SCIENCE WEEK
#scienceweek
13-20 Nov 2022

Ireland esero

Radio Astronomy

Primary Classroom Resource Booklet

BLACKROCK CASTLE OBSERVATORY
The Space For Science

Science Foundation Ireland
SFI For what's next

SFI Curious Minds/ESERO Framework for Inquiry

Theme	Radio Astronomy
Curriculum	**Strand > Strand Unit > Curriculum Objectives**: Energy and forces > Magnetism and electricity > investigate current electricity by constructing simple circuits, become aware of how some common electrical appliances work, become aware of and understand the dangers of electricity Materials > Properties and characteristics of materials > identify how materials are used Environmental awareness and care > Science and the environment > appreciate the application of science and technology in familiar contexts Skills Development: Working Scientifically: Questioning; Investigating & Experimenting; Analysing. Designing and Making: Exploring; Planning; Making; Evaluating.

Engage

The Trigger	Wondering	Exploring	Considerations for inclusion
Astronomy Picture of the Day of Radio Telescope images: Galactic Centre, The Radio Sky, Orion over Green Bank Images of Radio Telescopes	What can be seen in these pictures? What sort of light does this telescope collect? How are radio waves made? What makes interference that makes it hard to detect radio waves from space?	Make "**The Simplest Radio"** from a battery and coin or wire.	

Investigate: Make a Simple Radio

Starter Question	Predicting	Conducting the Investigation	Sharing: Interpreting the data / results	
How far away from an AM radio can the battery-coin/wire "radio" be detected? Children may decide on their own starter question that can be answered with their equipment. (For example: How well can we send morse code messages with this simple radio?)	Children should refer to their own science understanding to make their prediction. "The radio signal will be hard to detect because it isn't very strong."	Children should carry out a fair test to find out the answer to their starter question. They could change the distance from the am radio to the battery-coin. If they are using a battery-wire they might explore how the position of the wire affects the static that is detected.	Compare data from the class, did different battery-coin "radios" have different strength signals?	

Design and Make a Model Radio Dish

Explore	Plan	Make	Evaluate	
Find images of radio telescopes from the internet. Choose one to model.	Decide which materials to use in the model. How big will the model be? Draw a sketch or design sheet.	Implement the plan. Use a range of materials including paper, straws or wood to create the model.	Compare the model to the real thing! Is the model stable?	

Take The Next Step	
Applying Learning / Making Connections / Thoughtful Actions	
Find sources of RFI: use an AM radio that is tuned to static to find other sources of radio waves. **Use radio static to communicate via Morse Code.** **Design a Radio Telescope Array with this online simulator:** Use an observation simulator to find out how arranging the antenna in different ways affects the final image at https://public.nrao.edu/interferometry-explained/. Experiment with different configurations, make several observations and compare them. **Model the Milky Way** with ESERO 55: Living in the Milky Way	

Reflection	
	Did I meet my learning objectives? What went well, what would I change? Are the children moving on with their science skills? What questions worked very well? What questions didn't work well? Ask the children would they change anything or do anything differently. Are there cross curriculum opportunities here? What further questions did students have?

Radio Astronomy Background

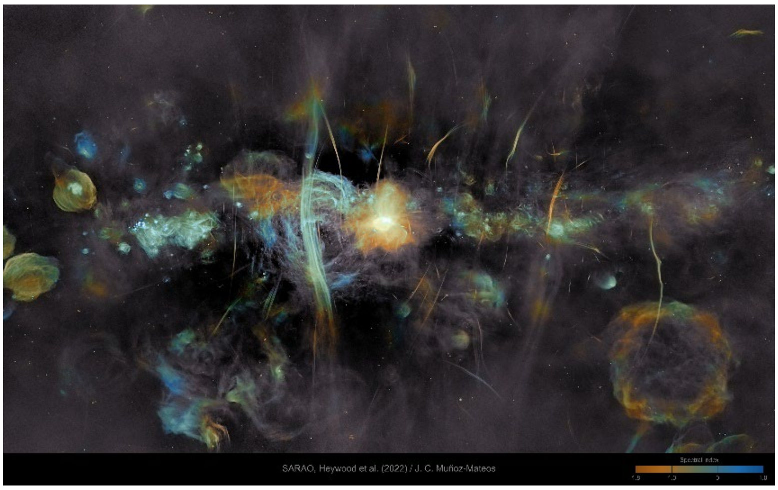
In the universe, accelerating electric charges make radio waves. Lightning is an awesome example of an accelerating charge!

Humans make use of this fact. For example, oscillating charges make radio waves at a radio station. Radio Astronomers call human-made radio waves "interference" or RFI. Interference means trouble for radio astronomers! Interference makes it hard to detect the much weaker radio waves emitted by objects in the universe.

Radio waves can be detected in daylight and through clouds (think about your radio at home – does it only pick up a radio station on a clear night?), which makes this part of the electromagnetic spectrum ideal for studying the universe.

In 1932 the American physicist Karl Jansky was the first to detect cosmic radio noise while he was trying to find out about sources of radio static that interfered with telephone service across the Atlantic Ocean. He found there was a strange hiss that moved across the sky during the day, and he worked out that it comes from the direction of Sagittarius, behind which is the centre of the Milky Way.

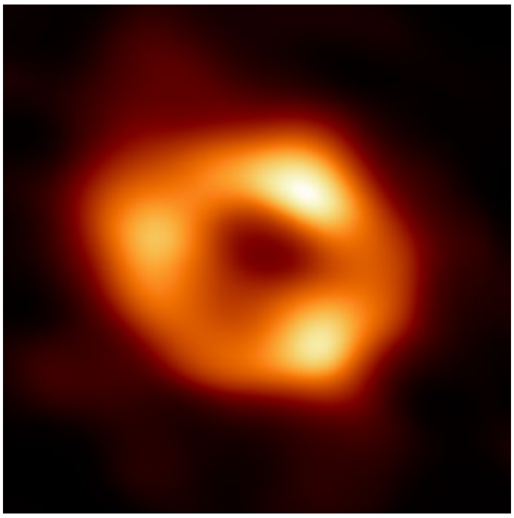
Radio astronomy has helped us work out the shape of our galaxy and the position of its spiral arms. With radio astronomy we found new types of objects, including the pulsars first measured by Jocelyn Bell Burnell. Astronomers found the afterglow of the Big Bang, the Cosmic Microwave Background Radiation, when trying to find out the source of radio interference in a radio dish. Radio signals can be detected from cool clouds of gas where new stars are forming and from supernova remnants where massive stars have exploded.



The Galactic Center in Radio from MeerKAT, credit: Ian Heywood (Oxford U.), SARAO; from Astronomy Picture of the Day 2 February 2022

Interferometry is a way of combining signals from more than one radio antenna to create better images. When two or more radio antennas observe the same object in the sky, the signal arrives at slightly different times due to the different positions of the antennas. With precise timing it is possible to combine the signals as if they had arrived at the same time, and this allows radio astronomers to use telescopes that are widely separated to act as one giant radio dish, the size of the distance between them!

[The Event Horizon Telescope,](#) an international collaboration of multiple radio telescopes from all over the world, used this technique to observe a black hole in 2019 and Sagittarius A*, the black hole in the centre of our galaxy in May 2022.

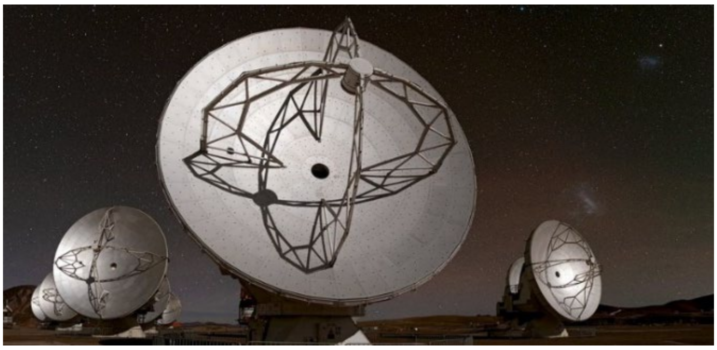


Sagittarius A image*

Radar is based on radio waves, and radio telescopes and radar on spacecraft have been used to map the surface of Mars and Venus from the Earth! Big radio antennas are used to track spacecraft through the solar system.

Radio astronomy can be carried out by different style radio receivers. Some look like dishes, others are sets of antennas.

Ireland is home to I-LOFAR, and Ireland is a member of the European Southern Observatory which operates radio telescopes in Chile.



Top Left: I-LOFAR

Top Right: ALMA radio array in Chile, Credit: European Southern Observatory

Bottom Left: Arecibo Observatory

UNAWE has an excellent booklet with activities for younger children at: https://www.unawe.org/static/archives/education/pdf/Radioastronomy_activity_booklet.pdf

The Simplest Radio

By tapping the terminals of a 9-volt battery with a coin, you can create radio waves that an AM radio can receive!

To make a radio:

Take a fresh 5-volt or 9-volt battery and a coin or a piece of wire.

Explore: Find an AM radio and tune it to an area of the dial where there isn't a strong radio station signal. (This is pretty much all of it since AM is not used in Ireland anymore). What do you notice? Can you hear anything? What radio frequency are you listening to? (it will be written as a three or four digit number on the dial, from 520 to 1700 kHz)

Now hold the battery near the antenna and quickly tap the two terminals of the battery with the coin (so that you connect them together for an instant). Do not hold the coin across the terminals since this will cause the battery to short-circuit and heat up.

Or

Tape one end of the wire (it needs to be bare) to one terminal of the battery. Or just hold it there. Touch the other end of the wire briefly to the other terminal of the battery. What do you notice? (See this short video https://youtu.be/OdvPOjHEGCE)

If you hear an increase in the static or crackle on the radio, that is caused by the connection and disconnection of the circuit; you have created radio waves for the brief moments that the current starts and stops flowing.

Your battery/coin/wire combination is a radio transmitter! It's not transmitting anything useful (just static). If you use the static to tap out Morse code, you can communicate with this crude device!

Investigate: Can you work out how far it can transmit?

Take the Next Step: Use your AM radio to find source of Radio Frequency Interference. Tune your radio to static and bring it near an electric outlet, a computer, a fluorescent light, a cell phone, a light switch… which of these are sources of RFI? Can you work out why radio telescopes are built in regions far away from these sources?

(adapted from: https://electronics.howstuffworks.com/radio.htm)

Design and Make a Model Radio Dish

Examine some radio dish designs, and design and make your own radio dish antenna.

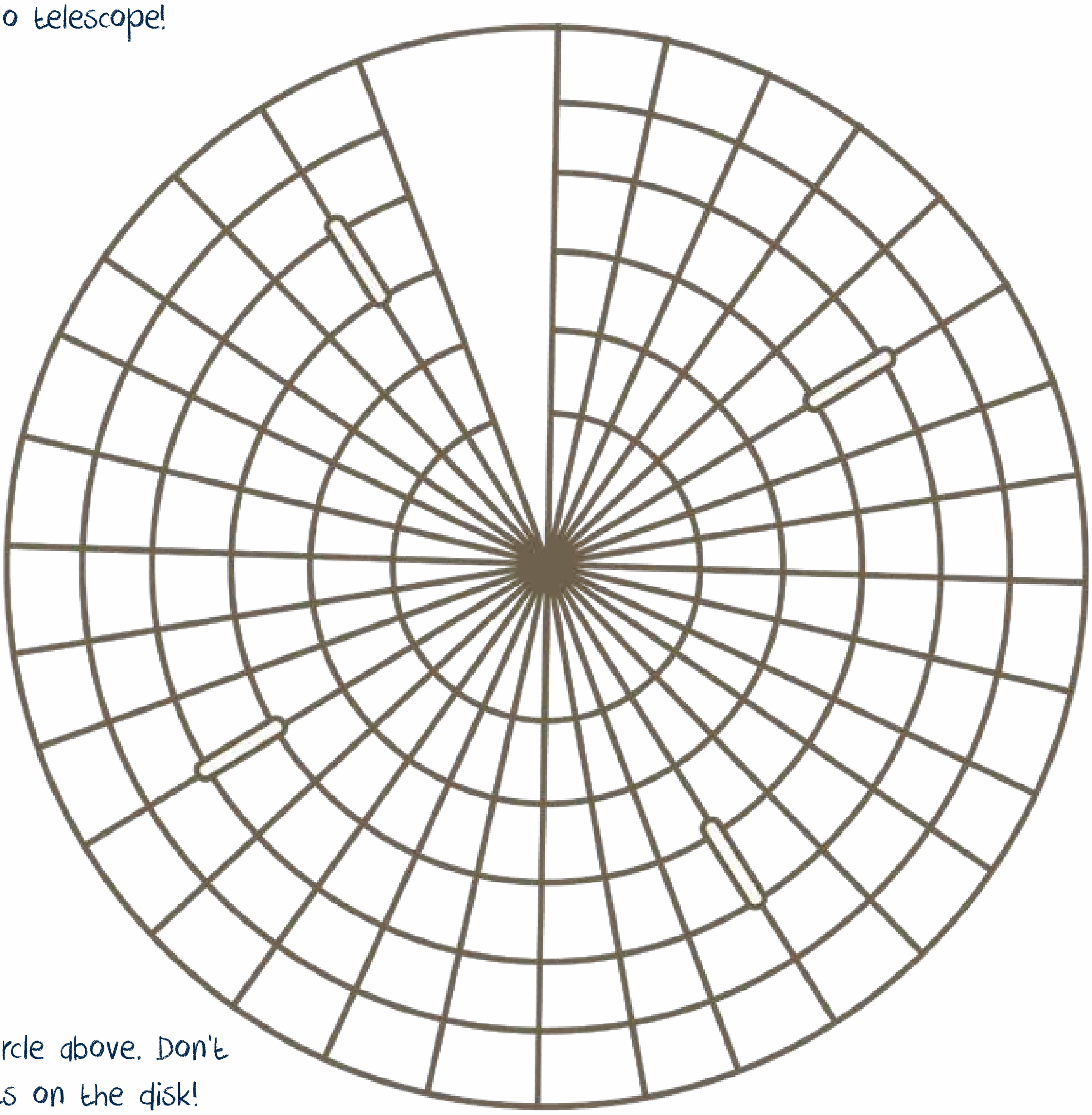
Ireland’s Elfordstown Earthstation at the National Space Centre is shown here as a 3-D printed model. Compare those models to the real dish!

How will you support the dish in a way that is strong, yet lightweight? You might use Amazing Triangles (https://www.sfi.ie/site-files/primary-science/media/pdfs/col/triangles.pdf or https://www.sfi.ie/site-files/primary-science/media/pdfs/irish/col/TriantainIontacha.pdf) to consider how to make a strong support structure.

Younger children could make the radio dish model from UNAWE’s Invisible Universe Booklet, and design their own support structure to hold up that paper dish.

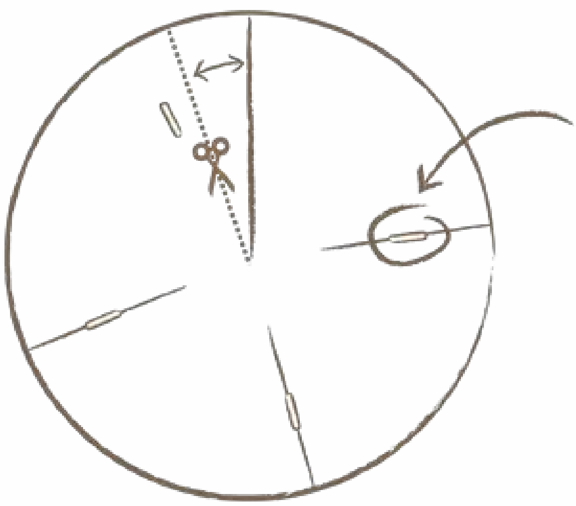
Build your own Paper Radio Telescope!

Follow the steps and build your own radio telescope!



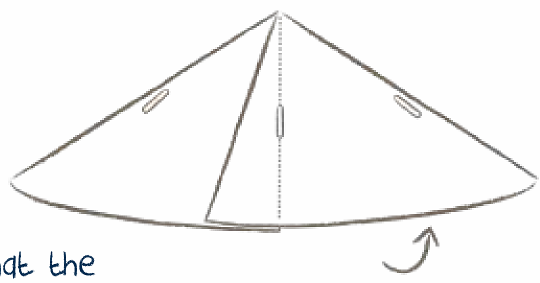
Step 1

Cut out the circle above. Don't forget the slits on the disk!



Step 2

Cut along the line with the scissors depicted in the illustration below. Put glue on the white patch and fold the sides on top of each other.

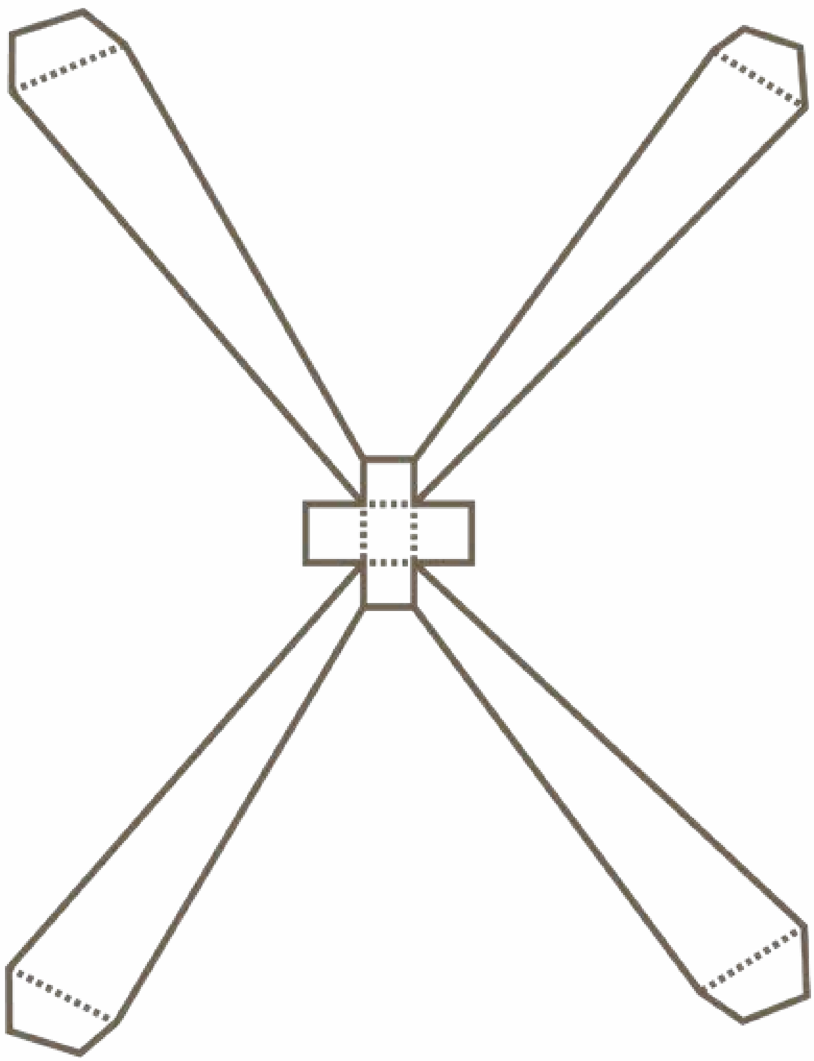


NOTE:
Make sure that the lines are on the inside of the hat.

Build your own Paper Radio Telescope!

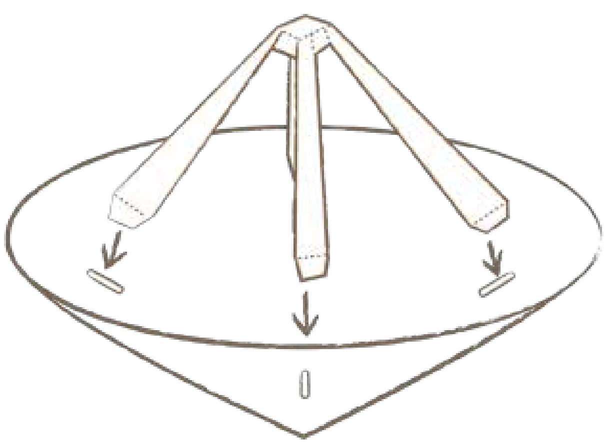
Step 3
Now you're going to build the antenna! Cut out the figure below.

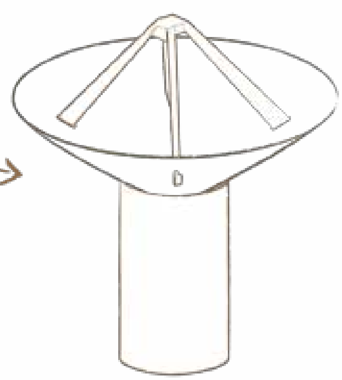
Step 4
The dotted lines are folding lines. Fold everything backwards.



Step 5
Put glue on the feet of the antenna.

Step 6
Slide the antenna feet between the dish's slits and glue them onto the other side of the dish.





Step 7
Glue the dish onto a toilet paper roll, and you're done! You just built your own radio telescope!

Morse Code Alphabet

A: • —

B: — • • •

C: — • — •

D: — • •

E: •

F: • • — •

G: — — •

H: • • • •

I: • •

J: • — — —

K: — • —

L: • — • •

M: — —

N: — •

O: — — —

P: • — — •

Q: — — • —

R: • — •

S: • • •

T: —

U: • • —

V: • • • —

W: • — —

X: — • • —

Y: — • — —

Z: — — • •

Curious Minds ESERO

Framework for Inquiry - Promoting Inclusion

SPECIAL EDUCATION SUPPORT SERVICE
building on ability

When planning science activities for students with Special Educational Needs (SEN), a number of issues need to be considered. Careful planning for inclusion using the framework for inquiry should aim to engage students in science with real purpose. Potential areas of difficulty are identified below along with suggested strategies. This list is not exhaustive, further strategies are available in the Guidelines for Teachers of Students with General Learning Disabilities (NCCA, 2007).

ENGAGE

POTENTIAL AREA OF DIFFICULTY	STRATEGIES
Delayed language development/poor vocabulary/concepts	• Teach the language of science demonstrating meaning and/or using visual aids (material, property, strong, weak, textured, dimpled, absorbent, force, gravity). • Have the student demonstrate scientific phenomena, for example gravity —using 'give me, show me, make me,' as much as possible. • Assist the student in expressing ideas through scaffolding, verbalising a demonstration, modelling. • Use outdoor play to develop concepts.

INVESTIGATE

POTENTIAL AREA OF DIFFICULTY	STRATEGIES
Fear of failure/poor self-esteem/fear of taking risks	• Model the speculation of a range of answers/ideas. • Repeat and record suggestions from the students and refer back to them.
Understanding Time and Chronology	• Practice recording the passing of time, establish classroom routines that draw the students' attention to the measurement of time. • Teach and practice the language of time.
Fine/Gross Motor Difficulties	• Allow time to practice handling new equipment. • Allow additional time for drawing diagrams, making models etc. • Give students the option to explain work orally or in another format.
Short Term Memory	• Provide the student with visual clues/symbols which can be used to remind him/her of various stages of the investigation.

TAKE THE NEXT STEP

POTENTIAL AREA OF DIFFICULTY	STRATEGIES
Developing Ideas	• Keep ideas as simple as possible, use visuals as a reminder of earlier ideas. • Discuss ideas with the whole group. • Repeat and record suggestions from students and refer back to them. • Encourage work in small group and in pairs.
Communicating Ideas	• Ask students to describe observations verbally or nonverbally using an increasing vocabulary. • Display findings from investigations; sing, do drawings or take pictures. • Use ICT: simple written or word-processed accounts taking photographs, making video recordings of an investigation.

REFLECTION

- Did I take into account the individual learning needs of my students with SEN? What differentiation strategies worked well?
- Did I ensure that the lesson content was clear and that the materials used were appropriate?
- Was I aware of the pace at which students worked and the physical effort required?
- Are there cross curriculum opportunities here?
- Are the students moving on with their skills? Did the students enjoy the activity?

More strategies, resources and support available at **www.ncse.ie**