

# STEM IN THE PRIMARY CURRICULUM

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# 1

# STEM AND MAKING LINKS WITH HOME

AMANDA SMITH

## INTRODUCTION

There is considerable evidence that when families see STEM subjects as 'hard' or 'boring' rather than 'exciting' and 'full of potential', children are less likely to engage with and see STEM as being for them (Smith, 2002; NIACE, 2013; Macdonald, 2014). Support from families and carers is vital if more children are to opt for STEM subjects.

This need to engage families and carers in the STEM-related learning of children is addressed in science via a number of projects and resources. Examples include *Learning Science Together*, *Science Opens Doors*, the Institute of Physics' *Marvin and Milo* cards, *Science Sparks* and *Pop up Physics for Families*. All focus on encouraging curiosity and hands on exploration.

## IN THIS CHAPTER

In this chapter, I focus on the *SCRUFF* project. This project not only engages families in science learning, it explicitly attempts to set up a positive dialogue within the family about science learning, a dialogue that is structured and reinforced by the school through the use of the *SCRUFF* resources. This is an approach to strengthen home-school learning that can be used across all STEM disciplines.

The activities presented in the second half of this chapter are inspired by the work of the *SCRUFF* project. They are intended to stimulate scientific thinking and discussion through practical activities completed at home, and will help you to enhance the attitudes and confidence of the children in your class.

There are a range of activities for children in the primary years that encourage scientific thinking and exploration.

## SCRUFF

Science for Children Ready to Use with Family and Friends (SCRUFF) comprises a set of science based teaching and learning materials designed to be used by children at home, with introduction and follow-up in school. SCRUFF has been created collaboratively by the Centre for STEM Education at Manchester Metropolitan University and its partner Primarily Science. The SCRUFF approach involves mapping the attitudes of children and their families towards science learning and tracking how they change as families engage in fun, interactive science activities together. The school plays a central role in structuring, driving and consolidating this learning process. The process has resulted in significant improvement in family attitudes towards children's STEM learning with more active support and encouragement being offered with homework and ultimately with subject choice (Smith, 2002).

### SCRUFF IN PRACTICE

SCRUFF has a 'comic book' appearance led by an appealing cartoon dog character who likes to go on adventures and make discoveries. The project is introduced in school and children take home activities to work on with a family member or carer. Where this is not possible, children are encouraged to work with a friend or an older child from the school. The activities are easy to run and the resources needed readily found in most homes. The purpose of each activity is not to arrive at a 'correct answer' but to have fun by investigating, observing and exploring together. The teacher's effective direction of the project is vital to its success.

The project takes place over a six-week period. The teacher initiates it by an explanatory letter home introducing the project, with a 'find out' meeting for children and families. The opening activity is a questionnaire for children to use with their families to explore their own experience and attitudes towards science. This is followed by fun weekly investigations with the teacher preparing the children to lead the activity in the home. The teacher follows up on the activity to consolidate learning, pursue ideas and questions and to talk about what it was like working on science at home. Children and their learning partner (family member or carer) are encouraged to keep a SCRUFF diary; this can provide good evidence of engagement and learning for all those involved. The final activity is a questionnaire where children and their partners reflect on what it has been like to work together and how their engagement and attitudes have changed.

### SCRUFF AND MEASURING ENGAGEMENT

In relation to the pre- and post-questionnaires on engagement and attitudes to science, the teacher is key in ensuring the children are well prepared to lead on these activities with their learning partner at home. In effect, the teacher conducts and models an interview with the children about their own engagement and attitudes to science learning. The interview comprises a series of straightforward questions that tease out the science they have done in school and how they approached it, and confirms that these approaches are scientific. This will help children to identify the scientific content they have explored and the scientific methods they have used, such as observing, experimenting, making predictions, investigating and so on. Finally, children should be encouraged to make statements about their attitudes to their science learning so far using open ended questions such as:

- 'What do you think of science?'
- 'Did you enjoy it and if so why?'
- 'Do you think science is important?'
- 'Have you learned any science outside of school?'

Children often draw on their experience of science in the media here. For example, there are a range of children's television programmes as well as magazines and books related to science. The interview may be supported by a writing frame using number scales and word fields that children draw on to help them structure their responses. The resultant information can be treated as a collection of data for the school to evaluate the affective impact of their science provision on the children. The key messages are then fed back to the group to help build a dialogue about their science learning to date.

A similar questionnaire can be developed with the children for use with their family learning partner. The teacher will have access to this for analysis. The teacher casts the children as interviewers and encourages them to use a recording device such as a smart phone to capture the interview. The interview itself focuses on experiences that we all have in common through questions such as:

- 'Did you learn science at school?'
- 'What did you think of it?'
- 'How did you learn it?'
- 'What sorts of things did you do?'
- 'Did you like science?'
- 'Have you learned any science since you left school?'
- 'Do you think science is important?'

Children report back on what they found out in the interview during the follow-up in school. They can use the recording to remind themselves of the key points and help focus their report. The teacher's role is to draw out the key differences and similarities between the responses the children gave about science and those of their family members.

When all the SCRUFF activities have been completed at home (usually one a week for six weeks), the final interviews are conducted. In school, the teacher draws out the learning from the project and what difference it has made to the children to work on science with someone at home. The children then interview their learning partner and try to draw out the benefits of the science experience they have shared using questions such as:

- 'What did you find interesting?'
- 'Did you enjoy the investigations?'
- 'Was it different to the way you learned science at school?'
- 'Did you enjoy us working together?'



## 1 STEM and making links with home

The learning pair should look at the recording grid and interview they made at the start and see if anything has changed. In a similar way, the teacher debriefs on the key findings and these are used to construct a concluding letter that celebrates the impact of the project with participating families. Some schools have a celebration event to talk about the experiences they have had. The intention here is to consolidate an on-going relationship between the child and their learning partner around their STEM experiences in school.

The activities in this chapter are designed to be completed by children working with their learning partner at home. The teacher needs to spend time introducing each activity and then discussing children's experiences.

### ACTIVITY

#### Get the Point?

##### What you need to know

At home, children and their learning partners work scientifically to investigate the differences in sensitivity of some areas of the skin to touch. They draw conclusions from their experimental findings and consider why different parts of the skin show differing sensitivities to touch. The final activity requires the learning team to consider the findings of recent scientific research and carry out an investigation to explore why fingertips go wrinkly in water.

##### Preparation

Objectives: Exploring which part of the hand and arm are most sensitive to touch

Curriculum links: Working scientifically - investigating everyday phenomena, conducting a fair test, recording and discussing outcomes

Year groups: Suitable for years 3 to 4. Older children might extend the skin sensitivity investigation to other parts of the body - they could form and test a hypothesis

Equipment: Paperclip and ruler. Marbles and warm water for the follow-up activity

##### Useful links

STEM Education centre website: [www2.mmu.ac.uk/stem](http://www2.mmu.ac.uk/stem)

Primarily science website: [www.primarilyscience.co.uk](http://www.primarilyscience.co.uk)

ASE website: [www.ase.org.uk](http://www.ase.org.uk)

##### Setting the scene

When dogs are born they cannot see or hear. The first sense SCRUFF developed was the sense of touch. SCRUFF has very sensitive pads on her feet and whiskers above her eyes that are sensitive to air flow. She also loves to be stroked!



Humans also learn a great deal about the world around them from their sense of touch. Our skin contains lots of tiny touch sensors but some areas of the skin have more touch sensors than others. This experiment will be done at home with a family member or friend. We will call them your partner. You will investigate which parts of your body are the most sensitive to touch.

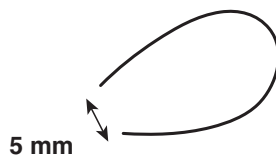
### Trigger questions

- Can you design an investigation to find out which part of your hand or arm is most sensitive to touch?
- Which part of your hand and arm do you think might be the most sensitive to touch?
- Why?

### Time to experiment at home

Sit down with your partner in a quiet place.

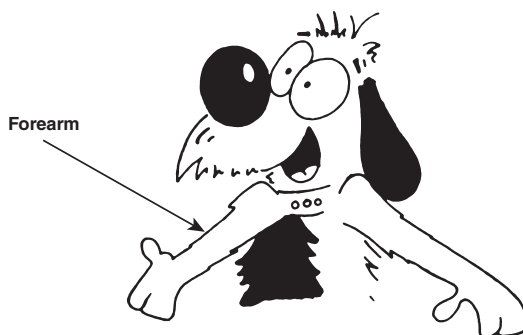
Bend a paperclip or hair pin into a horseshoe shape until the points are 5 mm apart.



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**How sensitive is your forearm?**



Ask your partner to close their eyes and keep them closed.

Gently touch your partner's forearm with either one or two points of the paperclip. Your partner has to guess how many points they feel each time.

Touch them 5 times with one or two points (you decide) and count how many times they get it right. Make a note of the score out of 5.

Now swap places and repeat the experiment. You close your eyes and your partner will test you with one or two points of the clip.

Make a note of your scores out of 5.

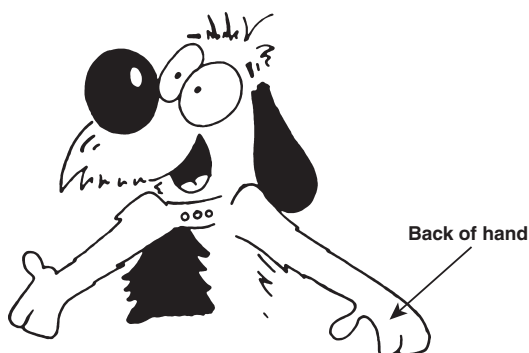
How many did each of you get right out of 5 goes?

**How sensitive is the back of your hand?**

Ask your partner to close their eyes and keep them closed.

This time touch the back of your partner's hand 5 times with one or two points.

Count how many times they get it right.



Now swap places and repeat the experiment. You close your eyes and your partner will test you with one or two points of the clip.

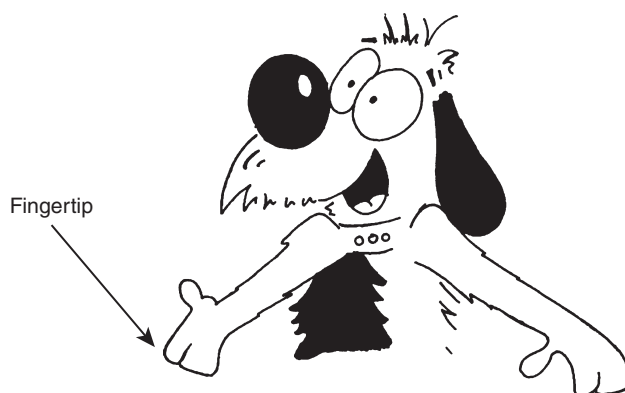
Make a note of your scores. How many did each of you get right out of 5 goes?

### How sensitive is your fingertip?

Ask your partner to close their eyes and keep them closed.

This time touch your partner's fingertip 5 times with one or two points.

Count how many times they get it right.



Now swap places and repeat the experiment. You close your eyes and your partner will test you with one or two points of the clip.

Make a note of your scores. How many did each of you get right out of 5 goes?

### Review and reflect

Look at the scores.

Did you notice any patterns? What did you observe in your scores?

Of the three areas you tested:

- Which was the most sensitive part of the skin for you?
- Which was the most sensitive part of the skin for your partner?
- Which was the least sensitive part of the skin for you?
- Which was the least sensitive part of the skin for your partner?
- Which part of your skin do you think contains the most touch sensors?
- Why do you think this part of the skin contains the most touch sensors?

*(Continued)*

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### Assessment

The teacher can use the responses to the activity questions in order to assess the outcomes.

They can carry out a debriefing session where children can share their findings, observations and ideas.

A SCRUFF diary might be completed by the child and family member to reflect on the experiment, and evaluate their findings and enjoyment of the activity.

The same can be done for the follow-up activity.

### Follow-up activities

#### Why do fingertips go wrinkly in the bath?

Have you ever noticed that your fingertips go wrinkly when you spend a long time in the bath?

Discuss with your partner what they look and feel like.

Do your arms and legs go wrinkly too?

What about your toes and feet?

Why do you think this wrinkling happens?

Jot down some of your ideas. Do not worry about getting a right or wrong answer. Try and think of as many ideas as you can, even if they seem wild!

Here is some interesting information:

Scientists have found that if the touch sensors are damaged on a fingertip it does not wrinkle in water!

## ACTIVITY

### How good are wrinkly fingers at picking up objects?

#### Experiment 1

Time how long it takes you to pick up and move 20 dry marbles one at a time from one bowl to another.

Time how long it takes you to pick up and move 20 wet marbles one at a time from one bowl to another.

Which was the fastest? Did you find it easier to pick up the dry or wet marbles?

Now let your partner have a go.

How did you make sure this was a fair test?

#### Experiment 2

Now soak your hands in warm water for about 20 minutes or have a bath!

Repeat the experiment above with your wrinkly fingers.

Which was the fastest? Did you find it easier to pick up the dry or wet marbles?

Now let your partner have a go.



What did you and your partner find interesting in your results?

Did you notice any patterns?

Why do you think this happened?

What ideas have you now got about why fingers go wrinkly in water?

## ACTIVITY

### SCRUFF's floaters and sinkers

#### What you need to know

At home, children and their learning partners work scientifically to explore floating and sinking with everyday objects. They look for patterns in the properties of the floaters and the sinkers. The activity is extended to consider what happens to fruit in water when its peel is removed. The follow-up activity aims to surprise the learning team and provoke ideas and conversation that leads to an exploration related to density. This activity does not include a scientific explanation of density.

#### Preparation

Objectives: Exploring floating and sinking

Curriculum links: Working scientifically - investigating everyday phenomena, conducting a fair test, recording and discussing outcomes

Year groups: Year 1 upwards. Older learners could use Plasticine to investigate whether different shapes float or sink, e.g. a hollowed out bowl or a compact solid shape

Equipment: Sink, bowl or tank, small objects made from different materials, e.g. spoon, pen, coin, paper, cotton wool, wood, plastic, orange and any fruit that will peel, lemonade or any clear fizzy drink, 6 raisins or sultanas

#### Useful links

STEM Education centre website: [www2.mmu.ac.uk/stem](http://www2.mmu.ac.uk/stem)

Primarily science website: [www.primarilyscience.co.uk](http://www.primarilyscience.co.uk)

ASE website: [www.ase.org.uk](http://www.ase.org.uk)

#### Setting the scene

SCRUFF likes to swim and fetch her ball in water. She has a special ball that is light and full of air. Some objects stay on top of water; this is called floating. SCRUFF's ball floats on water so she can see it easily.

We say objects sink when they fall to the bottom in water. It is not always easy to guess which objects will float or sink in water so we need to test them. You are going to investigate floating and sinking with a family member or friend. We will call them your partner.



### Trigger questions

- Think about objects that you have seen floating. What do you think objects that float have in common?
- Now think about objects that you have seen sinking. What do you think sinking objects have in common?
- Can you design an investigation to find out which objects float and which sink?

### Time to experiment at home

#### Everyday floaters and sinkers

Collect some small objects made from different materials.

Fill a bowl, sink, tank or bath with water.

With your partner decide which objects you think will float and which will sink.

Sort them into two piles.

Drop the objects into the water one at a time.

Watch what happens.

Which objects float? Is there anything similar about them?

Which objects sink? Have you spotted anything similar about these objects?

Can you find a way to make floaters sink and sinkers float?

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### **Fruity floaters and sinkers**

Now try putting an orange into the water. Does it float or sink?

Why do you think this happens?

Peel the orange and put it back in the water. Does it float or sink?

Why do you think this happens?

Place the peel in the water. Does it float or sink?

Why do you think this happens?

Try the same experiment with different fruits that you can peel, e.g. apples, bananas and lemons.

What do you observe? Can you explain why?

### **Review and reflect**

- Discuss your findings with your partner.
- What have you noticed about things that float?
- Do all the things that sink have something in common?
- How would you explain floating and sinking to someone else?

### **Assessment**

The teacher can use the responses to the activity questions to assess the outcomes.

They can carry out a debriefing session where children can share their findings, observations and ideas.

A SCRUFF diary might be completed by the child and family member to reflect on the experiment, and evaluate their findings and enjoyment of the activity.

The same can be done for the follow-up activity.

### Follow-up activity

#### Sinking sultanas

Pour some lemonade or clear fizzy drink into a glass.

What do you think will happen if you drop six sultanas (or raisins) into the lemonade? Will they float or sink?



Drop the sultanas into the lemonade and observe very carefully what happens.

Look closely at the sultanas. What can you see forming on their surface?

Discuss with your partner what you have observed. Can you explain what is happening?

## ACTIVITY

### Blowing for gold!

#### What you need to know

At home, children and their learning partners work scientifically to investigate the relationship between height and lung capacity (i.e. how much air your lungs can hold).

The learning team investigate lung capacity by measuring how far a tin foil ball can be blown across a surface using a drinking straw, following a deep intake of breath. They are encouraged to involve other family members and friends to collect a range of results and look for patterns.

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Finding ways to measure how much air you can breathe in or blow out can help us find out how much air your lungs can hold.

### Preparation

Objective: Investigation to find out whether your height affects how much air your lungs can hold

Curriculum links: Working scientifically, conducting a fair test, measuring and recording data, drawing conclusions from data

Year groups: Years 3 and 4. Older learners could record their results in a spreadsheet and investigate representing their data in a graph

Equipment: 2 drinking straws, tape measure or ruler, small piece of kitchen foil rolled into a ball

### Useful links

STEM Education centre website: [www2.mmu.ac.uk/stem](http://www2.mmu.ac.uk/stem)

Primarily science website: [www.primarilyscience.co.uk](http://www.primarilyscience.co.uk)

ASE website: [www.ase.org.uk](http://www.ase.org.uk)



### Setting the scene

When SCRUFF gets very excited she pants. The air goes in and out of her small lungs as she breathes in and out.

Do you think bigger dogs have bigger lungs that can hold more air?

You have two lungs and they are so big they take up most of the room in your chest. They are protected by a set of bones called your rib cage. Place your hands on your chest and breathe in and out

slowly and deeply. Feel your chest move upwards as your lungs fill with air. Doctors can tell how well our lungs are working by asking us to take in a deep breath and then blowing out air as fast and long as you can. The amount of air you can blow out tells us about how much air your lungs can hold.

**Trigger questions**

- Do you think big lungs can take in and breathe out more air than small lungs?
- Do you think taller people have bigger lungs than shorter people?
- If a person breathes in deeply, how can we test how much air they can blow out in one go? What kinds of things could we observe or measure?

**Time to experiment at home**

Let’s investigate how much air you can blow in one breath.

Take a drinking straw each and make a small ball with some kitchen foil.

Practise blowing the foil ball along a flat surface, like a table top or the floor.

Blow the ball back and forth to each other.

Next, hold your straw and place the foil ball in front of you on the flat surface.

Take a deep breath in and with one big blow through the straw, see how far you can blow the ball across the surface. Use a ruler or tape measure to find out how far the ball travelled in cm. Do this one at a time, using the same ball and surface. Place the ball in the same place in front of you each time.

Use a tape measure or ruler to measure your heights in cm.

Can you find more family members or friends to take part in your investigation? Have a competition to see who can blow the ball the furthest.

You could record your results on a table like this one:

Name	Height in cm	Distance travelled in cm

**Review and reflect**

- Why should you keep the ball, surface and starting point the same?
- Who was the tallest?
- Who was the shortest?

*(Continued)*

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- Who could blow the ball the furthest?
- Did you notice any patterns in your results?
- Who do you think has the biggest lung capacity (whose lungs can hold the most air)?
- Do you think taller people have a bigger lung capacity than shorter people?

### Assessment

The teacher can use the responses to the activity questions to assess the outcomes.

They can carry out a debriefing session where children can share their findings, observations and ideas.

A SCRUFF diary might be completed by the child and family member to reflect on the experiment, and evaluate their findings and enjoyment of the activity.

The same can be done for the follow-up activity.

### Follow-up activities

What other factors might affect how far the ball will travel?

Design your own investigation. Here are some ideas of things you might explore:

- Surface the ball travels on.
- Size of the ball.
- Size of the straw.

Can you design and make a good game to play using the kit from this investigation?

If someone playing your game is taller, have they got a better chance of winning the game?



Involving family members in practical activities at home can stimulate conversations that help to build children's confidence and attitude towards science. Completing the SCRUFF diary together provides a basis for dialogue with the home that puts children's learning foremost.

Children's attitudes towards STEM form early, and parents or carers have a profound influence (Archer Ker et al., 2013: ASPIRES project). Providing enjoyable shared experiences can make a real difference.

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## FURTHER READING

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## WEBSITES

Learning Science Together: <https://pstt.org.uk/resources/curriculum-materials/learning-science-together>

Institute of Physics, 'Marvin and Milo': [www.physics.org/marvinandmilo.asp](http://www.physics.org/marvinandmilo.asp)

Science Sparks: [www.science-sparks.com](http://www.science-sparks.com)