

THE POWER OF LIGHT

Learning resources that explore how investigating very small things can help inform our thinking about Big Questions

Suitable for use in classrooms, clubs and community engagement sessions



Resource Pack Teaching Notes

Offers strategies, using zines and hands-on activities, to build epistemic insight by increasing students' appreciation of how knowledge works.

Use these resources to explore examples of scientists' current innovative research that are taking place in UK's national synchrotron science facility at **Diamond Light Source**

Resources (zines & animation) are:

- developed to engage and sustain curiosity, and build observational skills
- encouraging conversations that explore questions about being human and the world around us

Zine 1 - Why do things change?
Zine 2 - Why does life exist?
Zine 3 - Why do we explore the world around us?

Teaching notes for exploring Zine 1 - 'Why do things change?' with its focus on the Mary Rose

These resources investigate the relationships between the disciplines of science, the arts, humanities and technology



Teaching Notes

for 'The Power of Light' resources

Science and Big Questions – Exploring how light is used to investigate and understand aspects of the world around us

What is the Power of Light project (and its resources) about?

The Power of Light project has been funded by STFC to develop, through co-creation activities, a series of 'zines' and an animation. These resources take children and adults on a journey to explore the contributions of science and technology when building our knowledge about the world around us. The 'zines' are developed as resources for use in the classroom, at home, and in community settings. The 'zines' use an appealing combination of text and images to create a concise comic-like narrative format (four sides of A4) and aim to generate enthusiasm about ways of investigating our world. Each zine brings together elements of a science curriculum with the real-world research of scientists, and includes practical/hands-on and multidisciplinary activities. The animation is designed to support the use of zines by introducing Big Questions and how a synchrotron supports scientists' research.

The Power of Light project supports a dialogue between primary science teachers and scientists' work to help spark the wonder and interest of 'working scientifically' in accessible ways to all students. Bringing this project's resources into classrooms helps to improve conversations about science and its connections across different topics as well as promote the value of STEM skills and careers to a wider audience.

'The Power of Light' resources follow the Epistemic Insight pedagogy. Children carry out hands-on investigations in which they learn to **observe** and record their **observations**. Activities and examples in these resources teach scientific enquiry and builds children' understanding of **science as a discipline**, in accordance with OFSTED guidelines. They practise using the scientific terms, 'observe' and 'observations' and so learn to 'think like a scientist'.

These resources are designed to engage and sustain curiosity about how knowledge 'works'. As children understand the distinctive nature of science, they can work with knowledge by comparing science with some other disciplines. Using strategies to build epistemic insight, these resources enable conversations that help children to appreciate that science is one way of answering questions we commonly have about being human (personhood) and the world around us (the nature of reality). Other ways of knowing such as history, maths, geography, religion and the arts can provide valuable contributions by adding **different disciplinary perspectives**.

The Power of Light resources and activities can be spread over several sessions, and can be used at different times to support activities and learning in different contexts. The Power of Light resources are being used in primary and secondary schools, home education, and community/family workshops for both children and adults.

Note – these teaching notes support sessions with Zine 1 "Why do things change?". To access teaching notes for Zines 2 and 3, use the QR codes, [The Power of Light – The Future of Knowledge](#) or [For Education](#) - - [Diamond Light Source](#)

Zine 1 - Why do things change?

Materials for quick hands-on activities: old pennies, lemons, optional: rulers/slides, petroleum jelly

What is the session about?

This session aims to support children and teachers in using the scientific language of **'observe'** and **'observations'** to help children to work scientifically.

Through exploring an area of research at Diamond Light Source (cultural heritage), this session enables children to learn how scientists can work with other scholars/researchers to understand more about the world around us. The case study in Zine 1 is focused on work to preserve the Tudor ship, the Mary Rose.

Research questions in school (for the Power of Light project)

Can children identify 'observe' and 'observations' as key to investigating scientifically? (*disciplinary knowledge/working scientifically*)

Can children compare the use of tools scientists use to observe when working scientifically? (*e.g. at Diamond Light Source*)

Can children identify how small things that are observed through scientific methods, and working with other disciplines, can help inform our thinking about Big Questions? (*nature and value of science and working in multidisciplinary ways*)

National curriculum content

Science - properties and changes of materials, use of light, working scientifically

History - an aspect in British history that extends pupils' chronological knowledge beyond 1066

Further links can be drawn to **RE** and **Geography**

Support & Free Materials

1 animation ([online version via Zenodo](#)), 1 Zine (A4 – four pages, full colour), 1 set of teacher notes

Use the [Epistemic Insight Glossary | Zenodo](#) to support use of vocabulary for sessions.

TEACHING NOTES for use in classroom settings

Session 1:

Note on use of animation video:

A four-minute animation has been designed to introduce the 'Big Questions' that can bridge Project of Light resources and zines. The animation helps to explain how scientists might use facilities at Diamond Light Source to investigate the structure and relationships of matter that is very small, and how scientists' work can inform the work of other disciplines/scholars.

- Ideally, show the video during each of the sessions when using Power of Light zines (each time children watch it, the process of re-viewing may enable children to pick up on different things/make different connections)*
- Be prepared to pause the video at points to bring children's attention to key discussion points*
- Consider the possibility of showing the video at different points in each session – it could be shown at the beginning of the session, or part of the way through a session to illuminate a discussion point in a zine/activity.*

There is a student worksheet at the end of these teaching notes.

Part 1 - Hook Questions – 5-10 mins

(Ask the following at the beginning of the lesson. Display these on the whiteboard):

- 1. Why do things change?** *(in feedback from pair and share, draw attention to this is a Big Question... a question about being human and the world around us, this could include a discussion of examples of things that change)*
- 2. What helps us to know more about things around us?** *(in feedback from pair and share, draw attention to ways we build knowledge – using the senses, looking at evidence from the past, testing, comparing)*
- 3. What might we use to help us observe changes?** *(in feedback from pair and share, draw attention to tools used in science to measure and to see small things... could refer to learning about materials, and use of magnifying glasses)*

Ask children: *"Can Science give us answers to all these questions?"*

(in feedback, it is important to encourage children to see the power of science to help us in our thinking about these questions... we are still discovering more, and we do not know if there will ever be a time when we have 'all the answers'! the key idea here is that we can get a fuller understanding of the world around us... and our questions... by using science and other 'ways of knowing' – this is discussed on the final page of Zine 1).

Part 2– Watch the online video – 8 mins (with a few pauses to draw attention to key points)

Part 3 – Reading and discussion time for page 1 of Zine 1 – 8 mins

This could be an opportunity for independent reading, then pair and share... or for reading together as a class. In the landscape with two figures (top left) there are two speech bubbles. These could provide an opportunity to compare observations about the past and present, as well as introduce what historians might use to build our knowledge about the past (stories and diaries, personal objects, things made by people [artefacts]).

The progression through the narrative is indicated by both numbers and footprints. The stamp was produced when the Mary Rose was brought out of the water in the 1980s.

Ask children: "What was the problem/puzzle that the scientist (Fred) was trying to help solve?"

Follow up with: "What might Fred need to do to investigate this problem/puzzle?"

Note: a glossary for key/new words is on page 2

Part 4 – Reading and discussion time for page 2 of Zine 1 – 8 mins

This page establishes two things:

1. The changes that were taking place in the materials of what was left of the Mary Rose when it was removed from the sand/slay/salt water appeared to be taking place particularly where wooden timbers and metal bolts were now exposed to air
2. To understand these changes (and try to slow/stop the deterioration of what was left) scientists needed to see inside the cell walls of the ancient wood. They needed something more powerful than a magnifying glass, or even a microscope.

This page also offers the opportunity for children work scientifically through a hands-on activity to observe 'change' in the surface of a material.

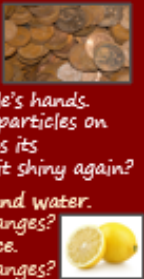
Part 5 – Practical hands-on activity in Zine 1 on page 2 - 15 mins

Try these activities

1) Can you make a penny shiny again?
When a penny is newly made, the metal (copper) is shiny. Over time, the penny becomes dull because it is exposed to oxygen, dirt and oils from people's hands. The interactions between these particles on the surface of the penny changes its appearance. What would make it shiny again?

a) Wash the penny with soap and water.
Observe – are there any changes?

b) Soak the penny in lemon juice.
Observe – are there any changes?



The scientists at Diamond Light Source use the synchrotron to observe and test changes that occur in matter.
(For example, to see why the acid from lemon juice affects the surface of a penny).

2) Make a mini-magnifier (with your teacher)
Use a ruler or clear plastic and a drop of water to make things appear bigger

Please try to give a penny to each child to experiment upon and observe. Children could be instructed to work out the ways they will test and observe. The worksheet on pages 7 and 8 should be used – **it may be that side two is discussed and completed in a session on a following day**

Helpful Notes:

- a solution of vinegar and salt can be used instead of lemon if there are issues with citrus allergies in the class
- have cotton wool/cloth available for children to rub the coin – suggest that they rub only one side so that they can compare changes
- It may be useful to have some vinyl food prep gloves available for children with sensitive skin/eczema (as the lemon juice may sting cuts)
- A magnifier can be made with a drop of water on a piece of laminating pouch (cut to 10cm x 15cm)

Ask children to predict and then, "record your observations"

Relate back to the video – to understand what is happening when things change, observing changes in materials very closely (making tiny things large enough to observe) needs to have tools that are stronger than a magnifying glass, even stronger than a microscope.

Session 2:

Part 6 – Exploring pages 3 and 4 of Zine 1 - 10 mins

Page 3 of Zine 1 focuses on three distinct areas:

- 1) To see very small things, scientists at Diamond Light Source use X-Ray beams. The small particles that can be observed (for example, observing the changes in the wood that had been in contact with metal bolts on the Mary Rose, and was decaying fast) are so small it would take 80 of them to be as thick as a piece of human hair
- 2) Other artefacts were found on the Mary Rose – these tell historians and others about the ways people lived on their ships 500 years ago
- 3) A profile of Fred, one of Diamond Light Source's scientists who helped historians and archaeologists with research on the Mary Rose

Page 4 of Zine 1 brings to the attention of children that science is a discipline (a way of knowing) it would be useful to discuss with students briefly that the word discipline can have several meanings (a footballer may be disciplined to train every day, a dog owner may train their dog to have good manners and be disciplined – in this context

A discipline is a way people specialise to investigate and understand a key area of knowledge (about the world), like science, history, languages, art, etc.

Each discipline has some questions and ways of investigating that are distinct, for example:

- science may ask what, when how and why, and will observe to find out more
- history may ask what, when, how, why, and who – and will look to evidence from the past to find out more

Therefore, there are similarities and differences between disciplines.

What is important to emphasise with children is that if we use only one discipline to learn about the world around us, we may only get part of the picture of a puzzle of why things in the world happen/work as they do.

Science can help inform our thinking by investigating things that can be observed – this can then help other disciplines to understand more.

Plenary

1. **Why do things change?** *(review – in the Mary Rose, the changes were happening when materials were in contact with each other in ways that were creating reactions – these reactions were taking place inside the walls of cells due to interactions between wood, metal, salt water, air – forming acids that were breaking down cell walls in the wood and causing damage to what was left of the Mary Rose)*
2. **What helps us to know more about things around us?** *(review – observing things very closely, over time, watching for changes that might take place and test our understanding)*
3. **What might we use to help us observe changes?** *(developing tools to help us see and observe small things, for Diamond Light Source – X-Rays in the synchrotron, having the patience to observe changes over time, being open to test to check that we are getting the 'fuller' picture of what we think we are observing)*

Further development opportunities in the classroom

1. Why do things change?

PRSHE - This could be discussed in terms of personal development: growth, attitudes, relationships, responsibilities. One's understanding can change as one gets older.

Science/Geography - This could also be discussed in terms of the natural world: seasons, time, cycles.

SMSC/RE - If children have learned about Buddhism, some discussion could relate to the key teaching of anicca – everything changes. A discussion about how changes in the year are marked by key festivals, and how changes in life can be celebrated by key rituals.

2. What helps us to know more about things around us?

Identify how we learn about the world around us, and why people might want to investigate and understand more about the world. This could open into a P4C activity about 'what is knowledge?', 'how do we know stuff?', and 'does knowledge change?'

3. What might we use to help us observe changes?

This could bring in a discussion about changes that happen quickly, or over time. There is an experiment on page 3 on Zine 1 that encourages children to 'think like scientists' – to create an experiment that may need time to observe and understand changes.

Additional notes and guidance:

Making a Water Magnifier (if you do not have access to magnifying glasses for hands-on activities): See the teaching and student notes for activity on Zine 1 page 2 – making a water magnifier via our website (via QR links)

Guidance for research-engaged teaching:

Research-informed practise is an important way to support professional development. During the pilot stage of the Power of Light project in 2022, research fellows worked with teachers to record and analyse children's responses to activities and resources.

In the final pages of these teaching notes, we have included the surveys used in our research – you are welcome to use/adapt these questions.

Key to the activity is that you signpost science as a discipline throughout by using the term 'discipline' along with regular use of key scientific terminology - explaining for example, that as a discipline, science has a focus on making observations, whereas history is another discipline and has a focus on what people have written about living in the past.

Please ensure each pupil's name is included on each survey/worksheet, to enable matching of responses.

For further information and support, please contact lasar@canterbury.ac.uk.

My full name is:



Why do things change?	
1. Examples of change that can be observed in the world around us:	
Penny Investigation	
2. Prediction: How can we make a dull copper penny shiny again?	3. Observations: What did you observe when trying to make the penny shiny again?
	Test 1: Test 2:
4. What could you use to help you observe changes that take place on the surface of the penny? (You can draw or write about what would help to see things that are very small)	
What was the puzzle/problem in the Mary Rose <u>that scientists</u> were working with historians to try to solve?	

Exploring a Big Question through different Ways of Knowing (Disciplines)



END OF ACTIVITY: Please answer the following questions. You can skip any you don't want to answer.

1. What did you learn about the work of scientists at Diamond Light Source today?

2. Was there anything that surprised or interested you in today's session?

3. Science can work well with other disciplines to help investigate Big Questions (Please circle **one**)

Yes	Maybe	No	I don't understand the question
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4. Write down a Big Question that you think would be interesting to investigate (you can add more than one):

Note – page 4 of Zine 1 will help with these activities/questions

Epistemic Insight

STUDENT SURVEY RESPONSE SHEET



Full name: _____ **I am a:** girl / boy / prefer not to say **Year group:** _____

This sheet asks you about different kinds of questions and things you might talk about in school or at home. The questions are answered by children in lots of schools – these help us make new lessons and activities.

Please answer all questions as well as you can. If you don't want to answer a question you can skip it.

You might not understand all the words. Don't worry if you are not sure what a question is asking or what a word means. If you don't understand a question, then circle the box that says: "I don't understand".

1. I want to find out more about science

Yes	Maybe	No	I don't understand
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2. I share what I am learning about science and/or technology at school with my friends and family

Yes	Maybe	No	I don't understand
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3. I am excited about studying science when I get to secondary school

Yes	Maybe	No	I don't understand
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4. I am interested in a career in science and/or technology

Yes	Maybe	No	I don't understand
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5. I understand how science and/or technology helps to improve our lives

Yes	Maybe	No	I don't understand
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6. I feel science will have a positive impact on our future

Yes	Maybe	No	I don't understand
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7. I understand what a discipline is

Yes	Maybe	No	I don't understand
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8. All of our questions can be answered by science.

Yes	Maybe	No	I don't understand
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9. I understand how investigating small things in science can help us think about Big Questions like 'why does life exist?'

Yes	Maybe	No	I don't understand
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10. Observation is a really important part of science

Yes	Maybe	No	I don't understand
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11. I can give an example of how science works together with other disciplines

Yes	Maybe	No	I don't understand
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12. Learning science increases my sense of wonder about our amazing world

Yes	Maybe	No	I don't understand
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13. Someone in my family is really into science or works in science

Yes	Maybe	No	I don't understand
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My religion is (circle one)

Christian / Muslim / Jewish / Hindu / Sikh / Buddhist / Agnostic / Atheist / Other / prefer not to say

Thank you for helping us with your thinking and answers!



STUDENT SURVEY RESPONSE SHEET



Full name: _____ **I am a:** girl / boy / prefer not to say **Year group:** _____

This sheet asks you about different kinds of questions and things you might talk about in school or at home. The questions are answered by children in lots of schools to help us make new lessons and resources.

Please answer all questions as well as you can. If you don't want to answer a question you can skip it. Some of the questions in this survey are similar to the ones you answered in the other survey you did.

You might not understand all the words or questions. If you don't understand a question or word, then circle the box that says: "I don't understand".

1. I want to find out more about science			
Yes	Maybe	No	I don't understand
2. I now feel more confident sharing what I am learning about science and technology at school with my friends and family			
Yes	Maybe	No	I don't understand
3. I am excited about studying science at secondary school			
Yes	Maybe	No	I don't understand
4. I am interested in a career in science and technology			
Yes	Maybe	No	I don't understand
5. I understand how science and technology helps to improve our lives			
Yes	Maybe	No	I don't understand
6. I feel science will have a positive impact on our future			
Yes	Maybe	No	I don't understand
7. I understand what a discipline is			
Yes	Maybe	No	I don't understand
8. All of our questions can be answered by science.			
Yes	Maybe	No	I don't understand
9. I understand how investigating small things in science can help us think about Big Questions like 'why does life exist?'			
Yes	Maybe	No	I don't understand
10. Observation is a really important part of science			
Yes	Maybe	No	I don't understand
11. I can give an example of how science works together with other disciplines			
Yes	Maybe	No	I don't understand

12. Learning science increases my sense of wonder about our amazing world			
Yes	Maybe	No	I don't understand
13. I understood what the session was about			
Yes	Maybe	No	I don't understand
14. I felt able to try to do the activities in the session			
Yes	Maybe	No	I don't understand
15. I felt able to ask questions during the session			
Yes	Maybe	No	I don't understand
16. I found the session interesting			
Yes	Maybe	No	I don't understand
17. I enjoyed the session			
Yes	Maybe	No	I don't understand
18. What did you find most surprising/interesting in the session?			
19. What area of science would you like to find out more about?			
20. What Big Question/s would you like to investigate?			

Thank you for helping us with your thinking and answers!



Closing survey