SPACE WEEK

Our Planet • Our Space • Our Time

Resource Book for Teachers

TOPIC: Investigating Light Pollution

BCO The Space For Science

Ireland esero

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World Space Week IRELAND

DPSM/ESERO Framework for Inquiry

Theme	Light Pollution
Curriculum	**Strands:** Materials, Energy & Forces, Environmental Awareness and Care **Strand Units:** Light, Caring for the Environment, Science and the Environment Curriculum Objectives: …describe and compare materials/investigate how materials can be used in construction/identify how materials can be used. …relationships between material and light. …identify and discuss a local, national or global environmental issue. …recognise and investigate human activities which have positive or adverse effects on local and wider environments. Skills Development: Observing, questioning, predicting, measuring, investigating and analysing. Maths: Record and Display data.

Engage

The Trigger	Wondering	Exploring
"Black Marble" maps of light pollution http://www.esa.int/spaceinimages/Images/2012/03/Night_lights_in_Europe or https://www.lightpollutionmap.info or https://www.nasa.gov/specials/blackmarble/media/BlackMarble_2016_EuroAfrica_composite.png Where are the darkest parts of Ireland? Where it is dark, how much more of the sky can be seen?	What are constellations? Use ESERO 34: http://esero.ie/wp-content/uploads/2015/01/34_What-can-you-see.pdf or DPSM Activity: https://www.sfi.ie/site-files/primary-science/media/pdfs/col/dpsm_class_activity_the_plough.pdf Discuss sources of light as objects that emit light energy. Natural sources of light include the Sun, the stars, glow worms etc. Artificial sources of light include light bulbs, torches, firelight, candles and matches. What sorts of objects emit light at nighttime? Can you have a shadow at nighttime? Why do we use lampshades in our houses? Why are streetlights important?	Use Stellarium (from http://stellarium.org/) to explore which constellations are visible at different times of the year. What is the effect of light pollution on visibility? How is light pollution caused? Explore https://www.globeatnight.org/light-pollution.php And https://nightsky.jpl.nasa.gov/docs/ShieldingDemo.pdf Light Pollution is often described in terms of Glare, Light Trespass and Skyglow – can children find examples of each of these in their neighbourhood?

Investigate: How can we reduce light pollution effects?

Starter Question	Predicting	Conducting the Investigation	Sharing: Interpreting the data / results
How can we design and make a better model light fixture to reduce light pollution?	Set up a model landscape with a variety of light sources (maglite torches, book lights etc). A good light fixture should illuminate the ground, but not the sky above. Children should predict which materials will make a good light shield.	Use a variety of materials to design and make light shields. See how well light shields work by counting stars in the box planetarium (instructions included). Record results and comparisons in a table or chart.	Compare designs and the results for different type of light shields. Do all designs reduce all types of light pollution? Use this data to decide which designs are most effective. Do the most effective light shields allow light to the ground where it is needed? Evaluate and re-design as needed.

Considerations for inclusion

Words:
Transparent: Material through which light passes and allows an object to be seen clearly
Translucent: A material that allows some light through, but object cannot be seen clearly e.g. a blurred image
Opaque: A material that does not let light pass through, neither transparent nor translucent. Opaque materials block the light and thus make shadows.
Shadow: A dark area where an object blocks light.

Standard and non-standard measurements of angles

DPSM/ESERO
Framework for Inquiry

Take the Next Step		
Applying Learning	Making Connections	Thoughtful Actions
Participate in Globe at Night: https://www.globeatnight.org/ Participate in Earth Hour: https://www.earthhour.org/ What is the effect of light pollution on animal life? https://www.noao.edu/education/files/TheNightYouHatched.pdf Find out about Dark Skies in Ireland and around the world: http://www.mayodarkskypark.ie/ , http://kerrydarksky.com/ and http://www.darksky.org/ Find out how assessing the lighting needs of your school is linked to Green Schools Energy Theme.		

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?

Investigation: Can we design a device to reduce light pollution from a model streetlight?

In this activity the teacher will set up a model street scene with streetlights in a large cardboard box. A smaller shoe box 'planetarium' will project stars onto the 'sky' inside the box. Students will assess the visibility of stars without a streetlight, with a streetlight and then with a shielded streetlight. Can we improve the design of lights to reduce the effects of light pollution in our local environment?

Preparation

Background for Teacher

Light pollution is excessive, misdirected, or obtrusive artificial (usually outdoor) light.
The natural night sky is our common and universal heritage, yet it's rapidly becoming unknown to the newest generations. More than half of the world's population now live in cities. Three out of every four people in cities have never experienced the wonderment of pristinely dark skies. Light pollution is a concern on many fronts: safety, energy conservation, cost, health and effects on wildlife, as well as our ability to view the stars.

Environment:

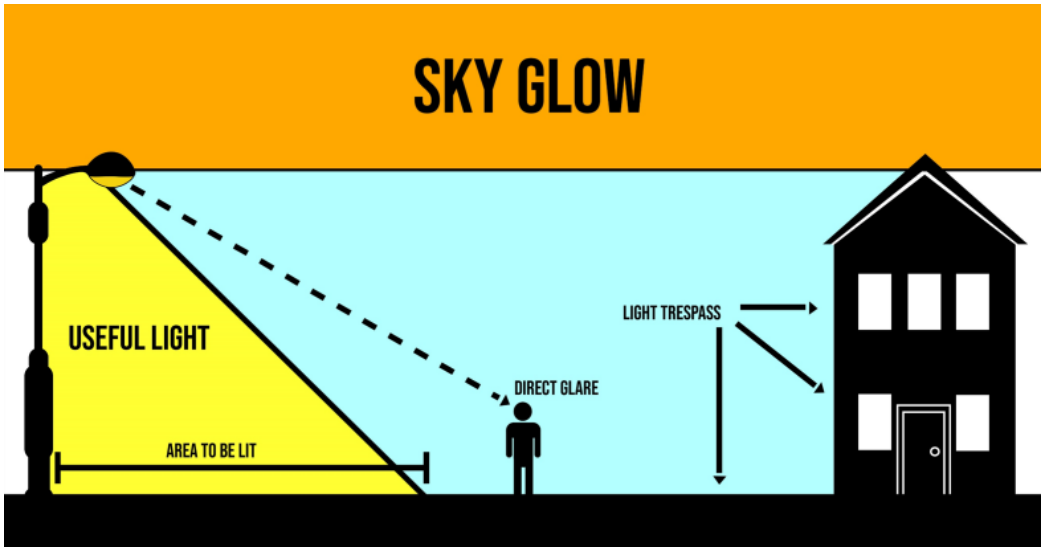
Light pollution disrupts our natural environment, which, for billions of years has evolved to rely on Earth's predictable rhythm of day and night. Nocturnal animals are particularly impacted by artificial light at night. Some animals, such as turtles, rely on the light of the Moon to guide hatchlings to the sea. They can be confused by streetlights near hatching beaches and do not survive.

Our health:

Studies show that exposure to artificial white light sources (screens, white LED, fluorescent lights) supresses our bodies transition into nighttime mode. Melatonin helps keep us healthy. If humans are exposed to a lot of white light, melatonin production can be suppressed. Research suggests that artificial light at night can negatively affect human health, increasing risks for obesity, depression, sleep disorders, diabetes and certain forms of cancers.

Energy:

Lighting is responsible for at least one-fourth of all electricity consumption worldwide. In Ireland, public lighting is estimated to account for up to 50% of a local authority's energy use. The 480,000 streetlights in Ireland use a total of 210 GWh (gigawatt hours) of electricity annually. As much as 20-30% of this energy could be wasted through poorly designed or inefficient lighting and the illumination of areas where light is not needed. Ireland's Local Authorities are trying to retrofit lights for increased energy efficiency.



Glare from unshielded lights can have the effect of inhibiting night vision.

Light Trespass occurs when unwanted light enters one's property, for example, by shining unwanted light into a bedroom window of a person trying to sleep or read or relax!

Sky glow refers to the glow effect that can be seen over populated areas. Skyglow is the combination of all the reflected light and upward-directed (unshielded) light escaping up into the sky. Skyglow is very evident around populated areas and can be seen at distances far from the source.

Solution

Light travels in straight lines. An unshielded light will let light out in all directions so light escapes up into the night sky.

Technology can allow us to develop 'smart lights' which only light areas needed, can be sensor activated and dimmed during different times of the night. This cuts down on energy use and reduces the effect of artificial light at night on the environment. Engineers and product designers are constantly working on more efficient ways of designing outdoor lighting to reduce the effects of light pollution on our communities and environment.

Student Background

Students may have learned about the reflective properties of light, perhaps with DPSM Activities or ESERO Activities.

Students may have used Stellarium to explore the night sky and the effect of light pollution.

The short film 'Losing the Dark' introduces the environmental effects of artificial light at night.

Materials/Equipment

A large cardboard box to act as street scene with figures (eg. lego people, trees, houses).

A light box planetarium: a shoe box with tinfoil as the lid. Tiny holes are punched in the tinfoil, the smaller and more numerous the better. A mobile phone torch inside the shoe box works very well as a light source. The lightbox is placed into larger box to project a model night sky (design adapted from this activity).

Streetlights: mini mag lights, tops removed to allow light spill out.

Scissors, tape or glue.

Various materials: tin foil, card, crepe paper, plastic, parchment paper etc.

Preparation: Collection of materials and equipment. Construction of light box planetarium.

Activity

Setting the Scene:

- Discuss the night sky.
- Have you ever seen the Milky Way?
- Can anyone name a constellation?
- Discussion about why the view of the night sky might be different in urban vs. rural areas.
- Introduce the words skyglow and light trespass.

Trigger Questions:

- Why do we need lights at nighttime?
- What is pollution?
- Would human exploration be different if we never saw the night sky?
- Can you give examples of glare or light trespass that might affect or come from your home?
- What bright objects in the sky can reduce the visibility of stars?
- Why do we need lights in towns and cities?
- Do all outdoor lights *help* to illuminate?
- Can you think of ways to reduce the amount of not useful light escaping into the environment?

Development of Activity: What properties of light mean that we can direct light escaping upward from streetlights? Imagine you are an engineer; can you design and make a device to direct light downward?

Safety: Safety with scissors/safety with light fixtures/heat/electricity.

Activity: Set up the light box planetarium in the larger street scene box. Count the numbers of stars visible inside the box. Record numbers in a table. Make notes of the quality or brightness of the stars.

Students could make other observations of the scene

- Is the model person visible?
- Is the footpath visible?
- Would a person feel safe walking here at night?

Place model streetlamp inside. Observe the visibility of stars. Count and record numbers of stars.
Again, make observations:

- Is the model person visible?
- Is the footpath visible?
- Would a person feel safe walking here at night?

Discuss the light energy being lost to the sky. How can that be stopped or directed downward?
Design and make light shields for the streetlights.
Repeat steps with light shields fitted, recording numbers of stars visible.

Review :
How has a light shield improved the visibility of the night sky? Has it also kept the footpath lit for people at nighttime?
Compare data between individual light shield designs in a table. Which designs worked best?
What are the properties of the best designs, which materials and features did they have?
If the teacher was the Mayor of the town, which design would they choose?

Assessment: Students describe their individual design and rationale of features and material choices.

Follow Up Activities
Students can learn a constellation and try to spot it in the night sky (winter activity).
Students can participate in a 'citizen science' activity with the Globe at Night to record and submit scientific data on light pollution.

DPSM/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.sess.ie**

Discover Primary Science and Maths
www.primaryscience.ie

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Ireland esero

Cross-Curricular Links

These are examples of some cross-curricular activities suitable for 3rd/4th class.

English / Irish

- Write a letter to your local councillor about the streetlights in your neighbourhood. Could the design be improved to reduce light pollution to the area?
- Read stories of constellation legends: 'Stories of the Stars' book PDF http://www.unawe.org/resources/books/contes_anglesT/
- Read space themed news article example: 'Beaming with the light of a million suns' http://www.unawe.org/kids/unawe1806/

P.E.

- The Night You Hatched is a physical activity based around hatchling turtles at night.

  http://www.lettherebenight.com/turtles.html

SESE Geography

- Geography: Study the planets, the solar system, investigate sunlight and its importance.
- Built environment: Conduct a light pollution audit of your home or street. Suggest changes to make better use of energy and to protect our natural environment.

SESE History

- Early Christian Ireland: learn about Newgrange and how early civilisations used the night sky and sun to mark time.
- Learn about traditions associated with night sky legends in Ireland and other countries.