify opportunities using these areas.

Some questions to think about are:

- What habitats could we study? Habitats do not need to be large areas. A habitat can be a tree, under a stone, under logs as well as a school field or a forest schools area.
- Could we develop other habitats?
- Where can we study plants? Where can plants be grown?
- What seasonal changes can be observed in the outdoor provision?
- How well do the grounds attract and provide for insects and birds?
- Where are the opportunities for children to extend their understanding of the properties and uses of materials? How can we develop this?
- Are there opportunities for children to learn about changes to materials? e.g. changes to materials due to weathering. How can we develop this?
- Are there opportunities for children to explore sounds in the outdoor provision?
- Are there opportunities for children to explore rocks, uses of rocks, soils?
- Are there opportunities to explore the effects of erosion? How could this be developed?
- Are there opportunities for children to explore light and shadows?
- Can we provide opportunities for children to explore forces and the effects of forces?
- Are we providing break time science opportunities?

Resources

Whilst some specific equipment will be needed to support children working outdoors, you will find that several of the resources are suitable for use both inside and outside the classroom (e.g.hand lenses, stop watches, tape measures, light meters). The SCORE science benchmarks are a helpful guide.

How will they record what you want them to? Pencil, paper and clip board may work well but don't be constrained by written evidence of learning. What digital technologies might you use – iPads, digital cameras, digital audio recorders?

To help create wraparound provision a cheap digital microscope that can be linked with your IWB is a great investment – it allows all the children to see tiny creatures in detail and promotes excellent discussion back in the classroom.

Who might help develop outdoor learning opportunities for science?

Some developments may be simple and low cost e.g. re-organising existing resources or thinking differently about how different areas of the school grounds can be used.

There are organisations that can help you develop your outdoor provision for specific purposes e.g. the RHS Growing School Project.

You may be able to enlist the help of parents to help you develop an area of the school grounds.

The Primary Science Teaching Trust have some useful resources for developing your outdoor provision – Science Trails and Garden Watch.

SECTION 5

Working with others

- Supporting you colleagues
- Working with governors
- Transition

How to develop science knowledge

Author: Louise Stubberfield, Wellcome Trust

Introduction

As with any subject, having secure subject knowledge for the science topics you are teaching gives you the confidence to be more creative in your teaching approaches and to encourage children's curiosity. This does not mean that you need to know everything. The good news is that we don't need to be an expert, but we do need to recognise what we don't know so we can avoid our pupils developing misconceptions. We also need to know how to teach science so that children develop their ideas appropriately.

Often we find out that we don't really know something only when something doesn't work quite how we expect or when a child asks an unexpected question. When this happens we need to have the confidence to admit that we don't know an answer or the reason why an activity went wrong.

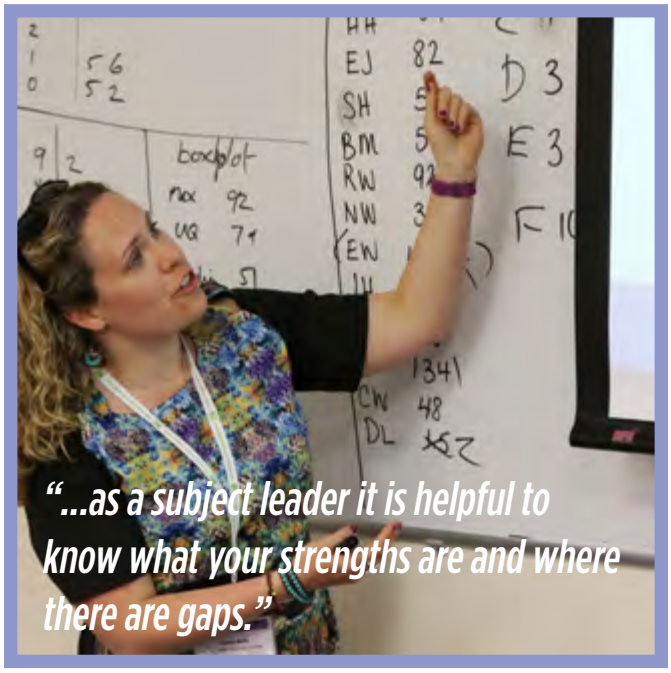
How can we help ourselves and support our colleagues in school to develop subject knowledge?

How to develop subject knowledge

When teaching science there are a number of different aspects of knowledge which will support effective teaching. Knowing your strengths and identifying your gaps and those of your colleagues will improve science teaching and learning.

1. Knowledge of working scientifically

'Science enquiry is what children do in order to answer scientific questions about the world around them.'[1] Are you familiar with the different types of enquiry and how to investigate? Are some teachers confused by variables, the difference between fair and comparative tests for example? ASE has an excellent resource (It's not



Fair – or is it?) that answers all these questions and relates these both to each of the phases in primary schools and to each of the three main science subjects, biology, chemistry and physics.

2. Science specific subject knowledge

Many subject leaders find it challenging to be an expert for every science topic in the curriculum, but as subject leader it is helpful to know what your strengths are and where there are gaps. Start first with the science curriculum and identify which areas of knowledge you are confident about and those that you are not. Encourage your colleagues to do the same for the science curriculum that they must teach their pupils (it could be too daunting to start with all of it!). Concept Cartoons are a good way to help identify these areas and if used in a staff meeting enable staff to support each other with developing confidence with subject knowledge.

There is an expectation that you are able to direct your staff to resources that will develop subject knowledge. It is good practice if you use a published scheme for science to encourage staff to study the science background information provided for the science topics they are expected to teach. If the scheme you are following does not

1 It's not fair - or is it? Jane Turner, Brenda Keogh, Stuart Naylor and Liz Lawrence, Association for Science Education and Millgate House Education, 2011

do this then an alternative is the Nuffield Primary Science Teachers' Guides which can be found on the STEM Learning[2] website for free. Chapter 5 in each guide has excellent background information and each guide also provides teaching ideas.

As a subject leader, if you find some areas of science you (or colleagues) would like to have a better grasp of, taking part in CPD is a worthwhile[3] investment, especially as there is much on offer that is supported by bursaries. Online CPD units can be helpful for staff to do together too.[4]

3. Knowledge of common misconceptions

Children are constantly making sense of the world around them and relating it to what they already know. In science this means that they develop ideas that are appropriate to their age. Good teaching can help them to make good progress, understand better and enjoy science more too. Knowing the common misconceptions that can arise will give you confidence to learn to use these in lessons to promote learning.[5]

Listening to children as they ask questions, explain their ideas to each other, or share their learning, will give you the first indication of any misconceptions that are arising. If you can't be there, looking at pupils' work will help. Check the progress that pupils make over time too in a topic – does their understanding move on, or does it seem to get stuck? Are they writing in their own words, or using words they've heard an adult say?

4. Knowledge of science vocabulary and language

Language and terminology in science can be a tricky issue and lead to misunderstanding too. A word in science can have a different meaning in everyday life. For example, we talk about materials in science – but we don't mean just fabric. When we talk about a "fair test" we don't mean that everyone in the group is able "to have a go".

2 www.stem.org.uk/resources

3 CPD offered by the ASE and the National STEM Learning Network ranges from online CPD to residential courses.

4 The Institute of Physics prepared units for primary teachers hosted on the Primary Science Teaching Trust website pstt.org.uk/resources/cpd-units/supporting-physics-teaching . The Ogden Trust have also prepared CPD units to support physics teaching www.ogdentrust.com/primary-science/primary-resources

5 Misconception's in Primary Science, Michael Allen, 2014, Open University Press, ISBN-13: 978-0335262663

How to run a CPD or staff inset session

Author: David Church, Torridon Junior School

Purpose

The purpose of any staff inset session or CPD session is to enhance teachers' current skill set so that they can support children in their learning of the key scientific concepts and skills.

Knowing your staff team

Before being able to plan for any inset or CPD sessions, it is important to understand the current skill set of the school's teaching staff. This can be achieved in a range of ways, such as carrying out a staff questionnaire, completing a learning walk, conducting a book scrutiny as well as considering how science fits into the school's improvement plan. By completing a range of these activities subject leaders are able to gain a greater insight into the current quality of science teaching and identify the areas for development.

Planning staff inset or CPD sessions

After identifying the areas of development for science teaching and learning at school, consider the priorities and how these can be addressed. Use the planning model to support this; yearly overview (long term), termly (medium term plan), individual sessions (short term). This model allows for a clear vision for improving science teaching and should align with the school's improvement plan.

It is important to consider:

- The aims of the academic year – refer to the school improvement plan. How will this impact on the areas that need to be improved? How will the science inset / cpd support the school improvement plan?
- Focus for each term – Are there particular skills that need to be improved? Are all year groups focusing on area of the curriculum at the same time? How can the inset sessions support this?
- Making links to the curriculum – will it be of use to teachers? Consider the science yearly overview to support the timing of science CPD / inset sessions. What is coming up for teachers? When is the most effective time to deliver a themed staff inset / CPD session?

Delivering effective staff inset or CPD sessions

When delivering inset / CPD sessions, there is a prime opportunity to model good science teaching to colleagues. Ensure that any staff inset / CPD session is engaging for the teachers. Hook them into the staff meeting through a small demonstration or practical activity, preferably linked to the theme of the staff inset / CPD session.

For example, when focusing on improving staff subject knowledge of materials, encourage them to identify a range of different liquids using their senses, or share a new or underused resource from the science cupboard. Do they know what it is called / used for?

Teacher confidence is regularly considered an area of improvement in primary science, therefore, by providing a quick investigation, teachers are able to consider their own subject knowledge and discuss this in a supportive environment before teaching this to their class.

Here are some good ideas when planning a staff inset or CPD session:

- Hook the teachers into the staff inset or CPD session:
    1. Curiosity – use a mystery object
    2. 'Fun' (research shows children find primary science fun, but teachers are anxious)
    3. Start with a working scientifically strategy, such as a concept cartoon for teachers to discuss in small groups
- Use the strands from the curriculum as context for the staff development – this gives it meaning.
- Allow teachers time to explore and experiment with any new resources before using them in class.

Evaluation

After each staff inset or CPD session, it is vital to reflect on what went well and what the next steps are. If possible, ask teachers to discuss if they found the session useful and why. What will they take away that will support children in their learning?

It is important to be flexible and continuously consider adapting further sessions to support teachers with their teaching and children and their learning.

When you next carry out monitoring or have informal opportunities to share the work of colleagues remember to evaluate the impact on teaching and learning of the CPD you provided.

What to do now?

- Look at the school's development plan to identify the school's priorities and how science inset / CPD can support this.
- Get to know your staff team, either conduct a learning walk, or send out a staff questionnaire
- Organise the dates and themes for any inset / CPD sessions for the academic year, agree these with senior leadership
- Contact any external CPD providers to book them for CPD / inset sessions

Providing tailored CPD for Teaching Assistants

Author: Shelagh Hendry

Introduction

Support from confident teaching assistants can enable teachers to deliver more creative and dynamic practical science lessons (2009 EPPI report IOE London).

Research indicates that within primary schools, as little as 3% of class teachers have a science specialism or higher science qualification, with many having a GCSE as their highest biology, chemistry or physics qualification. There is almost no research about the comparative situation of teaching assistants, but it seems not unreasonable to assume that the percentage is even smaller and yet, these are often the adults giving most support to specific groups of children in our classrooms – and are those most often unable to access high quality CPD to support this role.

How to: Advice and Guidance

There are three key areas for support:

- **Scientific Language** – the vocabulary and specialised use of certain terms with other meanings in everyday life
- **Scientific knowledge** – the facts of the topic being taught and learnt, and reasonable extensions of those to be confident in answering children's questions
- **Working Scientifically** – an understanding of the scientific process and how to support children in developing their skills and abilities in this area, including the recording, representing and analysing of results, the five types of science enquiry within the curriculum and the generating of scientifically testable questions

Encourage your colleagues to play to the strengths of their teaching assistants. If one assistant is a keen gardener, new parent or experienced cook, use their enthusiasm and experiences to support appropriate science topics, even if these are not within their usual year group, by negotiating the agreement to a temporary swap. Enthusiasm is infectious.

You could conduct an audit of teaching assistants, using a questionnaire, to ascertain the areas in which they feel insecure, but be aware that we do not always know what we do not know. You could combine this with an audit of your teaching colleagues to identify areas where their teaching assistants seem to be less secure.

You could undertake a series of brief lesson observations with a focus on the teaching assistant and their interaction with pupils in the use of scientific language, scientific knowledge and their support of working scientifically, which would enable you to identify immediate needs and consider appropriate support.

You can keep up to date with CPD on offer in your area with a focus on development for teaching assistants.

You could explore opportunities to share CPD with other nearby schools via a subject network, or perhaps a feeder secondary, again with a focus on teaching assistants.

Teaching assistants have very limited capacity beyond the contracted school day so, if you are fortunate enough to be allowed to deliver internal CPD, you may need to explore the possibility of withdrawal from lesson time for those assistants involved.

Lead by example – use specific vocabulary charts/cards with a very brief meaning for each scientific term to support teaching assistants in using (and assessing the use of) appropriate vocabulary correctly. This might also include some question outlines suitable for the science area being taught. You may find it helpful to also indicate common misconceptions *(eg children often refer to roots of plants 'sucking' or plants 'eating', neither of which are scientifically correct)*

Encourage your colleagues to share basic scientific information on the topic being taught with their teaching assistant as a matter of course – this could be by indicating which area of the curriculum is the focus of specific lessons and which skills are being developed from 'Working Scientifically', or by highlighting the specific scientific language, knowledge and skills to be targeted on a copy of the day/week plan. This is beyond just the learning objective.

Within internal CPD, ensure you have a focus on all three areas of significance, delivered within the context of practical activities to unpick language and understanding. Put the teaching assistants in the position of the children they support.

Ask skilled and experienced teaching assistants to support their colleagues by organising opportunities to discuss science topics, activities and support, perhaps during an Inset or closure day – this can be a very short personalised session when teaching assistants are not attending teacher sessions. If you are unable to attend, ask for very brief feedback to assess how useful this might be.

What to do now:

- Consider how you might assess the need for CPD and which areas of science are of most immediate concern.
- Discuss the capacity of both yourself and teaching assistants to engage in science CPD, the finance available if any and the identified need, with senior leadership.
- Identify sources of CPD available including those on-line.

Further reading

If you would like to develop this further you might like to explore fiendishlyclever.com

How to give constructive feedback to colleagues

Author: Wendy Precious, Entrust Education and Mary Darby, Keele and North Staffordshire SCITT

Purpose

The purpose of feeding back to colleagues is to support and challenge them to develop their practice so that children have improved opportunities to learn and achieve in Science.

Points to consider

When do we feedback to colleagues?

After monitoring activities:

- Lesson observations – peer to peer feedback as part of team teaching as well as feedback from more formal lesson observations helps colleagues to develop their practice
- Learning walk
- Book and planning scrutiny

It is helpful to give feedback on developments in the school action plan

Giving feedback following Pupil voice activity, a survey of teachers or Parents survey can stimulate reflection about what is working and possible developments.

Preparing for the feedback

When preparing for feedback consider how the feedback reflects the school's vision for Science. If staff have ownership of the school vision then this helps them see the benefits of developing their practice.

It might be useful to think about why things you wanted to develop have not been put into place. Could it be that the teacher(s)

- did not understand what you felt needed to be done?
- did not see why it needed to be done?
- did not see what the benefits and advantages might be?
- did not believe what you claimed it would do?

What are the barriers? What could they do as a result? What support will they need?

Are you prepared for any questions? How might you deal with them?

Who will you feedback to?

- Will you feed back to staff as a whole, groups or individuals or a combination. E.g. generic areas of good practice and whole school developments to staff, specifics to groups or individuals.
- Consider how you would feel receiving the feedback. How do you think different people might react? What outcome do you hope to achieve? How will you know that the feedback has improved teaching and learning?
- Conversations might be along the lines of 'when you did this, the children did this? What does this tell us? When we did the book scrutiny we saw this.

What form will the feedback take?

This could be:

- Summaries of findings either to the staff as a whole or to groups or individuals. Will these be written or verbal?
- Planning and book scrutinies, videos of learning walks and lesson observations can provide a focus for reflection and discussion. You might ask staff to feedback strengths and "even better if" against a set of criteria you

have identified.

- Face-face meeting with individuals
- How soon will feedback take place after monitoring?
- Is there an agreed school policy, do staff know when to expect feedback by? Have you let them know?
- Will you feedback on your own or with a more experienced member of staff?
- Who in your school do you think might support you to develop this skill?

Feeding back

When giving feedback start with what went well. Give examples followed by questions such as:

- What do you think the consequences of doing more of this will be on children's learning and achieving the school vision?
- How might doing more of this support others to develop their practice?

Then talk about even better if. Give examples of what you have seen/heard. Explore what the consequences of continuing this will be on children's learning and achieving the school vision. Back up your claim for the change with evidence e.g from action research or research, that you or others are trialling.

- What are the advantages and benefits?
- What will be different for the children?

You might need to arrange to talk further at a later date to give the person time to reflect.

Be approachable, show empathy, but hold people to account to support school vision and principles.

Hot tips

- It is always a privilege to look at teaching and learning, we all learn something, so thanking staff for that privilege is important.
- Give ownership through vision and involving staff
- Explore evidence to agree judgements
- Focus on the what will be better for the children – which often lightens teacher workload
- Share benefits of changing.
- Offer support to develop.

Mentoring Associate Teachers and Newly Qualified Teachers

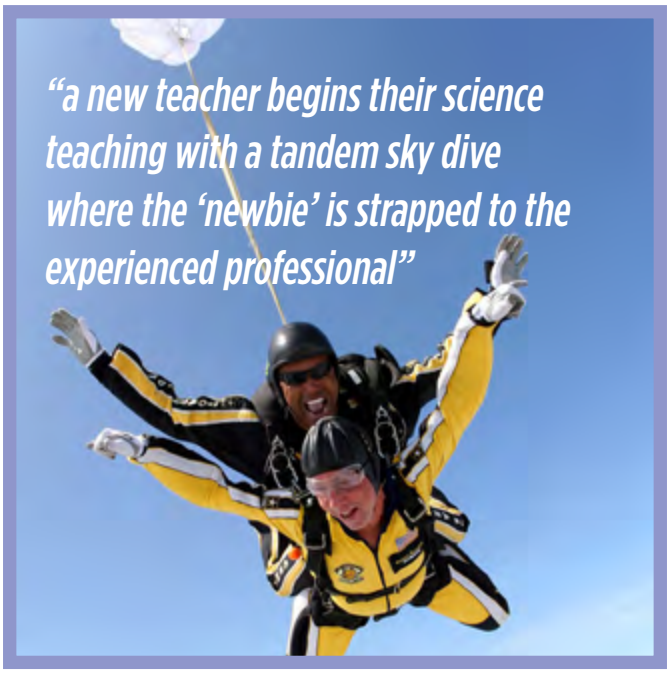
Author: David Allen

Introduction

Both Associate Teachers (ATs) and newly qualified teachers (NQTs) will need support to become successful teachers of science, to maximise their performance, to develop effective science practice and to strengthen their passion for the subject.

It is imperative that all new teachers are empowered and enabled to teach science well and this is why the mentoring process is so very important. During their Initial-Teacher-Training (ITT) associate teachers should observe exemplar science sessions and teach science lessons/ activities whilst on placement. If you are working with a trainee during their ITT it is important to ensure this is facilitated so that these foundations can be built upon during their first year of teaching.

To use an analogy, a new teacher begins their science teaching with a tandem sky dive where the 'newbie' is strapped to the experienced professional. They jump together with many support mechanisms in place to ensure the 'jump' is as safe as it can be. After instruction and training, future solo jumps take place with support and encouragement (accompanied by a parachute and maybe a crash mat).



The mentor, as a 'more experienced other', draws on their professional science teaching experience and science teaching capital to work with the AT/NQT to move towards the shared goal of planning and delivering the very best science learning opportunities for young children. This commonality of purpose is the key to a successful mentor-mentee relationship.

So what should a mentor do?

Build a relationship

Start with swapping histories; share your backgrounds and beliefs in science. Create a firm footing and develop a mutual understanding. This will lead to clearer communication.

Share Commitment

Both parties need to be committed to the mentoring process for the experience to be productive and worthwhile. Make an agreement at your first meeting and establish that you are working together to achieve a common goal. Acknowledge this agreement at the outset and arrange regular meetings.

Empower the Mentee

The roles of mentor and coach are intertwined. As a mentor it is important to support the AT/ NQT and to respond to their needs. As a coach, you will nurture and encourage the mentee to reflect and evaluate by inviting them to find their own solutions. This empowers them to have ownership of their targets and motivates them to achieve.

Communicate

Open the channels of communication so that both parties have an opportunity to engage in active listening. Be open, available, approachable and clear.

Be a Role Model

As a mentor, you are a role model, (epitomising outstanding science teaching) and a facilitator (signposting further CPD opportunities).

Early Days tasks

- Sharing school science processes and practices*
- Highlighting health and safety information*
- Orientation – where is the science equipment?*
- Managing the workload. How to prioritise.*
- Signposting*. Where to go for help: excellent science teachers, resource websites, science organisations, science publications, online tutorials, reference material

Ongoing Key Tasks

- Team teaching*
- Mentee observing best practice, including: lesson observations*, outdoor learning, science visits and visitors
- Mentor observing mentee's lessons*
- Joint planning
- Joint marking
- Joint assessing
- Collaborative problem solving. E.g. how do I overcome this misconception my class has?
- Target setting*. Link to professional standards (government standards, ITT provider's documentation, NQT documentation)

Icing on the cake tasks

- Joint work scrutiny
- Arranging training to fill the gaps in scientific enquiry and substantive science knowledge
- Shadowing of the science subject leader in science event planning

Note: An AT is likely to undertake fewer of these tasks than an NQT. Priority tasks for an AT are marked with an asterisk.

Running an action research science network

Author: Joe Wilson. Eastbury Primary School

Introduction

An action research science network consists of a group of schools working together to research, plan, trial, evaluate and implement change. It has two key benefits:

- providing a systematic framework to make improvements to the teaching and learning of science and pupil outcomes in your school; and
- being a collaborative learning experience which enables the sharing of learning and best practice with other colleagues and professionals.

How do you do it?

First, find a group of schools which share the objective of improving science. This could be based around a teaching school alliance, local authority or multi-academy trust. There is no perfect number of schools: around four to twelve schools should enable a sufficient diversity of skills and approaches without becoming difficult to co-ordinate.

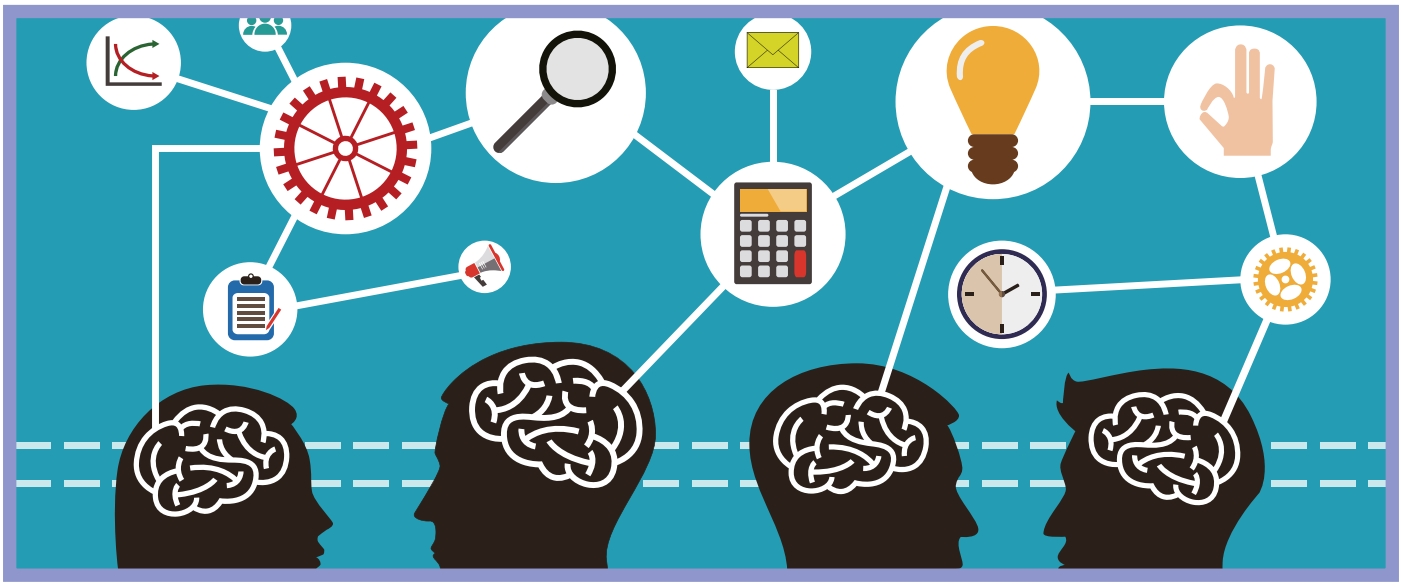
It's not essential, but it is extremely useful to have a 'critical friend' for your network – ideally someone who is both a science education professional and has an understanding of action research. Your local university or STEM consultant may be able to help identify someone. But the most important factor is your leadership of the network - setting up the learning community and guiding network members through the action research process.

You could also consider external funding sources (such as the STEM Enthuse Partnership Award), which might be used to pay for a critical friend or for CPD.

What next?

Once you have your network established, it's time to begin the action research process:

1. Determine a shared strategic focus. What does the network of schools want to improve? Examples might include developing scientific enquiry, closing the gap in science outcomes for disadvantaged children or increasing the engagement of girls in science. The strategic focus is for the network to decide, but make sure that it's a common need for all participating schools, that it's not too narrow and that you have support for this area from your senior leadership team.
2. Read, review and research. The network members should find out about different options for making improvements to their strategic focus area. This is where a critical friend can be really useful in identifying relevant research and literature. But you can also look at the Internet, books, articles (for example in the ASE's Primary Science magazine) and best practice in other schools. From these, produce a list of possible changes that could address your strategic focus area.
3. Plan your change(s). Share your lists with the network and decide what you want to pilot/trial in your school. This does not have to be the same for every school: in fact, there are significant benefits in terms of sharing best practice for the network schools to trial different improvements around the core strategic focus area. The key, however, is planning. As the network leader, provide a template which enables members to plan their change:
    - Describe the change(s) that you are trialing/piloting
    - How are you trialing them? In which class / year group (be realistic in terms of scale!)? What needs to be prepared? What is the timescale?
    - What will success look like? What will pupils and/or staff now be achieving/feeling/doing/saying?
    - How will you measure this? What data do you need to capture at the beginning and the end?



4. Collect the baseline data. You can draw on a wide range of possible qualitative and quantitative data, including attainment and progress data, pupil and/or staff attitude surveys, focus groups, peer observations, reflective journals or comparative data from other classes. You might find it helpful to have a look at the TAPs pyramid model for ideas
5. Pilot/trial your change(s). While individual schools are trialing their changes, the network as a whole continues to have a central role in facilitating an iterative improvement process:
    - sharing best practice as it emerges;
    - giving support and challenge to individual schools – helping them to reflect on the changes being made;
    - providing professional development, particularly in identified areas of shared need;
    - sustaining momentum: ensuring the project as a whole stays on track; and
    - joint determination of next steps.
6. Evaluate the impact. At the end of the trial period, evaluate the success of the changes – comparing them to the baseline data. As with planning, it helps for the network leader to provide a template for the evaluation report or poster. Network members can then present these to each other and decide on …
7. …Roll-out. Which changes will you implement across your school to achieve your original strategic focus? Will these include elements from other network schools? What CPD will be required for staff to support them in implementation? The network is still important during this roll-out period: providing support in change management, addressing issues as they emerge and continuing to share best practice.

Finally, you can celebrate the impact you have made on science through the action research network!

Further Reading

If you would like to develop this further you might like to read:

http://infed.org/research/b-actres.htm

http://groupspaces.com/eednet/pages/about-us/action-research

For information on STEM Enthuse Parternship awards see https://www.stem.org.uk/community/groups/37348/enthuse-partnership-awards/105631

How to make effective links with secondary schools

Author: Kirsten Mould

Introduction

In the school life of a child, there are many transition points. But when it includes a move to a new school they become particularly significant. There are issues around repeating work, a changing environment and culture of learning, value of previous learning and trust in assessment. How can both the social and academic threads remain intact?

As professional science leaders in our schools, we can take steps to reverse the documented transition dip effect in science both in terms of continuing the enquiry led approach and ensuring progression. To tackle transition, you need to work with other primary and secondary schools. A good starting point is to think about other schools you already work closely with.

How to: Advice and Guidance

If you have not worked with other schools in your locality, here are some possible starting points:

- Arrange to visit schools local to you to get to know their science leads, include primary and secondary schools. Get a keen group together – when you are seen to be having so much fun, others will want to join you!
- Set up a science moderating group, looking at expected standards of work across different year groups and encouraging enquiry-led learning. Create a 'graffiti wall' of expected work to photograph and share electronically. Your assessment lead in school might help here.
- Identify a common need from the schools you have got to know and share the cost of science training. Go to the ASE conference together.
- Plan National Science Week or other STEM celebrations together.

If you already have good working relationships with other schools, here are some ideas to deepen those partnerships:

- Visit your secondary school Head of Science to explore developing science together. Suggest a science roadshow with their students working with your pupils. Invite their colleagues to your moderating sessions to see standards of work. Plan a cluster STEM celebration event to be held at the secondary school.
- Find out when your cluster of Head Teachers meet and ask to be invited to discuss collaborative working in science.

What could you do now?

Moderate science work together across primary schools, what does 'expected' look like for any year group? Invite your local Y7 science teachers along too. This is a great way to start conversations and partnership working.

There are a number of grants available to promote schools working together. If you are in the UK, apply for an ENTHUSE Cluster Award through the National Science Learning Centre to start working as a group of schools.

Further reading

If you would like to develop this further you might like to read the following.

ASE (2011) ASE Guide to Primary Science Education Association for Science Education

Mould, K. (2015) Transition, from primary to secondary science: keeping the threads intact. ASE Primary Science 136, 5-8.

Ofsted (2015) Key Stage 3: the wasted years? London: Ofsted publication.

Welcome Trust (2009) Perspectives on Education: Primary – Secondary Transfer in Science.

SECTION 6

Teaching and Learning

How to develop a long and medium term plans

Author: Nicola Beverley

Introduction

As a science subject leader, you may become involved with three distinct levels of science planning. You could be asked:

- to create a long term plan or map showing how the science curriculum is to be taught across the school
- to provide outline medium term planning for teachers to adapt;
- to support teachers directly – particularly those new to teaching or in need of support – with their short term planning.

Your role will, to a great extent, depend on how your school leadership team distributes responsibility for planning. In a large school, for example, year group or phase leaders may be responsible at least in part for long and medium term planning across core subjects.

Long term planning

A long-term plan should map, broad brush, science across your school (including early years). It is best described as a 'helicopter view' of science, usually big picture and with little detail.

Some schools successfully combine different levels of plan, e.g. by providing a more detailed long term plan that includes medium term planning too.

It is important to ensure that repetition across plans is avoided, while referring to and reflecting the schools policy for planning (often found in a generic teaching and learning policy).

Your long term plan should:

- **Show how the 'must dos' of the statutory science curriculum are covered.** What are they, in your context? e.g. in England these would be the programmes of study for science, including working scientifically as well as content strands.
- **Map progression in the 'big ideas' of science.** How will your long term plan help to ensure that children's learning, e.g. in relation to a topic such as light, develops appropriately as they move through school? Will the long term plan help avoid repetition, or will this detail feature in your medium term planning?
- **Reflect the distinct nature of your school's science curriculum.** What is it that's special about science in your school? For example: Is it the amount of science time children spend outdoors? Is it the emphasis on planting, growing and producing food? Is it the emphasis on problem-solving or thinking skills?

It might also describe:

- How science is taught in a two-year rolling plan, rather than a single year plan. This is a particularly useful model in smaller schools with mixed age classes.
- Provision for science related learning in the early years, e.g. In England, pre-National Curriculum.
- Time allocated to science, e.g. a notional number of weeks per topic or strand.
- How, in a theme-based curriculum, science topics link to 'umbrella'/whole curriculum topics.
- How a published teaching resource or scheme should be used to support effective teaching and learning in science.

Medium term planning

Medium term plans are usually more detailed than long term plans, and may sometimes be described as a scheme of work. They include information and planning guidance for each term or half term across the school year. Depending on your setting, this might be organised into units or a learning sequence aligned with an umbrella topic, or show science learning as discrete and separate from the wider curriculum (apart from in relation to English, Maths and IT, where meaningful links should always be exploited).

Some schools successfully combine different levels of plan, e.g. by providing a more detailed long term plan that includes medium term planning too.

It is important to ensure that repetition across plans is avoided, while referring to and reflecting the schools policy for planning (often found in a generic teaching and learning policy).

Medium term lesson plans might:

- Indicate coverage of programmes of study across a learning sequence
- Provide an outline of the lesson content
- Identify learning objectives / outcomes for each lesson in the sequence
- Identify success criteria for all / groups
- Identify key questions to prompt / assess learning
- Indicate how learning will be differentiated
- Have an assessment focus, e.g. describe what 'secure' should look and sound like
- List resources required

How to plan effective lessons (short term planning)

Author: Nicola Beverley

Introduction

Short term planning in science is generally a teacher's weekly lesson planning, describing learning intentions, success criteria, assessment opportunities etc.

Your lesson plans should:

- Take into account children's prior learning and any assessments you made during previous sessions.
- Include clear learning intentions (sometimes described as outcomes or objectives) that are science-focussed and contain an active verb, e.g. describe, explain, plan, compare, create. Try to limit the number of these and ensure that both science enquiry and content learning intentions feature.
- Include clear success criteria that show children how they can be successful and aid teachers in making assessments of children's knowledge and understanding. Limit the number of these too, and ensure that both science enquiry and content success criteria feature.
- Indicate how different abilities of scientist will be challenged. How will planned tasks differ? Will brighter scientists have a related problem-solving task, rather than doing the same and more than other children? How will brighter scientists that have limited reading or writing skills be challenged? How will they demonstrate their learning?

Short term lesson plans might:

- Describe learning that will take place over a number of sessions, depending on content.
- Be structured in a variety of ways, e.g. made up of three parts, an Explore/Activation phase, Enquire phase and a Reflect and Review phase, depending on time available, focus for learning and school policy.
- Identify key questions that might be used when teaching.
- Identify key vocabulary that children should be taught, practise or use during the lesson.
- List resources required to teach the lesson.
- Indicate a focus for on-going teacher assessment, e.g. specific groups or children that will receive your special attention or the nature of the assessment being made – 'do green group understand the concept of a fair test?'

How to support children with SEND

Author: Jon Hickman

Introduction - Why focus on Special Educational Needs?

Quite simply every child should be given the best possible opportunities to education. With the new progress 8 measures being introduced this will now be even more crucial. All pupils need to be seen to be making progress. This can be achieved with some of the following strategies:

Dyslexia is a learning difficulty that primarily affects the skills involved in accurate and fluent word reading and spelling. Characteristic features of dyslexia are difficulties in phonological awareness, verbal memory and verbal processing speed. Dyslexia occurs across the range of intellectual abilities.

Dyspraxia/DCD is a lifelong condition affecting fine and/or gross motor co-ordination, in children and adults. Dyspraxia also affects planning, organising and carrying out movements in the right order in everyday situations. Dyspraxia can also affect articulation and speech, perception and thought.

Developmental Dyscalculia (DD) is a specific learning disorder that is characterised by impairments in learning basic arithmetic facts, processing numerical magnitude and performing accurate and fluent calculations.

Strategies for Dyslexia, Dyspraxia and Dyscalculia: May include practical interventions, such as:

- Allowing the use of a laptop or iPad to record information;
- Introducing new scientific language in advance;
- Highlighting important instructions and allowing a student more time to carry out and complete tasks;
- Providing handouts to reduce the need for handwriting.

Pupils who are deaf span a whole range of abilities and, given the right support, have the same potential to attain and achieve as their hearing classmates. However, as most teaching and learning takes place through the main senses of sight and hearing, pupils who are deaf – even those with mild hearing loss – can face particular challenges.

Adapting your teaching and learning strategies

The science curriculum often includes abstract concepts and vocabulary that can be difficult for deaf pupils, who may not have the language or background knowledge to understand them. To address this:

- Try to make your lessons as visual as possible. Use pictures and diagrams that illustrate their meaning.
- Go through key words for the lesson – if possible, these should be visible for the whole lesson.
- Provide supplementary vocabulary sheets when possible (a teaching assistant may be able to prepare these).

Understanding autism

People on the autistic spectrum take things very literally and struggle to understand social rules, pick up on social cues or communicate their feelings in a conventional way. Because of this, it is important to treat all the students' behaviour as communication and to use multiple ways of communicating with them.

Many autistic people rely on routines to cope with an unpredictable and chaotic world. They can experience high levels of anxiety if their routine is disrupted or they go somewhere unfamiliar. Always prepare someone for change, for instance, showing pictures of new places or visual stories can be helpful preparation for school trips.

- Do NOT rely on verbal communication alone;
- When using language, be clear and precise;
- Allow at least 10 seconds for each piece of

information to be processed;

- Set realistic goals that you and your student should feel proud of achieving.

Supporting pupils with visual impairment

Pupils who are visually impaired span a whole range of abilities and, given the right support, have the same potential to attain and achieve as their sighted classmates. However, as most teaching and learning takes place through the main senses of sight and hearing, pupils who are visually impaired can face particular challenges.

Strategies to help visually impaired students:

- Seat the student away from glaring lights (e.g. by the window) and preferably at the front of the class.
- Use descriptive words such as straight, forward, left, etc. in relation to the student's body orientation. Be specific in directions and avoid the use of vague terms with unusable information, such as "over there", "here", "this", etc.
- Describe, in detail, pertinent visual occurrences of the learning activities.
- Describe and tactually familiarize the student to the classroom, equipment, supplies, materials, field sites, etc.
- Give verbal notice of room changes, special meetings, or assignments.
- Offer to read written information for a person with a visual impairment, when appropriate.
- Order the appropriate text books for the students in their preferred medium.

Further reading

Further information can be found at: www.ase.org.uk/resources/send/

How to support Children with EAL

Author: Michelle Grimshaw

Introduction

Many teachers in both the primary and secondary sectors of education have learners in their classroom who have English as an additional language (EAL). These are pupils, in British schools, who may already know one or more language and are adding English to their existing repertoire (DfES, 2007).

Pupils with EAL are not a homogenous group. They come from a diversity of ethnic and linguistic backgrounds, including asylum seekers, economic migrants and those who were born and raised in the UK speaking a language other than English in their homes.

As with any other group of learners who find accessing the core curriculum problematic, EAL pupils also need to have lessons adapted in order to allow them to gain knowledge and understanding and to develop their spoken and written English.

Teachers can do this by involving learners with EAL in activities where the language is challenging but appropriate to their abilities and interests. This can often be difficult to achieve as EAL learners in classes may be at varying levels of English language acquisition and some may have little or no prior knowledge or experience of schooling.

Jim Cummins, a Canadian educationalist and researcher, has developed theories and models which help us to look at how bilingual learners develop their language skills. He talks about two distinct developmental stages;

BICS - Basic Interpersonal Communicative Skills

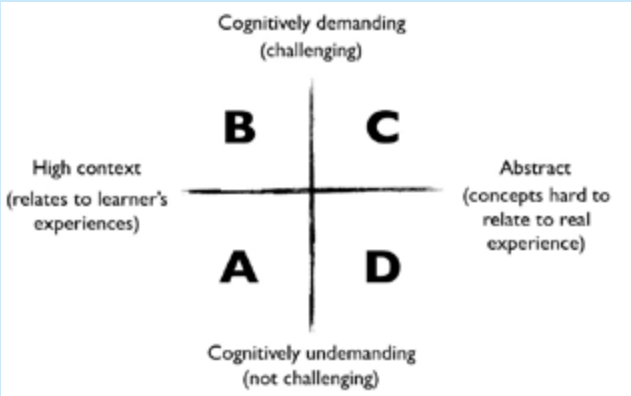
This is the language of the playground and other situations where conversational language takes place. It takes an EAL learner around two years to become proficient in this language model.

CALP - Cognitive and Academic Language Proficiency

This language model is where the development of thinking and learning skills takes place. It requires an understanding of the technical language required by subjects such as science and the ability to apply these in a range of situations.

Cummins found it took between five and seven years to become proficient with cognitive and academic language.

The teacher models vocabulary such as attract and aids their learning by asking questions. Use of a graphic organiser would also help understanding.



Sentence starters used to help a child construct their thoughts plus working collaboratively to record findings.

Guidance to support EAL Pupils in Science

How can we plan for EAL pupils in a science lesson to ensure that they develop knowledge and understanding as well as a command of spoken English?

It is important to remember just because a pupil demonstrates a good understanding of CALP it doesn't follow that their academic language and understanding is at the same level.

Many of the recommendations are down to good all round classroom practice.

Science has the advantage in that it should be a subject where practical investigations are at the forefront in developing concepts and understanding for all children.

Other tools and techniques that can aid understanding are:

- Use more visuals: Pictures, photographs, and

so on can help learners make sense of new information. Ensuring that visual resources are culturally relevant also aids understanding. Key visuals, such as a life cycle of a frog, are exceptionally helpful in enabling understanding but also promoting language development.

- Collaborative Activities: Plan for regular activities that allow EAL pupils the opportunity to work alongside mixed ability peers. Children do need to be taught the rules for successful collaborative working.
- Language Models: Using a writing frame to model how a text should be organised. Creating a speaking frame which models key vocabulary and language structures are highlighted.

> I know this is a solid because ...It is different to a liquid because ...

> I know magnets are attracted to....
> Because ...

- Drama: Activities such as modelling the molecular structure of solids, liquids and gases and making a human electrical circuit are examples of where drama can aid understanding.
- Scaffolding: This is one of the key support tools that can really support EAL learners in all subjects particularly science and incorporates many of the strategies above. It is the main way that learners can move from supported to independent learning. Using a storyboard to sequence say the stages in flower pollination or to recount an experiment showing the digestive system is an effective way of recording information. This then can lead on to a written explanation as the learner become more proficient in English.
- First Language Support: It is important to understand that it is easier to learn new or difficult concepts in a first language then transfer to the second. We can support EAL learners by providing dual language science vocabulary word banks. The benefits of allowing same language learners to work together with a bilingual teacher or teaching assistant are many and will lead to accelerated language development and conceptual understanding.

Further reading

Hainsworth M (2017) Developing EAL learners' science conceptual understanding through visualisation, Primary Science 146 (Jan/Feb 2017) 33-35

www.sgsts.org.uk/SupportForVulnerablePupils/EMTAS/SitePages/Science.aspx

www.collaborativelearning.org/

DfES, (2007) Primary National Strategy, Excellence and Enjoyment: Learning and teaching for bilingual children in the primary years. Teaching Units to support guided sessions for writing in English as an additional language (Pilot materials)

Science in the Early Years Foundation Stage

Author: Elly Hoskin

Introduction

'Science' in the Early Years Foundation Stage (EYFS) sits within Understanding the world, alongside other subjects such as R.E, technology, history and geography. Within Understanding the world, the sub heading of 'The world' details the exact science expectations.

The science focus within EYFS, relates closely to the children's world and environment around them. This naturally focusses learning upon places, living things, plants and materials as children are encouraged to observe and talk about what they see.

Characteristics of Effective Learning

Within EYFS, there are also the 'Characteristics of Effective Learning' that help develop and focus the child. These characteristics are split into three sub areas of 'Playing and exploring', 'Active learning' and 'Creating and thinking critically'. 'The world' within EYFS links very closely to developing these characteristics, as children are encouraged to explore, find out, be willing to have a go and develop their own ideas. These characteristics explored through 'The world' activities then begin to lay the foundations for the development of skills via 'Working Scientifically' in the KS1 and KS2 Science National Curriculum.

As a Science Subject Leader (SSL), why is it important to understand how Science fits into the EYFS curriculum?

The EYFS curriculum has seven learning areas. These learning areas are organised into 'Prime' and 'Specific' areas. The Prime areas focus upon personal, social and emotional, communication and physical 'core' skills that all children need for essential learning. Alongside these core skills, are the specific areas, which entail the subject knowledge meat for the bones. As a SSL, it is worth noting that Science (The world) is a specific area but all specific area activities should also include one or more prime areas within the activity.

As a SSL, is my role still the same within EYFS?

Yes, all SSL roles and responsibilities also apply to EYFS as well as primary. Monitoring of planning and teaching should still take place to ensure curriculum coverage and progression. Scrutiny of science books is not generally an expectation within EYFS so SSL should use photographic and observational evidence instead.

As a SSL, it is important that you value the core investigative work that often takes place within EYFS and exploit opportunities to link EYFS and Primary science within your school. One approach to this is to ensure science topics explored in EYFS link clearly through to KS1 and then on into KS2 where possible. The strong thread of Animals including humans, initially introduced in EYFS, which then runs through KS1 to Upper KS2, provides scope for this.

How to: Advice and Guidance

Planning for Science (The world) in EYFS- What should science planning in EYFS look like?

Most planning in EYFS should centre on broad topics that are periodically changed. These topics should be influenced by the children's interests and accommodate all learning areas. EYFS planning should take account of group led and continuous provision activities and link closely to curriculum learning goals. Continuous provision focuses on learning without an adult present and there is great scope for science investigative learning through continuous provision, sand, water, investigative, outdoor and small world play areas. As a SSL, it is important that you look for a good balance of science (the world) related group and continuous provision activities within a topic theme on EYFS planning.

Assessment of Science (The world) in EYFS- What should science assessment in EYFS look like?

Assessment within EYFS links closely to the core principles of primary AfL. Assessment evidence should be collected through photographs, videos, short observations and examples of children's recordings to collate a picture of each child against curriculum requirements. Different settings store this gathered assessment information differently. Examples of this include electronic capture and storage using apps, journal and scrapbooks, folders and trays.

Further reading

Johnston J (2011) Chapter 4 Learning in the Early Years ASE Guide to Primary Science Hatfield : ASE

How to use working walls to support science learning

Author: Rachael Webb

Introduction - What is a Science Working Wall?

A working wall, also known as a learning wall, is a display board in the classroom that is used to document the development of a topic using children's own questions, ideas, drawings, writing and photographs, annotated by the teachers for younger children.

Purpose of working walls

The learning environment that is provided for children can have a huge impact upon their learning and independence. Previously, classrooms have tended to display celebratory work which is usually the final product of a unit of work, regardless of the subject. However, changing the emphasis of the content of the display can support the children in their day to day and longer term learning.

The term 'working walls' is used to describe displays that support the attainment of curricular targets and children's learning during specific units of work. The content of a working wall should change regularly to support learning and teaching as it develops in the classroom. The ultimate aim is for children to access prior learning, make links to what they already know and apply this to future learning. A working wall enables children to refer to concepts and resources, supporting them to become more secure independent learners. It is the public display of the learning process. It is important for long term learning objectives and short term intentions to be displayed on the working wall. When success criteria are appropriate they are developed with the children and clearly displayed on the wall, demonstrating to pupils how they will be able to achieve the agreed learning intention.

Creating effective working walls

Empty display boards can seem very scary to teachers! We are used to providing an attractive classroom environment, which often includes getting work displayed as soon as possible for our children. New technology allows us to produce neat and tidy displays that have been triple mounted and laminated but this is not always necessary - we need to be asking ourselves what is the purpose of display and therefore what makes a really effective display. If we are attempting to support learning and teaching, having resources tripled mounted does not necessarily add to the learning process. Often it is the brainstorm or work in progress that is captured and displayed that serves to be the most effective resource for learners.

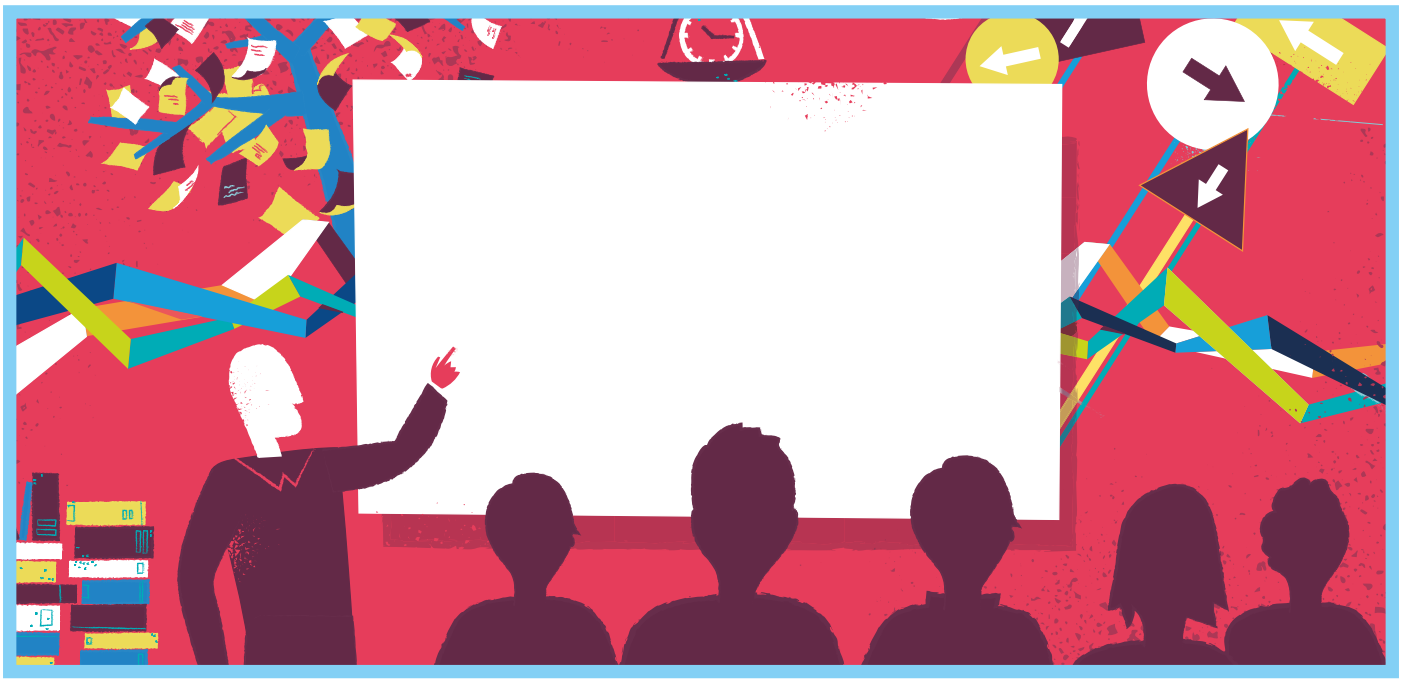
Working walls display those concepts, ideas, conclusions, strategies and findings that have been captured to support further learning. Captured work can be referred to over a period of time and built upon at a later date. Work captured in this way does not necessarily need to be neatened or rewritten: part of how children will use this information later rests upon how they have visually recorded it in their minds at the time of composition, so to rewrite in a different format or in different colours or font may detract from the purpose. Key vocabulary for the learning can also be displayed on the working wall whilst mind mapping, modelled examples, re-drafting and pupils' examples can also be regular features.

By building up the learning over time and adding to a working wall, children and teachers have access to the learning through a sequence which becomes known by all; it becomes transparent how one lesson builds upon another and leads ultimately to the final outcome. When children understand the pathway they are taking they are empowered as learners and are better equipped to make links between concepts and to apply the knowledge and skills they have to other areas.

Working walls are effective in:

- supporting curricular targets
- sharing objectives and reviewing learning
- capturing visual prompts and interactive resources
- promoting key vocabulary

Teachers who have implemented the working



walls approach have reported that it is a quick and effective method of transforming teaching and learning and that it becomes an embedded classroom routine.

Encourage teachers to include:

- Key vocabulary both Scientific and everyday, common language and sentences
- Definitions written (and improved) by children
- Questions asked by children
- Questions to provoke discussion or research
- Children's work / Examples of good Science
- Facts, information, posters, diagrams, etc. to engage and stimulate
- Table tops used for interest tables and to consolidate, to stimulate or to further learning
- Progression of a topic displayed – what we know, what we want to know / what we aren't sure about, what we have learned - BIG PICTURE
- Support for working scientifically e.g. reminders of the different types of enquiry or specific skills and types of recording that are being developed

Encourage a discussion by teachers of the different examples of display across the school – either, visit each other's classes during a staff meeting or share photographs of each other's science walls. What positive feedback can they share? What could they try next in their own classroom?

Using working walls effectively

If not used appropriately however, there is a danger that the working wall can become just another design of classroom wallpaper. It is the teacher's role to model how to use the working wall, accessing the available information and selecting relevant aspects to use. If working walls have been set up and used in a way that supports learning and teaching, the children will be able to tell you how important they are and how they value them as a vital part of the classroom.

Many schools are in the process of reviewing their current display policy in order to reflect recent thinking about the importance of a high quality learning environment. Celebratory displays will always be important in school but there is a very important place in the classroom for the working wall display. Celebratory displays are much more appropriate in corridors, halls and other shared spaces where they demonstrate the important role of science in the curriculum of the school in a way visible to the whole school community.

We are grateful to Rachael Webb of Lancashire Grid for Learning for permission to use this guide.

How to develop home learning opportunities (working with parents)

Author: Deborah Herridge

Introduction - Working with parents, families and carers

Parents are a valuable resource in any subject area, after all we are with the children for only a few hours each day but the main people in children's lives will generally be their parents or carers. However, while parents may feel confident to help their children out of school with something like reading, very often they have less confidence in helping with science.

There may be many reasons for this including their own poor experiences of science in school, a view that science is seen as 'elitist' or hard work or something that only middle aged, middle class white males can be involved in. Perhaps it is timely to question that stereotype!

Most parents want to help their children to achieve in school and are an incredible, often untapped resource. Consider having a talk at parents' evenings or run a course to let them know what science their children will be covering and how they can help.

The influence of parents

Children enjoy science but often do not see themselves as scientists. The Aspires Project (2013, King's College) identified the importance of 'science capital' as being key to children's aspirations towards pursuing STEM based careers. 'Science capital' refers to science-related qualifications held by family members, their understanding, their knowledge about science and 'how it works', interest and social contacts e.g. knowing someone who works in a science-related job. The influence of families cannot be underestimated.

However, many children and adults have a narrow view of where an interest in science can lead them and often have a limited knowledge of science based careers feeling that the only options may be a career as a doctor or a scientist.

Teachers can help identify the science we use in all sorts of jobs for example a hairdresser must have some knowledge of mixing chemicals and their effects on hair, installing a central heating systems requires the technician to know something about volumes and pressure of gases and fluids, a baker must know something about the effects of temperature yeast and so on.

Invite parents who work with any aspect of science to visit and give a short talk or demonstration about how they use science in their work.

Empowering parents and building knowledge

Many children enjoy science and often come home excited about what they've learned but that excitement is not followed up at home. With a little guidance we can help parents understand that they do not need to be knowledgeable about science themselves in order to support their children. The most exciting answer is, 'I don't know' because it leads to 'Let's find out.'! Teachers can help by reinforcing the idea that it's alright not to know the answer; after all, that's how scientists work. The opportunity for discussion at home is

more important than having a 'right' answer.

Practical tasks at home

Sending a practical task home for parent and child to do together is often a great way to start a science discussion in families. If you choose to do this remember to either provide the materials yourself or make sure that they are resources which can be obtained easily from a local supermarket – no test tubes or Bunsen burners please, and do remember to provide some written guidelines on what to do and sample prompts for questions. There are some fabulous ideas and great, simple explanations of investigations and ideas to do at home on the following sites:

Marvin and Milo - Do try this at home!
www.physics.org/marvinandmilo.asp

The Science Museum, resources for Educators
www.sciencemuseum.org.uk/educators/teaching_resources.aspx

British Science Week challenge packs from the British Association www.britishscienceweek.org

Pinterest Loads of ideas from home schoolers and teachers for ideas to do at home
uk.pinterest.com

Other ways to involve parents could be to:

- Invite parents to view children's work at the end of a topic and provide a real audience for the children to talk about, display and share what they have learned;
- Invite parents to a class assembly based on the science the children have been learning;
- Invite parents to a science day / week / event and get the children to lead a practical activity for the parents to take part in (Hyperlink to organising a science event for parents)
- Have a science in the dark event to either, celebrate darker nights, look at the stars, investigate reflective fabrics or any other imaginative ideas.
- If parents come into school be sure to get them to fill in a 'guest book' to collate their comments about their experiences.

Once a science club for children has been established consider running a parents' science workshop where parents come with their child to learn more about science over a series of weeks. Some adults may not have had positive past experiences of science so why not educate them as to how fun science can be. You might even inspire some parents to take up a science career.

Further reading

The Aspires Project Report
www.kcl.ac.uk/sspp/departments/education/research/aspires/ASPIRES-final-report-December-2013.pdf

SECTION 7

Making effective use of assessment

How to use assessment to support learning

Author: Sarah Earle

An excellent overview to help guide your thinking about the purpose of assessment is the **ASE statement on assessment**

Introduction

Assessment can drive what and how primary science is taught, skewing lessons to things which are easily tested. his guide will argue that it needn't be this way: we can use assessment to support learning, to find out where children are and to consider how to move them forward in their scientific thinking. Assessment for learning (AfL) is a way of teaching which takes the learner's needs into account, arguably having the biggest impact on pupil progress.

Guidance

You may already be familiar with key features of AfL from other subjects, these are equally relevant to primary science:

Clear learning objective and success criteria

Be clear about the focus for your lesson. For example, during a whole investigation the focus for teaching and recording could be on drawing conclusions, so a class could explore cars down ramps then spend time discussing what a good conclusion looks like. Whilst a focus was on controlling variables might mean that more teaching time would be spent on the planning stage.

Questioning

Using open person-centred questions will support the children to consider what they already know: what do you think….? Why do you think …? Eliciting the children's ideas at the beginning of a topic or lesson will help you to find out pre-existing ideas, which may be different from accepted scientific knowledge. This information will help you to plan how to address any alternative ideas which the children hold. It will also help you to pitch the lessons appropriately so that you can challenge and extend, rather than go over something which they can already do, for example, if they can already make a circuit then challenge them to make their own switch for a purpose.

Feedback and next steps

Oral or written feedback which identifies next steps can provide children with ways to move forward. Could they try to use more scientific vocabulary, take more readings or label their diagram? Give the children time to act on your feedback, within the lesson or in the next. For example, instead of pausing at the end of the lesson to review learning, pause in the middle to share ideas and then the children have the rest of the lesson to put those ideas into action.

Peer and self-assessment

More detail about this later in this section.

Where to start

Start with your own lessons - what AfL strategies could you try in science? Share these ideas with other staff. What have they tried?

Do a book scrutiny - can you see a clear focus for the lesson? Is there a balance of skills and concepts? Is there evidence of feedback?

Further information

www.pstt.org.uk/resources/assessment.aspx

www.gl-assessment.co.uk/products/black-box-series

How to make effective use of peer and self-assessment

Author: Sarah Earle

Introduction

Handing assessment over to the pupils sounds like a risky affair, but it means that they become the active agents in their own learning. If they know what it looks like to produce a good labelled diagram of the digestive system, or how to check whether they have been measuring accurately, then they are much more likely to be able to do these things – knowing 'what a good one looks like' is most of the battle.

Guidance

Peer and self-assessment overlaps with other AfL strategies, since to be able to assess themselves, they need to know the criteria; this means that there needs to be a clear learning focus for the lesson for this kind of assessment to be successful. Usually learning objectives are decided in advance, but it could be that this is negotiated with the children during the lesson, as they choose the focus for their enquiry.

Strategies for peer and self-assessment include:

- Traffic lighting, thumbs or smiley faces to show confidence levels or how well they feel that they met the objective;
- Evaluating work half way through the lesson, sharing good points with others and asking for help with parts which are difficult;
- Returning to work, highlighting/underlining key vocabulary or best bits;
- Providing feedback on a peer's work or presentation e.g. 2 stars and a wish, WWW (what went well) and EBI (even better if);
- Responding to feedback with a comment about how they feel now;
- 'I used to think this… but now I think this … because…'
  'I used to think this… and I still do because…'

Where to start

Start with your own lessons - what peer and self-assessment strategies could you try in science? Share these ideas with other staff. What have they tried?

Further information

www.pstt.org.uk/resources/assessment.aspx

www.gl-assessment.co.uk/products/black-box-series

How to use your ongoing assessments to inform summative assessment

Author: Sarah Earle

Introduction

Primary science is a practical subject and enquiry skills, which are an integral part of any assessment of science learning, are not easily captured in an end of year test or task. It is more valid to use information from a range of experiences across a longer period of time, when summarising attainment for reporting purposes. The Teacher Assessment in Primary Science (TAPS) project team are collecting examples of different ways in which schools are using formative assessment to inform summative reporting (see website below).

Guidance

Methods of planning, recording and tracking vary across schools, but there are key principles below which will help you to evaluate the systems in your school. Importantly, science does not need to have the same assessment processes as English and Maths – it is not taught daily so it does not need as much detailed recording. Many teachers annotate their planning to keep a note of children who have not got there or who have gone further, others use a class list to make notes, others have an electronic system. The key to deciding whether any current assessment processes need to change is to ask whether they meet the following 3 criteria:

1. **Is it manageable?** Maintaining records for every child for every lesson or curriculum objective is unlikely to be sustainable, so consider what is needed for reporting. At the end of the term or year what information needs to be passed onto senior leaders, the parents or the next class teacher?
2. **Is it valid?** Using a wide range of information will make science assessments more valid since you will be considering performance across different contexts, groups and recording methods. This is particularly important for Working Scientifically, so you may find enquiry skills an area you would advise colleagues to track. It is easier to summarise formative information if the lesson has a clear focus – which skill or concept is being taught? A shared understanding of progression will support both the formative focus and the summative reporting.
3. **Is it reliable?** Moderation discussions based on a shared understanding of progression will help judgements be more consistent. A starting point for this dialogue could be colleagues simply comparing the outcomes of a lesson with a year group partner to agree what it looks like to have 'got it'.

Where to start

Use the TAPS self-evaluation pyramid tool to consider how your school is currently assessing.

Start with a focus on AfL (the blue layers of the TAPS pyramid) – this is where you will have the most impact on pupil learning, and if formative assessment is good then it will be easier to summarise for reporting purposes.

Further information

www.pstt.org.uk/resources/assessment.aspx

SECTION 8

Enhancing science

How to make effective links with mathematics

Author: Shelagh Hendry

Introduction

Data handling is an integral part of any Working Scientifically programme of study, and accurate measuring (and conversion of measurements) is a skill necessary to make progress in working scientifically; so, the need for making links is written into the curriculum. To be effective however, those links need to provide real and engaging purpose for using and improving maths skills, with clearly planned connections between the mathematics and science teaching.

Guidance

You will lead by example.

- Scales are simply number lines in a range of orientations. Encourage your colleagues to make this connection explicit in their science sessions and through displays relating the mathematical concept to the science context.
- Encourage your colleagues to consider whether their children have the maths skills and number knowledge to address the measuring and data handling necessary for the science task at the planning stage, and consider making this a focus of your planning scrutiny.
- Encourage the use of already prepared results charts and graphs to model both analysis of results and to improve skills of recording effectively.
- Encourage your colleagues to allow children to choose how to present scientific data and results as groups and as individuals, making discussion of clarity, effective presentation and readability part of their evaluation of results process.
- With your mathematics leader, support whole-school use of common agreed language across maths and science in relation to measuring eg mass being the amount of stuff in any given object measured in Kg and g (which will not differ where ever that object is in space) whereas weight is dependent on gravitational attraction, measured in Newtons (and will differ if the object is not on Earth).
- Consider the possibility of co-delivering a development session alongside your mathematics colleague, giving purposeful science examples of measurement and statistics in use alongside the mathematical development eg to explore the actuality of litres and millilitres in a science context so as to increase practical experience of the relative

"Encourage differentiation by labelling on scales and axes for children who struggle with understanding graphs"

size of each and so improve estimation and calculation within mathematics.

- Look for good practice in linking maths and science when conducting a book scrutiny and celebrate this.
- You could encourage problem solving mathematics sessions to make use of child-generated scientific data and science activities already undertaken to save colleague time and reinforce connections for the children.
- Consider whether the yearly school science plan links the timing of science topics which require accurate measuring skills (eg the need to measure quantities of liquid for a fair test with the ability to calculate totals and difference in the numbers likely to occur), or specific data-handling capabilities (eg the use of an axis indicating passage of time and the ability both to read a timer/clock in sufficient detail and calculate with likely periods of time to recognise patterns and relationships in results) to the maths year plan as effectively as it can, and consider reorganising if there are clear discrepancies.
- If classes are organised differently for mathematics and science – perhaps maths is streamed but science not, or maths is taught by form but science by year –you could use a planning scrutiny to ensure that the two subjects are not so discrete that potential effective links are missed; encourage your colleagues to consider this issue when planning for the future.
- For children, who find calculating in measures difficult, support better progress by encouraging differentiation by quantities within science lessons; also encourage differentiation by labelling on scales and axes for children who struggle with understanding graphs

What to do now

Use your next book scrutiny, planning review or class observation to consider how effective the links made between mathematics and science are in your school, celebrate successes and include action to develop them further in your next subject action plan. If possible, involve your mathematics subject leader in the analysis and action planning.

Further reading

Dr A Cross & Dr A Borthwick, Connecting Primary Maths and Science: A Practical Approach, Open University Press, 2016

L Kelly & D Stead, Enhancing Primary Science: Developing Effective Cross-Curricular Links, Open University Press, 2013

N Hiscock, Making Links Between Maths and Science, Primary Science 124, ASE, October 2012

How to develop effective cross curricular links

Author: Lois Kelly

Why make links with other subjects?

Well planned cross curricular links:

- Give a context for children's learning and provide a 'hook' for learning.
- Help to manage the demands of the primary curriculum.
- Allow for greater breadth and/or greater depth of learning
- Enable knowledge and skills learnt in one subject to reinforce learning in other subjects.

Cross curricular work helps children to develop skills that will be useful to their future careers because, in real life, insights from different subject disciplines are used to solve problems.

How to develop effective cross-curricular links

Starting with the science topic consider which science skills will be developed and the science knowledge to be learnt and then consider how these will be supported by or will support other subjects.

When planning for cross-curricular links 'less is more'. Learning is most effective when there are strong reasons to make links between 2 or 3 subjects.

Make the links between subjects explicit and do not to assume that children will necessarily transfer knowledge and skills learnt in one context to a different context. Use prompts such as:

- "Do you remember how we …. "
- "We are going to use the results to---"

When planning for cross curricular links it is helpful to consider how does or how could the subject support science enquiry?

Enquiry is not unique to science. Geographical enquiry and historical enquiry follow a similar cycle of raising questions, looking for evidence, evaluating the evidence and drawing conclusions.

Which science skills will be developed by making cross-curricular links with a particular subject?

- Making accurate measurements and handling data develop mathematical skills as well as science skills
- Developing lists of adjectives, similes and metaphors to describe sounds, sights or touch develops observation skills as well as having links with literacy.

How might science knowledge be applied in the other subject?

For example:

- Knowledge about the properties of types of rocks will help to explain the features of a local river using evidence of erosion and deposition.
- Pupils can consider how knowledge about phases of the moon influenced decisions about D-Day landings in World War 2.

Some issues to consider are:

- Making links between a wide range of subjects as the links tend to become tenuous.
- Subjects losing their identity. This tends to happen if the focus becomes the product of a topic rather than the development of knowledge and skills.
- Maintaining an appropriate balance between the subjects that contribute to the theme or topic to ensure the rigour of the study.
- How your assessment will take account of how children have applied their knowledge and skills and not focus solely on subject specific knowledge and skills.

Getting Started

- Choose a science topic you are confident to teach and consider how STEM subjects can enhance children's learning. (see how to develop a STEM Curriculum and How to make effective links with maths)
- Work with the subject coordinators in your school to develop cross curricular links.
- Build up a set of resources that are designed to make effective cross curricular links with science such as Primary Update, Science topic webs produced by the Royal Society of Chemistry.

Further Reading

f you would like to develop this further you might like to read:

Primary Science Issue 146 January 2017 Science at the Centre

L Kelly & D Stead, Enhancing Primary Science: Developing Effective Cross-Curricular Links, Open University Press, 2013

How to develop a STEM curriculum

Author: Nicola Waller

Why develop a STEM Curriculum?

As a primary teacher, making links across the curriculum with science, technology and mathematics is a great way to capture children's interest and enthusiasm for these subjects. Research shows that STEM is one of the fastest growing occupational categories, essential for developing technological innovation and global competitiveness. In short, STEM jobs are the jobs of the future!

Encouraging children to develop the skills required for science, maths and technology by engaging in exploration, enquiry and problem solving experiences is a great way to help nurture their future success. If you are considering planning a STEM curriculum or aiming to make stronger links with STEM and other curriculum areas, this guide will provide some ideas to help you get started.

Advice / guidance

Many primary schools plan their curriculum around specific topics or themes, however, teachers quite often comment that the science or maths each week is taught separately rather than forge unnatural links between these. A great starting point to developing a STEM curriculum would be to select science topics as overall themes, for example 'Rain forests' 'Changes' 'Feel the Force' 'Danger – High Voltage' or 'Space Mission' and then use these titles as an impetus to intentionally link different subject areas across an existing curriculum.

For each of these themes, use a large piece of flip chart paper and divide this into rows equivalent to the number of weeks in the half term you are planning for. Next, divide the paper into columns with the headings of science, maths, design and technology, computing, English etc. You could start by mapping out your initial ideas for science activities to be carried out for each of these weeks and then think carefully about areas of the mathematics curriculum that are integral to these sessions. Examples might include:

- Year 1 children telling the time to the hour and half past the hour and drawing the hands on a clock face when learning about how day length varies (Seasonal Changes)
- Year 3 children measuring and comparing lengths (m/cm/mm) whilst finding patterns in the way that the size of shadows change (Light)
- Year 5 children interpreting information in tables whilst learning about the distance of the planets from the Sun and their movement, relative to the Sun in the solar system (Earth and Space)

There is maths to be found in almost every science activity and, finding these links, will help children to appreciate how the two subject areas are inextricably linked as well as develop the essential skills that bind the two together.

There are plenty of creative opportunities to link science, maths and computing practically with the design and technology curriculum. Projects may enable children both to apply existing scientific knowledge when designing and making and carry out science investigations as focused tasks within a D&T unit of work. For example, children who

are making a lamp or nightlight will apply their knowledge of electrical circuits when designing and making; bread making may require children to carry out comparative tests on different raising agents and conditions needed by yeast before they can design their final product. The latter will use the maths skills of careful measuring of quantities and temperatures and presenting data. Some D&T projects also include computing. Children who are making fabric products may use computer aided design to create a pattern in addition to applying science knowledge and/or enquiry skills when selecting fabrics for properties such as thermal insulation, how waterproof or reflective they are or strength and durability. Creating electrical products that are computer controlled can involve all aspects of the STEM curriculum.

Developing a STEM curriculum can be a daunting prospect for teachers and it is important that you have the support of your SLT. Aim to facilitate as much collaborative planning as possible to develop a shared understanding of the goals in sight and remember that any kind of curriculum change should be a gradual and reflective process. Don't attempt to change too much in one go. Start with a STEM day perhaps during a science week, then try just a half term or term at a time. ensure that you try things out, adapt, refine and evaluate as you go along.

As a final piece of advice, STEM teaching should have enquiry skills at the heart, with teachers providing just the right amount of guidance if and when this is required. Aim to provide opportunities for children to explore, discuss their ideas, work as a team, develop higher order thinking and engage in open problem solving challenges – transferrable skills that will extend to all other curriculum areas and also lead to success in many areas of children's lives.

Next Steps

- Plan a STEM day, for a class, a Key Stage or the whole school.
- Reflect on "what went well" and "even better if…"
- Identify one topic or theme which you can develop into a STEM topic.

Further Reading

Primary Science Winter 2015/2016 Special Edition Tinkering for Learning http://www.ase.org.uk/journals/primary-science/

Primary Science Issue 144 (September/October 2016) The Appliance of Science

Primary Science Issue 145 (October/November 2016) Maths 4 Science

Primary Science Issue 139 (September/October 2015) STEM

How to use topical science contexts

Author: Paul Tyler

What is Topical Science?

Topical Science is about developing an awareness of science issues in the news and the important science stories that affect pupils' lives and the world around them. It's about making science relevant for pupils, which is essential for engaging them in the classroom.

There are four broad themes to using Topical Science in the classroom:

- Developing awareness of the big science stories in the news and how science impacts all our lives.
- Critical Literacy to develop Scientifically Literate students who can analyse, verify, comment on and debate the main points of science stories in the news.
- Citizen Science to get pupils engaged in real scientific research and understanding the methods used.
- Developing understanding of scientists and what they do, career opportunities in science and how science has changed the world through history.

Why use Topical Science?

'Excellence tends to follow interest.' (Alfie Kohn; The Homework Myth; 2007)

Engaging pupils with any subject involves making it relevant to them and to their everyday lives. This is especially true in STEM subjects where concepts can seem a bit abstract without a relevant context. Embedding Topical Science into the classroom gives science a context that is relevant, real and engaging.

Citizen Science is an excellent way to stimulate pupil's interest by engaging them with real scientific investigations. There are bee counts, bird surveys, air quality surveys, planet hunting, weather monitoring and many more all of which feed data into on-going scientific investigations, for example the tree survey on BBC Terrific Scientific. There are also the annual RSC Global Experiments which allow pupils to add their data to that of thousands of other collaborators around the world.

How to keep up with Topical Science

One of the problems for teachers is how to keep up with the latest developments and advancements in the rapidly moving world of science. Newspapers and magazines are a good place to start; First News has a great science page as well as pages on environmental issues and animals which often have scientific relevance. WhizzPopBang magazine always has excellent topical content often linked to practical activities. Primary Upd8 provides curriculum-linked lesson ideas based on topical science. It is a subscription website, heavily discounted for ASE members, which also includes free content.

The internet is the best way of keeping up with Topical Science and there are lots of great websites that have child friendly, up-to-date scientific stories (see table 1). Social Media is also excellent for finding the latest science stories; there are excellent Facebook groups, YouTube channels and Twitter feeds (see table 2) that promote up-to-date science stories which can engage and inspire in class.

How to use Topical Science in School

In a packed curriculum one of the major hurdles

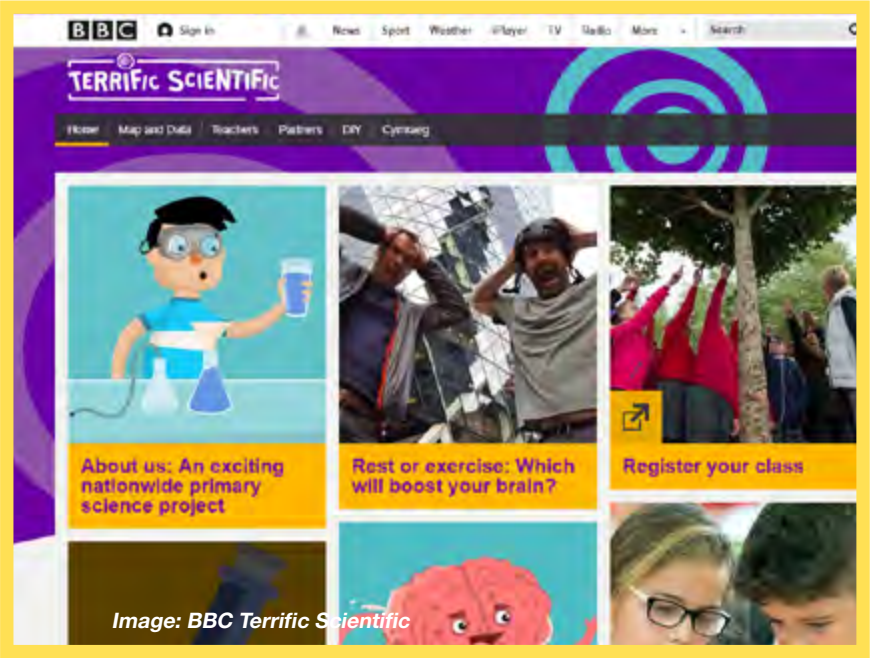


Image: BBC Terrific Scientific

facing teachers is where to fit Topical Science in. One answer is to make Topical Science the context for learning in other curricular areas (Table 3). Another way of engaging children with Topical Science is to make it the focus of an assembly once a month, through a science club or by using it for homework activities. You can also look for science stories and topical lesson ideas which directly link to your current unit of work; they can provide an engaging context for children to ask and answer their own questions.

What to do next

The key to embedding Topical Science in your school is being able to keep teachers up-to-date with the big science stories in the news and the latest scientific discoveries and advancements. There are some important online resources that will make this easier for you.

First of all check out the Reach Out Reporter website (link in Table 1) which is an online primary science news service helping teachers integrate topical science into everyday teaching and learning. It has high-quality film clips and a variety of excellent teaching resources. Reach Out Reporter is updated weekly with new content and is available free of charge to all primary schools across the UK.

Secondly, sign up for Topical Science Updates by emailing topicalscienceupdates@gmail.com and requesting to be added to the email list. This is a free monthly newsletter highlighting 3 or 4 of the current big science stories with links to articles, video clips and resources to use with your class.

Finally, consider setting up a Twitter account for pupils to follow accounts that tweet about science that is in the news.

Table 1. Topical science on the web

Organisation	Website
BBC Science	www.bbc.co.uk/news/science_and_environment
NASA	www.nasa.gov/
NASA Kids Club	www.nasa.gov/kidsclub
Reach Out Reporter*	www.reachoutreporter.com/
DOGOnews	www.dogonews.com/
Live Science	www.livescience.com/news
Science Daily	www.sciencedaily.com/
TIME for Kids	www.timeforkids.com/
ESA	www.esa.int/ESA
Primary Upd8**	www.primaryupd8.org.uk
BBC Terrific Scientific **	www.bbc.co.uk/terrificscientific

Table 2. Topical science on the social media

Facebook	YouTube Channels	Twitter
Topical Science Updates	Veritasium	@reach_out_uk
Unleash the Infants	NASA	@guardianscience
Unleash 2 – KS2 Science	TED-Ed	@RIscience
Live Science	Scientific American	@NASA
New Scientist	New Scientist	@ESA
International Space Station	Science News	@livescience
Latest Science and Technology News	ESA	

Table 3. Curricular links to Topical Science

	Recommendations
Literacy and English	Most of us find out about new science stories and discoveries by reading, listening or watching so there are very explicit links to literacy & English where Topical Science can be used as a hugely engaging context for reading. It is especially good at engaging reluctant readers and boys. • Reading recent science stories in the news, science magazines or online • Critical literacy – developing the ability to evaluate what they are reading and comment on whether the source is reliable. Developing the understanding that sometimes science stories are out of context and misleading. Developing the ability to check and verify the reliability of a story in the news. • Writing newspaper articles, posters, leaflets to inform others about the big science stories in the news or to highlight key aspects of recent discoveries and their relevance. • Digital literacy – watching short films, documentaries about big science stories and discoveries. Being able to take notes and discuss the relevance and implication of the story. • Talking & Listening – debating the big science in the news, Climate Change, vaccination, animal testing etc. Solo talks or presentation in class of research into science stories.
Numeracy and Maths	Almost all science is backed up by mathematical evidence presented in some way. It's a great opportunity to reinforce understanding of the following mathematical concepts, among others: • Measure and scale • Big, small and negative numbers • Data handling and presentation • Fractions, Decimals and Percentages • Time, timescales and duration • Averages
Health	There are many relevant links to recent scientific research in many areas of health such as: • Healthy eating, sugar consumption, 10-a-day, salt intake • Our bodies, transplants, new medical procedures, Antibiotic resistance • Smoking & Alcohol, revised safe daily limits, law changes • Drugs & medicines, where do medicines/drugs come from, how to use them safely, new medicines
Technology	New technology is where scientific discovery invariably ends up and exploring how technology has changed, is changing and might change in the future is an important part of Topical Science. • Innovation and invention, have a look at technology children use every day – Where did it come from? What might it look like in the future? What science was needed to create it? • Materials, new materials are being discovered and produced all the time to meet people's needs. What materials can children find and why are they suited to the task they're doing? Can children 'invent' new materials to use in specific tasks? • ICT – Using the internet to research current stories, using ICT to present findings to peers • Engineering – investigating how engineers use science to solve real problems, e.g. the Omniprocessor, Plastic Bottle Solar Light Bulbs, bridges & tunnels and transport solutions.

How to organise a science event for parents

Author: Kulvinder Johal

Introduction - Why have a science event for parents?

- To promote a love and enjoyment of the subject
- To engage families in a learning experience and build meaningful relationships
- To have a better understanding of your pupils and their backgrounds
- To show how the subject is linked to real life and can be taught through experiences at home
- To raise the profile of the subject
- To galvanise the school in an event
- To ensure parents are better informed about what their children learn at school and the range of strategies used

How do we organise a science event for parents?

- Planning for this event needs to take place well in advance, preferably a term earlier. You will need to liaise with senior management to get their support; ensure the event is put in the school calendar and allow them to have had some input into the activities.
- Make sure staff have an overview of what is going on across the school so there is a shared understanding of the purpose of the event.
- Agree with the staff whether the science event will be for the whole school, or whether you will invite the parents of children in a particular year group, phase or Key Stage.
- Also decide whether the event will be themed on one particular aspect of science; based on what each year group is currently learning; or linked to a special event, such as a science fair.
- Plan where you will hold the science event. Make sure that the space will accommodate the expected number of parents. Remember, if necessary, to book the space. Check that the space allows for the safe movement of parents, children, bags and buggies. Is there somewhere to park prams and buggies?
- You will need to think about the most suitable time to hold the event. Choose a time when most parents can attend. Consider your usual practice at a parents evening and take this as your gauge. If parents work, you might try an evening event, or a weekend event?
- Consider how you will organise the event. If you want parents to do science activities think about who will present each activity to the parents; will it be your pupils or will it be the staff? If the event is to showcase the science in your school will the staff give a presentation or will the children?
- When you prepare the activities for the science event make sure that you have sufficient resources for the number of people expected. Resources get used and some may get lost or removed so make sure that they can be topped up.
- Make sure that the activities can be accessed by all parents e.g. if you have parents for whom English is an additional language they might be put off if there is a lot of reading.
- Health and Safety. Make sure that you have carried out a risk assessment for each of the science activities. Refer to the 'Be Safe!' booklet and CLEAPSS guidance, when carrying out your risk assessment.
- Good communication is key to the success of the event. Ensure all staff are aware of the event, including the building manager and office team. Send letters in good time so parents can make arrangements to attend. A reminder letter/group text should go out a few days in advance of the event.

Further reading

Further information about organising a science event for parents can be found at:

www.nationalstemcentre.org.uk/elibrary/resource/745/parents-in-primary-science

How to organise a science fair

Introduction - What is a science fair?

A Science Fair is one type of event which you may hold that raises the profile of science in your school. Typically a science fair will have a variety of different science activities for pupils and /or visitors to participate in. It can be a stand alone event or part of a larger event such as a Science Week. Guidance is given here for two types of science fair; each has a different approach.

One approach is for organising a science fair where children present their own work where the work was carried out either as part of everyday teaching and learning or as child-led enquiry projects carried out for the fair.

The other approach is for organising a science fair where there is more of an emphasis on setting up simple practical activities for participants to try, led by pupil facilitators.

Part 1 - How to organise a Science Fair where children present their own work

Author: Maria McGrory, Hudson Road Primary School

Why a science fair?

A Science Fair is a great way to show case the learning of a class, a key stage or a whole school.

It is an amazing tool, a way of showing to others the learning that is taking place in your school, the changes that have been made, the enthusiasm of the pupils/staff for Science and a way to involve parents/carers, local schools/businesses/VIPs etc. It can start small and grow or it could be a one off!

How to start?

Sell the idea to your Head teacher or senior management team first. Think it out, how could it work, who could benefit, what would each class involved have to do? Think of the answers to when, where, who, how, what it will look like and be ready with solutions.

Your role?

It takes at least one person to be full of enthusiasm, someone who will give their time to the planning of it, someone who can enthuse other staff at meetings. This is most likely to be you! Your role is to:

- ensure pupil's voice comes through,
- explain the purpose and the effort needed.
- lead by example,
- give reminders,
- organise the space before and on the day. Allocate tables, positions and display boards.
- make sure equipment is available and not overstretched;
- give encouragement and the gentle push if needed!
- ensure the invitations are out on time with the correct information,
- ensure that dates are added to the web site and newsletter.

Basically your role as Science Lead is to cover all the bases and to maintain a sense of purpose and excitement.

Why go to the trouble?

It gives children and teachers a focus for hands on investigative approaches and supports the application of science skills while creating opportunities that demonstrate understanding through interaction with others, describing, discussing and leading simple investigations with visitors and other children. Most importantly it gives a platform for children to step into the role of scientists and to lead others to discovery and understanding.

What could it include?

Your Science Fair could focus on one topic or theme studied across the school thereby showing progression of skills and understanding or it could look at different topics/themes or units as chosen by the pupils or by staff according to your Science approach or outlook.

It could be favourite investigations from across the Science learning, or something the children loved

and want to show others to demonstrate how they investigated and what they learned and now understand!

It could include visitors making something that pupils had made and used in an investigation e.g a bird feeder to add to their back yard or garden to encourage wild life. They could plant seeds and watch something grow over time to help them think about plants and food growth. They could hunt for mini beasts in the garden and be shown how to use hand lens and or microscopes.

It is about being as hands on and investigative as you can in the space you have, trying out equipment or tasks and visitors being encouraged by pupils at each exhibit to engage and question what is there.

Delegate and Support

Whatever your school decides to showcase you need to have planned ahead. Get other people involved at an early stage. Meet with senior leadership to decide on the date or dates for the event, who should be invited, which area will be used for exhibits or displays. Is it all inside or have you outdoor areas that are to be included as well?

Plan routes - Are children available and able to act as guide? Will the children take turns to showcase their exhibit?

Produce handouts as a guide to what visitors might get involved in at the Science Fair. Which staff will be on duty?

Countdown

Use a few minutes at staff meeting, assemblies and School Council meeting times as a countdown to the event so it doesn't come as a shock!

All hands on deck!

Big or small?

First or never again?

Have a go and good Luck!

Part 2 - How to organise a school science fair led by pupil facilitators

Author: Dr Susan Burr

Introduction

The advantages of organising a school science fair are:

- It raises the profile of science in your school
- It builds confidence for pupil presenters and staff
- It includes the whole school community
- It provides an opportunity to work with the wider school community, secondary school or other local schools /cluster.
- It allows pupils to be effective contributors
- To develop good links between primary and secondary schools and support transition

Guidance

Detailed planning is the key to organising a successful science fair. This is often the responsibility of the science subject leader but, where possible, try to enlist the help of a small staff team.

Well in advance you will need to:

- Liaise with the senior management and book the date in the school calendar
- Book the space – a gym or school hall is ideal in which to set up the stations for the different activities
- Make sure staff have an overview of what is going on across the school so there is a shared understanding of the purpose of the science fair.
- Get the message 'out there'. Contact the local press, send invitations to governors and parents and carers. Make sure it is publicised on the school website.
- Think about what displays you will need during the event and also if there will be a display of the event afterwards.
- Organise how the day will be reported after the event. Ask a member of staff, and/or pupils, to take photos of the day

The next step is to research a set of 'simple'

science activities. This will include a risk assessment for each activity (see Be Safe!). It is important to trial these, possibly with a small group of pupils, to make sure that the activities 'work' and that they each take about the same length of time to complete. The programme works well with between 8 and 9 activity stations each taking about 10 minutes. Choose science activities that use inexpensive materials.

A science fair is a great opportunity for pupils to facilitate the activities. Think about who will be in your team of presenters:

- Will you use the science fair as an opportunity to liaise with your secondary school, with some of their pupils acting as facilitators?
- Will the facilitators be from just one year group in your school or will different year groups present the activities?
- Will the facilitators be members of the science club?

Once you have chosen your team of facilitators make time to hold a training session for them. It is a good idea to provide them with

- A set of instructions for their activity
- Questions they could ask the pupils and other visitors attending the fair
- Worksheets/ workbooks for pupils to record their findings.

Remember to have certificates to present to the pupils who facilitated the activities.

Next steps

Start planning your school science fair!

Further reading

Useful sources for science fair activities:

Usborne; Big book of Science, things to make and do. Activity cards www.usborne.com (light tricks; fantastic flyers; magic moments; sounds; chromatography)

BBSRC Real Bugs
www.schoolscience.co.uk (minibeast models)

www.evolutionmegalab.org (sensational snails)

In the Zone
www.getinthezone.org.uk(measuring me)

SCDI: Science on the Menu kits
www.yecscotland.co.uk(fabulous food)

Earth Science Ideas, ESEU activities; www.earthlearningidea.com

www.earthscienceeducation.com (cool crystals; water,water)

Practical Work in Primary Science
www.practicalprimaryscience.org

Gopher Science Labs www.rsb.org.uk

British Science Association
www.britishscienceassociation.org/crest-star/crestcontacts

Centre for Industry Education Collaboration
www.ciec.org.uk/resources.html

How to organise a science week

Author: Kulvinder Johal

Introduction - Why have a science week

- To improve the learning outcomes of pupils
- To promote a love and enjoyment of the subject
- To raise the profile of the subject
- To provide ideas, training and support for staff
- To galvanise the school in an event

Guidance

- Planning for this event needs to take place well in advance, preferably a term earlier. You will need to liaise with senior management to get their support; ensure the event is put in the school calendar and allow them to have had some input into the activities.
- Agree a budget for science week. If you use external providers you could try and access the CPD budget because staff will observe and learn from the providers. If your science week includes other STEM subjects these subjects could contribute.
- Make sure staff have an overview of what is going on across the school so there is a shared understanding of the purpose of the event and also an understanding if there re knock on effects to timetables.
- Agree with the staff whether
  1. there will be a theme for the week for the whole school
  2. you are linking the week to the current science topics
  3. you will be revisiting/consolidating knowledge of a science topic.
- If possible get a team together to organise the event and share the workload.
- Could you work with other local primary schools and / or your secondary school to pool resources and share ideas?
- You will need to decide how to timetable your science week. Will the science be timetabled just in the afternoons, for full days or just on chosen days in the week?
- It is a good idea to launch your science week with a whole school opening assembly. Discuss what will be happening and maybe have a WOW presentation to set the scene
- Think about who will be running the activities. Are you going to use some external providers? Will the teachers be organising the activities with their classes? Will children from one class be running the activities for children in another class? Are they sufficiently prepared with knowledge, resources, support?
- Plan the spaces where the activities will take place. Do you need to book any of the spaces? How might you use the outdoor space during science week?
- End the science week with a closing assembly so that the experiences are shared through pupils talks, video and photos and they learn from each other.
- Good communication is key to the success of the event. Ensure all staff are aware of the event, including the building manager and office team.
- Send letters in good time to inform parents of the event. You may require resources from home or a voluntary contribution. You may want to link this to a **science event for parents** or have a family challenge.
- A science week provides an opportunity to capture wow moments on camera and video and also helps to promote your school so invite the local press.

How to make effective links with industry

Author: Joy Parvin

Introduction

Linking science taught in school with industry can motivate pupils, help them understand that science is relevant and important in industry (rather than seeing scientists as isolated in academic university-style environments), and increase their awareness of and aspirations towards STEM[1] -careers in industry.

How to link with industry

With 24 years of working for the Centre for Industry Education Collaboration, experience suggests there are three tiers of industrial link:

1. The bronze standard – industrial contexts used in science lessons

There are a plethora of resources out there to support the use of industry contexts in the primary classroom, and a useful set of websites are provided at the end of this guide where you can access such resources.

Teaching science in the context of industry has proven to be highly motivational for primary pupils[2] , as the context offers a purpose for carrying out science activities – so in addition to finding out about the world around them, they are solving problems of the type industry faces every day. For example, CIEC resources offer lesson plans for enquiry-driven science activities, as well as interactive websites aimed specifically at the 4-11 age range.

These contexts can include the use of career profiles in lessons, in which the content of the lesson is linked to a career, e.g. if learning about health and medicine the profile of a chemist working for a pharmaceutical company can be accessed online on sites belonging to Association of the British Pharmaceutical Industry (ABPI), Royal Society of Chemistry (RSC), Institute of Physics (IOP), Royal Society of Biology (RSB) and at Future Morph. Some of these are aimed at older students, but are accessible to primary children.

1 Acronym for Science, Technology, Engineering and Maths

2 www.ciec.org.uk/pdfs/research/CCI-research-report.pdf

2. The silver standard – industry ambassadors visit the classroom

Ideally, inviting industry ambassadors into the classroom will build upon, rather than replace the contexts described above. Many industrial companies have ambassador schemes themselves, or are part of national or regional ambassador networks, such as www.stemnet.org and www.ciec.org.uk[3]. Encourage visits to interact with small groups of children, rather than offer a long 'front-of-class' talk. Ask them to bring interesting artefacts and short demonstrations that represent their work, and if they want to bring an electronic presentation, ask them to use photographs and images as the main means of communication.

An important tip for the success of these visits is, to paraphrase Tony Blair, "planning, planning, planning"! Always aim to tailor off-the-peg offers, to ensure that you can maximize the impact on the children's learning of enthusiasm for STEM subjects. Look for schemes and companies that offer young role models to visit school, which represent young people from diverse backgrounds, wherever possible. This does require in-depth conversations with those visiting the school. There is rarely time for face-to-face meetings of this nature, so try Skype, Facetime, or the good old-fashioned telephone, and agree the content of the discussion via email first, to ensure all eventualities are covered efficiently.

3. The gold standard – class visits to industry

The highest level of impact on children is visiting industry, in conjunction with classroom activities that develop industry contexts. As with classroom visitors, plan to maximize the impact of a visit to industry. A useful list of things to consider, plan for and discuss with industry, is available at cciproject.org/industry/visit1.htm. Meeting male and female scientists and engineers in their working environment is a great way of

3 CIEC's ambassadors are often linked to the Children Challenging Industry programme

raising aspirations of primary children, who might otherwise have already decided that science is not really 'for me'. Well-planned visits which meet the needs of the children and the curriculum, and follow on from relevant classroom activities (e.g. seeing large scale filtration after filtering through paper towels in the classroom) can be truly inspiring. For an example of such a visit, read 'A successful recipe for engaging primary school children with industry' in issue 140 of Primary Science (available free-of-charge at www.ase.org.uk/journals/primary-science/2015/11/140/).

What to do now

Check out what's available in your area, at www.stemdirectories.org.uk

Go through the short online CPD unit on linking with industry, at cciproject.org/industry/index.htm, and start planning!

Useful websites

www.ciec.org.uk/primary.html#resources

www.stem.org.uk/resources (get to CIEC, ABPI, etc.)

www.bloodhoundssc.com

practicalaction.org/technology-justice-schools

www.rsc.org/diversity/175-faces

careers.abpi.org.uk

futuremorph.org/11-13/case-studies

www.iop.org/careers/undergrad--postgrad

biologyheritage.rsb.org.uk/bcw-interviews

www.bloodhoundssc.com

practicalaction.org/technology-justice-schools

www.ciec.org.uk

futuremorph.org

How to run a STEM club

Author: Nicola Waller

Why run a STEM club?

Running a STEM club is a brilliant way to extend and enrich children's learning above and beyond the statutory requirements of the primary curriculum. Most clubs use the opportunity to explore areas of science not covered in weekly classroom sessions and provide additional opportunities for children to develop the essential skills of enquiry.

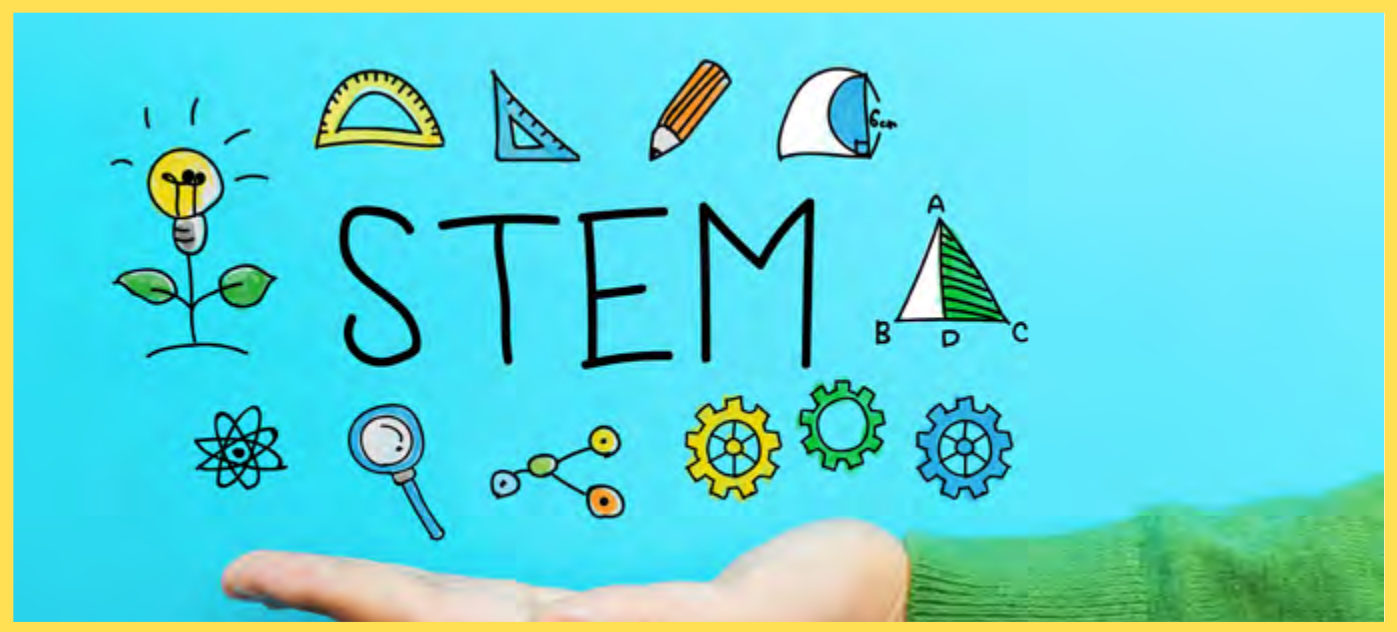
Having a dedicated club once a week allows children the freedom to explore, make suggestions and have a go. A successful STEM club will see children grow in confidence, find their voice as well as nurture their interest to try ideas out at home and bring things in to share with others too. STEM clubs can encourage children to find science, maths and technology in the world around them which, in turn, can raise the profile of STEM across the school and improve children's attitude towards these subjects.

How to run a STEM Club

The prospect of organising and setting up a new club, in particular building up a bank of new and innovative activities each week, can be rather daunting for the busy primary teacher! This guide aims to provide ideas on how STEM clubs can be run successfully and highlight key factors that should be taken into consideration.

You will need to decide which children will be joining the club. This could be a particular year group or key stage, or a focused group of children identified for a particular reason (more-able, underachieving, girls only, parents and children etc.). You will need to consider how many children could attend each session safely. The focus should be on practical experience and hands-on exploration so a ratio of one adult to ten children might be a good place to start and then build from there as your confidence grows.

You will also need to decide when the club will be held – either before or after school, during a lunchtime session or at some other time in the school day. A successful STEM club could run comfortably in a primary school setting for at least 30 minutes and up to one hour in duration, allowing enough time for children to be introduced to their activity or challenge, explore and investigate, talk about what they have found out and then tidy up equipment and resources. Don't forget to agree upon a location for the club to take place – usually a classroom or a shared area in school with a sink or wet area if at all possible and



access to tables and chairs so that children can think, discuss and work collaboratively in small groups.

Running a STEM Club can lead to an incredible journey of discovery for young learners. You could begin by talking about real scientists, engineers and mathematicians and the work that they do, addressing children's misconceptions and raising aspirations. You could look at examples of equipment used by people in STEM careers and then learn how to use them efficiently too - Who can transfer a fragile Cheerio, Sugar Puff and single Rice Krispie using tweezers without crushing them? Who can read tiny letters printed in font size 1 using a magnifying glass to crack the secret code? Which team can use a funnel to transfer coloured water from a bucket into a pop bottle without spilling? Who can collect slime from the 'bog monster's swamp' using a giant turkey baster and then a pipette?

You can have great fun planning, adapting, trailing and perfecting STEM activities, however, this can be extremely time consuming! Many 'wow' activities might look great on websites and in teacher resource books but must be tried out in advance to make sure that they work exactly as described. Great places to look for ideas in order to get you started are:

- Crest Star Investigators: run by the British Science Association
- British Science Week Primary Activity packs: run by the British Science Association
- ExpeRimental videos and ideas: produced by the Royal Institution
- Activity list: produced by the National STEM Clubs Programme

Don't forget to risk assess all of the activities you plan to deliver each week. A great place to look for support and guidance is CLEAPSS, science and technology advisory service, as well as the latest ASE 'Be Safe' publication.

Next Steps

If you would like to develop STEM Clubs further, you might like to visit the National STEM Clubs Programme website www.stemclubs.net and also complete the Science Club CPD Unit found on the Primary Science Teaching Trust website: https://pstt.org.uk/resources/cpd-units/science-clubs

How to develop global Links

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Why develop global links?

Global links provide opportunities to support the curriculum, giving it context and bringing knowledge, ideas and concepts to life. Through partnerships with establishments in other countries, children can broaden their horizons and begin to see more clearly their place in the wider world. While working with their global partners, children learn to appreciate diversity and deepen their understanding of other cultures.

Getting started

- Make use of the personal contacts of you and your colleagues to develop links.
- Get parents involved –Do any of them work in fields that might be of interest/use and are they willing to help?
- Build on links that already exist within the local community.
- Contact other establishments doing what you want to do and ask for advice and support.
- Contact external agencies, such as The British Council, who provide support, advice, training and funding.
- Get involved with charities working overseas – many of them have educational packages and opportunities for developing work further.

What next?

Once you have established a link you could develop a joint project together – Something that will be useful to both partners; something that fits into your existing curricula and work patterns; something that you can work on separately and jointly and share your findings, ideas, learning etc –

Some possible ideas for projects might be: How do we manage our water? What wildlife can we find in our local environment? What do we eat? What games do we play? How do we keep healthy?

How to sustain your links and partnerships

- Get to know your colleagues overseas What are their names? What are their areas of expertise and interests?
- Swap email addresses
- Make a long term plan with goals that are useful to all parties.
- Explore ways to sustain and develop the partnership if funding dries up – a lot can be done at a distance with the help of modern technology – and the postal system!

Useful websites

www.eal-teaching-strategies.com/globallinks.

schoolsonline.britishcouncil.org

globaldimension.org.uk/support/school-links-partnerships/

How pupils can guide their own learning and how to use pupil voice

Author: Lucy Wood

Introduction

Pupils can guide their own learning and make suggestions about the school's science provision by:

- Asking their own questions at the start of a topic or an investigation to influence the direction of study;
- Being given the opportunity to choose certain aspects of their learning and/or to set their own success criteria;
- Giving feedback to the teacher at the end of a topic;
- Evaluating science at whole school level through Pupil Voice.

Guidance

Pupils' ideas and views can be gathered in many ways, with group or individual activities. Try to use different strategies throughout the year and decide what works for you. This may be different for each topic and year group. Discuss your experiences with other colleagues. Be prepared to adjust so that you find strategies which are manageable and work for you.

Generating and using pupil questions

Provide pupils with a stimulus at the start of a topic, to promote discussion about what they already know and also to encourage them to ask questions. This can be done in groups or in a 'think, pair, share' sequence, to give pupils time to consider their ideas at an individual level before discussing them with others. There are many ways of stimulating conversations and generating questions:

1. Give pupils the opportunity to experience a phenomena. For example letting them experience the effects of a range of different magnets will lead to a discussion about what they already know and generate questions.
2. Practical explorations. For example giving children different types of sugar and allowing time for them to explore how they dissolve will help them raise questions that can then be investigated.
3. Watching a demonstration that leaves children wanting to how. A simple example is making water 'disappear' by pouring it into a beaker containing sodium polyacrylate –the nappy liner.
4. The KWL grid with headings of "What I already know", "What I want to find out" and "What I have learnt" generates pupils' questions in the second column.
5. A poster with question starters such as "How..", "Why..", "What..", "When.." can help pupils frame their questions.
6. Post-it notes or white boards can allow pupils to have tentative ideas and arrange the questions into groups.
7. Drama scripts can act as a stimulus to generate children's enquiry questions (see the creativity chapter in the *ASE guide for Primary Teachers* by David Allen)
8. Objects or artefacts can provide a prompt for enquiry questions.

You may not be able to answer all the questions and this can form part of the discussion, but some can inform your planning of the rest of the topic. If they relate to investigations already planned, the questions can provide an initial focus: 'today we are going to try and answer Alex's question'. If the questions require the use of secondary sources, these could be addressed through research either within school or as a homework activity.

Pupils' own questions can be a valuable addition to a working wall/learning wall near the beginning of the topic. (see 'How to use working walls to support science learning' by Rachael Webb) They are also part of Assessment for Learning activities. (see 'How to use assessment to support learning' by Sarah Earle)

Providing decision making opportunities during learning

Learning objectives and success criteria are usually decided by the teacher in advance, but they can be negotiated and adjusted during a lesson or topic by giving pupils the opportunity to choose their own focus for enquiry and to develop the detail of their own success criteria in discussion with others.

- Learning objectives may be developed from pupils' own questions generated earlier in the topic.
- The type of enquiry to be pursued can be discussed and agreed with pupils, so they can develop their skills in selecting from the five enquiry types of Observing over Time, Identifying and Classifying, Pattern Seeking, Research and Comparative & Fair Testing. (see 'It's not fair – or is it? Jane Turner et al. (2011) for more details)
- The precise direction of an enquiry can be decided by the pupils. For example, in a research exercise about endangered species the specific animal chosen could be different for each pupil; in a fair test investigation, the choice of variables to change, control and measure could be discussed and agreed separately by each group;
- The success criteria of a lesson or enquiry can be negotiated with the pupils as part of their own planning.

Pupil Voice and end of topic feedback

Pupil Voice at a class level or a whole school level can be a powerful way to ensure pupils' views are being considered and acted on.

- Individual questionnaires allow pupils to write their views privately.
- Informal group discussions provide a collective view.
- Recorded 'interviews' allow pupils to act as researchers and find out the views of others.

Questions can be specific to a topic, or ask for more global views about how science is perceived (see also 'How to raise the profile of science' by Rachael Webb).

Where to start/What to do now

1. Start with your own class. Have pupils asked their own questions at the start of a topic or lesson? Have some of these questions been used to adjust the topic plans? Have pupils refined their own learning objectives and success criteria? Have you asked for feedback at the end of a topic?
2. Use opportunities for Pupil Voice across the school.
3. Share your experiences with colleagues and make it a focus for your school action plan.