

Awareness of Light Pollution through Hands-on Learning

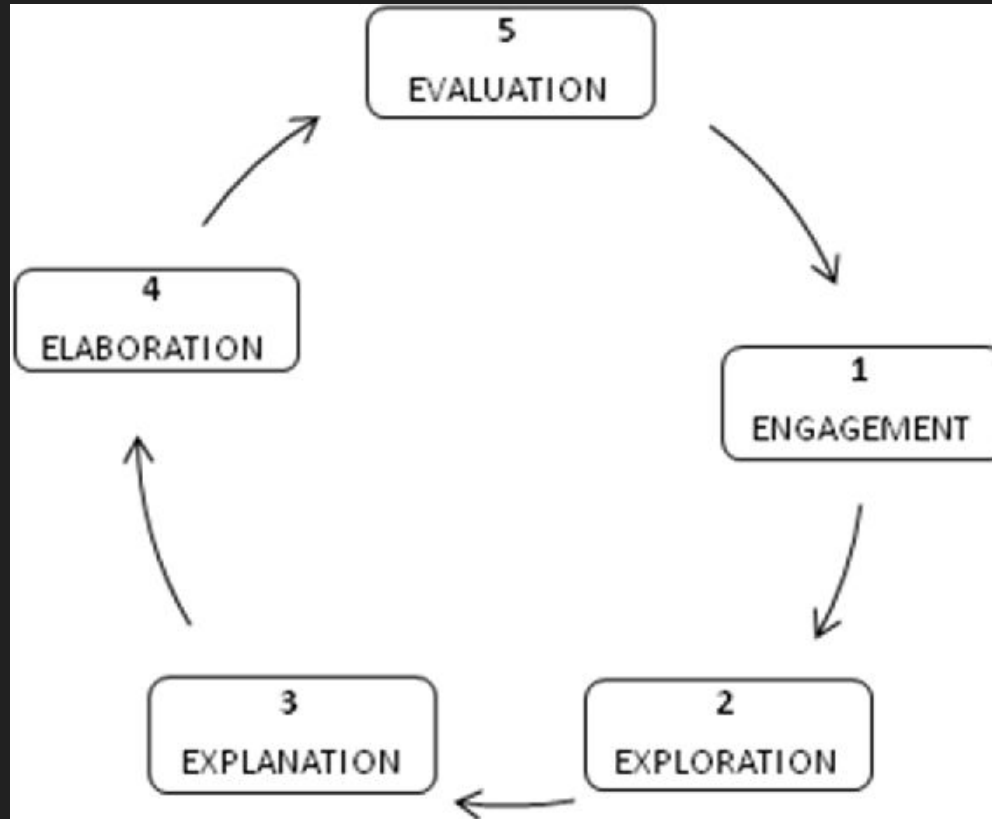
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Process

Next Generation Science Standards (NGSS)

- Cross-cutting concepts
 - Explore connections across the different sciences
- Science and Engineering Practices
 - What does “inquiry” mean to scientists?
- Disciplinary Core Ideas
 - Core ideas build on each other as students progress
 - Ex: the Universe and its Stars
 - Ex: Human Impact on Earth Systems
 - Ex: Definitions of Energy

5E constructivist learning cycle





1

Know the causes, solutions, and
relevance of light pollution

What Is Light Pollution?

- “Excessive and obtrusive artificial light with adverse effects” (from slides)
 - Caused by: streetlights, satellites, security lights, etc.
 - Can cause: Light trespass, glare, clutter
 - All bad for the environment (animals and humans)





Why Should You Care?



- Light pollution is not very well-known by non-astronomers
- It is important to spread awareness
- To make a change
 - It affects all living organisms and long-term effects are not yet known
- Prevents astronomers from looking at the sky
 - Brightness of satellites gets in the way of observations



Light Pollution In Pittsburgh Through Scales

- Light pollution tends to be higher at lower altitudes, as air is not as dense and streetlights are not sitting clustered directly above the individual.
- Animals experience light pollution differently based on their species.
 - Ex. Nocturnal animals (moths, bats, owls, etc.) may face different consequences of light pollution than amphibians and reptiles (snakes, frogs, turtles, etc.); however, regardless of the species, light pollution disrupts the life of all animals.
- Citizens also experience light pollution differently based on their location within the city.
 - Ex. Citizens living in the suburbs surrounding Pittsburgh may experience less light pollution than those living in apartments downtown.





2

Become a lighting steward of
your community



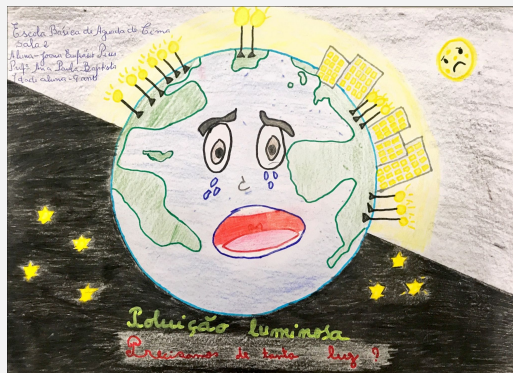
What Can You Do About It?

- Turn off lights that are not being used
- Avoid unnecessary lighting (decorative)
- Make sure that your lighting fixtures are not trespassing other's property
 - Lighting fixtures should be facing downwards
- Opt for motion sensitive lighting
- Implement automatic lighting
 - Turns off and on at certain times for a certain period of time
- Share what you know about the issue and invite others to make a change



Dark Skies Rangers – Portugal

1. Drawing contest
2. Reporting contest



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Students are unaware of the phenomenon of light pollution and the right to a starry sky

The environmental audit of the Eco-school, carried out this year at the EB2/3 André Soares School in Braga, points out that the vast majority of students at this educational establishment are unaware of what light pollution is.

DON'T DARKEN YOUR FUTURE WITH LIGHT

ABSTRACT

In this report, we have tried to explain the light pollution which is one of the environmental pollutions with our research and observations. Firstly, we would like to thank our teacher, Dilem Tuncer, who has helped us a lot in preparing this report and thank us as well as to many other people who were convenient of light pollution that has helped us. While preparing this report, we had a better understanding of the negative effects of light pollution on the environment and all the living. By the help of this report, we became much more aware and also learned how to contact with the authorized people. We have tried our best to transcribe the information we have achieved on the following pages. Enjoy reading.

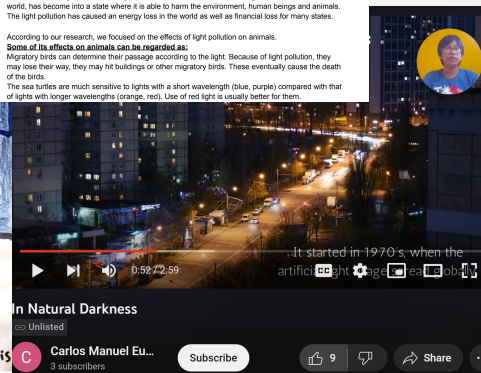
INTRODUCTION

When this competition was announced to us, we thought we were familiar with and knew about light pollution. But as we tried to understand the problem during the project, we realized that we did not know exactly. What is Light Pollution? Light pollution is the use of light in wrong places, at wrong times and at wrong amounts. The light pollution that has caused a lot of significant problems in the world, has become into a state where it is able to harm the environment, human beings and animals. The light pollution has caused an energy loss in the world as well as financial loss for many states.

According to our research, we focused on the effects of light pollution on animals. Some of its effects on animals can be regarded as:

Migratory birds can determine their passage according to the light. Because of light pollution, they may lose their way, they may hit buildings or other migratory birds. These eventually cause the death of the birds.

The sea turtles are much sensitive to lights with a short wavelength (blue, purple) compared with that of lights with longer wavelengths (orange, red). Use of red light is usually better for them.





3

Analyze light pollution in your
city/neighborhood/home

Interactive Activity



We will experience light pollution from different locations in Pittsburgh

Locations:

- Mt. Washington (high)
- Commercial street
- Own house (low)

Purpose: To deepen our understand of the presence of light pollution in the city & also understand how it may affect the animals around these locations.



Ex: Light Shielding Lab – NOAO



Ex: Outdoor Lighting Audit – NOAO



The National Optical Astronomy Observatory's
Dark Skies and Energy Education Program
Outdoor Lighting Audit
Student Pages



Lamp Data Sheet

Type of Lamp: _____

Wattage of Light:

Hours turned per year:

Number of Lights:

SQM Reading [mag/sq arcsec]:

Near Lamp: _____

Far from Lamp: _____

Lux Meter Reading [lux]:

Near Lamp: _____

Far from Lamp: _____

Check if Applicable:

Light Sensor ☐ Shielded ☐

Motion Sensor ☐ Timer ☐

Additional Notes:

Light during daytime

Light during nighttime

Light with spectra



The National Optical Astronomy Observatory's
Dark Skies and Energy Education Program
Outdoor Lighting Audit
Teacher Guide



Part 2: Calculating the Energy Used

In this next part of the lighting audit, students will begin to complete calculations about the energy consumed, cost, and greenhouse gases that are byproducts of outdoor lighting. Below is an example of the student worksheets. These calculations help put the observations that the students have made into numbers which can be understood.

Sample Student Worksheet

Here is what you needed to get started. This sheet will act as a reference throughout the rest of the calculations. Fill in each of these with the information from the lamp data sheet. Since you may have many different types of lamps with varying wattages, you'll need to fill out the blue and red squares for each of those.

The gray square is used for the cost of electricity per kilowatt hour of all the electricity. Although there can be varying costs per kWh depending on the amount being used or the time of year, here we will use just one value so an average value should be assigned.

Lamp Type #1

Number of lamps around the building: 2

Wattage of the lamps: 100 W

Estimated hours turned on during a year's time: 1460 hrs

Lamp Type #2

Number of lamps around the building: 3

Wattage of the lamps: 45 W

Estimated hours turned on during a year's time: 1460 hrs

Lamp Type #3

Number of lamps around the building: 2

Wattage of the lamps: 100 W

Estimated hours turned on during a year's time: 4015 hrs

Lamp Type #4

Number of lamps around the building: 7

Wattage of the lamps: 75 W

Estimated hours turned on during a year's time: 4015 hrs

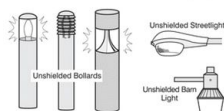
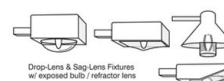
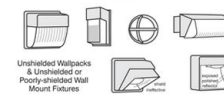
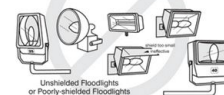
For all lamps:

Cost of electricity per kilowatt-hour¹: \$0.08

Examples of Acceptable / Unacceptable Lighting Fixtures

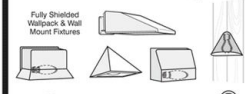
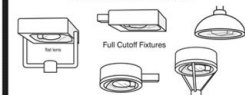
Unacceptable / Discouraged

Fixtures that produce glare and light trespass



Acceptable

Fixtures that shield the light source to minimize glare and light trespass and to facilitate better vision at night



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4

Empathize with the experiences
and needs of other species



Birds

- Light pollution may reduce their immunity to diseases
 - “The ability of animals, including birds, to respond to external parasites and pathogens greatly depends on the time of day” (Dormini 2015)
- Disrupts sleeping cycle
 - “Artificial lighting caused experimental birds to wake up earlier, sleep less (–5%) and spent less time in the nest-box as they left their nest-box earlier in the morning” (Eens et al., 2015)
 - Less sleep is more noticeable in female birds
 - Disruptions in sleeping pattern could potentially negatively affect their fitness





Bunnies, Cows, Deer (Herbivores)



- These animals avoid eating in brightly lit areas at night to hide from predators
 - So, what happens when nights become brighter for longer due to artificial lighting?
 - May be obligated to stay hidden for longer periods of time
 - Affects eating cycle
- Artificial light may also be harmful to the predator
 - "Such concentrations [of food] could lead to faster disease transmission among predator species not to mention the faster depletion of their food source" (Longcore et al., 2013)
 - Particularly for predators that hunt animals that may be found gathered around a source of light



Moths, Butterflies, Maggots (Herbivorous Insects)



- There is evidence that artificial light affect the weight of these insects as larvae
 - “larvae reared under streetlights weighed 43% less than larvae reared under unilluminated conditions” (Murphy et al., 2019)
 - This affects their lifetime fitness
 - “larvae with low body mass translate into adults with fewer resources for finding mates and producing offspring” (Loewy et al., 2013)





5

Relate the issue of light pollution
to other current issues

Worksheet

What now?

Formalize lesson plan

Iterate on worksheet

Merge concept with content

Sources

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