Grade 4 Learning Experiences: Sound and light with a purpose

Experience 2: Design a Solution to Light and Noise Pollution

Long Range Plan: Grade 4 Model 1

Overview of learning experiences – why these activities	**Overview of Learning Experiences** In this series of activities, students will first become aware of issues related to light and noise pollution produced by humans **(Experience 1)**. They will then be called to design solutions such as better lampposts, or sound-dampening surfaces for example (**Experience 2**). There are also optional experiments that would help students in their design if the topics of sound and light, reflection, and absorption have not yet been addressed (**Experience 3**). For the *Career Spotlight*, the class connects with an expert in the field to either get ideas for the design, get feedback on their design or make career path connections (**Experience 4**). **Guiding Questions** What is sound and light pollution and how does it affect living things? How do machines that make sounds and lights affect living things?
Prior Knowledge / Prior Skill Set(s)	**Background Knowledge and Concepts (Teacher)** ● Maintain safe facilities & laboratory equipment ● Identify potential workplace hazards & mitigation measures ● Aware of Transferable Skills ● Aware of Culturally Relevant & Responsive Pedagogy ● Aware of universal design and differentiation Learning for All UDL (p.13), DI (p.17) ● Aware of strategies to help new language learners Supporting English Language Learners A practical guide for Ontario educators Grades 1 to 8 ● Understand how to engage in Scientific and Engineering Design Processes ● Understand basic block-based coding concepts, platforms, functions, and algorithms for software such as Scratch and Micro:bit Make Code. The following resources can be used by teachers to review the material or for students to do research.

Research and concept resources

Light pollution
Light pollution primer from Let's Talk Science
Light pollution - Earth Day
Dark Sky - Light Pollution Effects on Wildlife and Ecosystems

Noise pollution
Noise pollution - National Geographic
Noise in our environment Ontario Government
For Whales Noise is Pollution too

Background Knowledge and Skills (Students)
Research on a light or sound problem (See Experience 1).

The sound and light concepts may have been seen with students in a previous unit (Potential experiments can also be done before or during the engineering design process; see Experience 3).

- Light travels in a straight line.
- Light is reflected and absorbed differently by various surfaces.
- Sound travels in a straight line.
- Sound is reflected and absorbed differently by various surfaces.

Animal habitat concepts

- Light and sounds are part of animal habitats
- Some animals are active during the day, night, or dawn/dusk (diurnal animals, nocturnal animals, crepuscular animals)
- Some animals use sounds to communicate, and/or to locate themselves (echolocation) in their habitat

Students often have misconceptions about Sound and Light. Some can be found on the Amasci Children's Misconceptions about Science website.

For example:

- A white light source, such as an incandescent or fluorescent bulb, produces light made up of only one color.

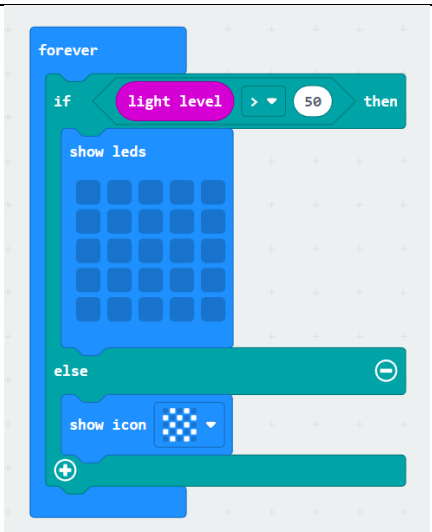
	• Light is associated only with either a source or its effects. Light is not considered to exist independently in space; hence, light is not conceived of as "traveling". • Light reflects from a shiny surface in an arbitrary manner Additionally, students may not understand that light and sound travel from a source.
Strand A - STEM Investigation and Communication Skills	**The following expectations from the A strand will be covered in the activities.**  **A1.1** use a scientific research process and associated skills to conduct investigations  **A1.3** use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems  **A1.4** follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials  **A1.5** communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes  **A.2** identify and describe impacts of coding and of emerging technologies on everyday life, including skilled trades  **A3.1** describe practical applications of science and technology concepts in various occupations, including skilled trades, and how these applications address real-world problems  **A3.2** investigate how science and technology can be used with other subject areas to address real-world problems **Optional**  **A2.1** write and execute code in investigations and when modelling concepts, with a focus on producing different types of output for a variety of purposes

	Specifically, the Strand A expectations are combined and connected to the following four activities:  **A1.3, A1.4, A1.5 (**  **A.2 coding option)** **Experience 2: Design a Solution to Address Light and Noise Pollution** Engineering process: students design a solution to address light pollution (e.g., better lampposts, or coding lights that turn on and off) and communicate the design and results with peers and professionals.
Overview / Big Ideas/ Fundamental Concepts	**Big Ideas** Light and sound affects the habitats and life of animals. The engineering process can help us find solutions to problems. **Fundamental Concepts** https://www.dcp.edu.gov.on.ca/en/curriculum/science-technology/context/fundamental-concepts **Structure and Function:** This concept focuses on the interrelationship between the function or use of a natural or human-made object and the form that the object takes. **Sustainability and Stewardship:** Sustainability is the concept of meeting the needs of the present without compromising the ability of future generations to meet their needs. Stewardship involves understanding that we need to use and care for the natural environment in a responsible way and making the effort to pass on to future generations no less than what we have access to ourselves. Values that are central to responsible stewardship are as follows: using non-renewable resources with care; reusing and recycling what we can; and switching to renewable resources where possible.
Learning Goals / Success Criteria	The following success criteria are examples of what can be co-created with the class. **Experience 2: Design a Solution to Address Light and Noise Pollution** Learning Goal: Students will design a solution to a problem Success Criteria:

	● I can draw an initial design with details ● I can justify my choice of materials for my design ● I can build a prototype using tools safely ● I can present/communicate my design using the appropriate vocabulary ● I can review and improve my design after testing it of after getting feedback **Ministry of Education Key Points** The key points listed below will be addressed within these experiences. ● **STEM Skills and Connections**: Perspectives and approaches that provide opportunities for students to investigate and apply concepts and skills from all areas of learning. ● **Research and Experimentation Processes**: Provides students with the scientific literacy skills needed to approach scientific questions that are becoming a part of everyday life. ● **Hands-on, Experiential Learning**: Includes hands-on, experiential learning opportunities to support classroom activities that encourage curiosity ● **Coding:** Allows students to explore a wide variety of science and technology concepts and contexts through coding, while also learning valuable skills related to the automation and control of systems. ● **Emerging Technology**: Ensures that students are aware of exciting and innovative solutions in science and technology that are being implemented today and that may be introduced in the future. ● **Skilled Trades**: Students consider the practical application of skills and concepts within the skilled trades and related occupations. ● **Contributions to Science and Technology**: Showcases the important contributions made to science and technology by people with diverse lived experiences. Students also explore real-world issues by connecting scientific and technological knowledge systems and perspectives from various cultures, including connecting Indigenous sciences and technologies and Western science and technology.

Learning Experience(s) **Minds-on**	**Minds-on** This minds-on activity can be done at the beginning of Experience 2 or any of the other experiences (1, 3, or 4) if Experience 2 is skipped. Discussion as a class: ● Can you think of times when light/sound bothered you? (bright light, loud music) ● What did you do? (put on sunglasses, close the blinds to sleep in the dark, turn down the music, close a window) ● What do you notice or wonder about these images (Grade 4 - Sound & Light - Images to prompt discussion) Draw from student experience about different living environments, how we light our dwellings inside and out, and what produces sounds in our surroundings. Use images to support multiple language learners. Note: Students have a wealth of experience to draw on. Some students may have (or know someone that has) sensory sensitivities and can pull from that experience to explain to others what they can do. Some may be familiar with city centers and construction sites. Some students may be familiar with the lights from greenhouses in agricultural settings. Note: The focus of the research in Experience 1 and design in Experience 2 is on problems with sounds and light from urban centers, but some students may not be familiar with extreme sounds/lights from city centers and may need additional images and videos to situate the following research. Using visuals is essential for some and beneficial to all. Building vocabulary: this is a great opportunity to build vocabulary. As discussions unfold words can be written on an anchor chart or in a virtual word wall like slides with additional images. For example light, sound, noise, brightness, night, day, loudness dampening, headset, sunglasses, blinds/curtains.
Action  **A1.3, A1.4**	**Experience 2A: Design Process** Students choose one problem (for example too much city light affecting turtles' behaviour) and create an initial design of a solution (for example design a lamppost that doesn't affect turtles in a negative way). The choices can be student-led, or can be suggested by the teacher depending on the comfort level of the teacher. The choice can be the result of research from Experience 1.

Optional  **A.2**	Here are some options that students could come up with: **No tech** ● Building a better lamppost (see information in Light Pollution Primer from Let's Talk Science ● Design building coverings that absorb sound **Low tech option** ● Using Scratch (or another block programming software), code a lamppost that turns on when it's dark and turns off when it's daytime. ○ Turn on the lampost - example code: This code uses messages to notify the "lamppost sprite" if it is night (the moon is clicked) or it is daytime (the sun is clicked). When the message is sent the lamppost either takes on the costume that is "lit" or the costume that is turned off. **Tech hardware option** ● Use a micro:bit (or another microcomputer or microcontroller) to code when street lights turn on or off. In this example of code, the micro:bit is constantly checking if the sensors are reading that the LIGHT LEVEL sensor has a value greater than 50. The value can go from 0 (no light) to 255 a lot of light). If the value is greater than 50, then the micro:bit shows nothing (i.e. the micro:bit-lamppost is turned off). If not, then the micro:bit-lamppost turns on to illuminate in this case with a checkered pattern. Note: the teacher may have to play with values and turn off the lamppost. A strong light source like direct sunlight or a flashlight may be needed. Students may also want to design a structural stand that would make it look like a lamppost. This Experience can be extended by connecting an external LED to the micro:bit so that the sensor is on top (micro:bit), and the light emitted is below. Note: This is similar to how some road lampposts work; turning off when it is bright.

A1.3	 • Using a micro:bit to code when street lights should turn on or off if the micro:bit senses motion. **Activity 2B: Design Review** Based on experiments, trials, feedback, info from the experts, and/or additional research, the students review their designs. At this point they can reflect on their design, using appropriate vocabulary, justify their choices and propose further improvements.
Consolidation **A1.5.**	**Consolidation** The consolidation can be the culmination of a combination of the 4 activities Students may choose from a variety of ways to present their research (Experience 1), experiments (Experience 3), and/or design and reflection on potential improvements (Experience 2). Potential formats include oral presentations, poster, slide decks recorded through screen capture, podcast interviews of students by students, design fairs with invited guests, and gallery walks). The intended public can include the experts of the Career Spotlight (see Experience 4), other classes, and members of the community. Students are invited to reflect on how they can make connections with the concepts of sound and light and animal habitat and the designs presented. The teacher can remark when students are using appropriate vocabulary.

Science and Technology Expectations	**C. Matter and Energy: Light and Sound** C1.1 assess the impacts on society of devices that use the properties of light or sound, or both C1.2 assess the impacts on the environment of light energy and sound energy produced by various technologies, while taking different perspectives into account C2.6 describe how different objects and materials interact with light and sound energy **B. Life Systems: Habitats and Communities** B1.1 assess positive and negative impacts of human activities on habitats and communities, while taking different perspectives into account B1.2 analyse the impact of the depletion or extinction of a species on its habitat and community, and describe possible actions to prevent such depletions or extinctions B2.1 describe habitats as areas that provide organisms, including plants and animals, with the necessities of life, and identify ways in which a local habitat provides these necessities
Science and Technology Vocabulary	**Light** - Radiative energy that can be detected by the human eye and makes things visible. When light strikes a surface, it is absorbed, reflected, or transmitted. **Sound** - A kind of energy that is produced by vibrating matter and transmitted by waves through air and other media; the sensation produced when these waves stimulate the organs of hearing. The eardrums convert this vibrational energy into signals that travel along nerves to the brain, which interprets them as voices, music, or noise. **Energy** - The capacity to do work. **Reflection** - Changing of the direction of a light ray by bouncing it off a surface. All objects reflect light to some extent (some, such as a mirror, better than others). Sound can also be reflected; a common example of this is an echo. **Absorption** - When the light or sound is absorbed by a surface and not reflected.

	Skyglow - The brightness of the night sky in a built-up area as a result of light pollution. **Glare** - Strong and dazzling light. **Light trespass** - Light trespass occurs when spill light is cast where it is not wanted. **Loudness** - The attribute of a sound that determines the magnitude of the auditory sensation produced **Dampening** - Make less strong or intense **Opaque** - Not allowing light to pass through. **Translucent** - Allowing light, but not detailed shapes, to pass through; semitransparent. **Transparent** - Allowing light to pass through so that objects behind can be distinctly seen. **Daytime** - During the day **Nighttime** - During the night **Diurnal animal** - Active during the day **Nocturnal animals** - Active during the night **Crepuscular animals** - Active early in the morning (dawn) and in the evening (dusk). **Natural light** - Light coming from the sun or fire **Artificial light** - Light coming from a human-made source **Migration** - The movement of animals from one region to another. In most cases, organisms migrate to avoid local shortages of food, usually caused by winter or overpopulation. Animals may also migrate to a certain location to breed, as is the case with some fish.
Equipment and Materials	**For the design challenge the materials will depend on the choice of design.** **Household/Classroom Items (examples)** Cardboard, paper, tape, glue, paint, materials from the recycling bin to use as building materials, paint, and markers. **Building Items (examples)** Glue gun, saw, cutting utensils, wood dowels **Technology tools (examples):** Device with access to block programming Scratch (Chromebook, computer)

	Micro:bit, LED, Alligator clips, light sensor, sound sensor **Materials list for the experiments:** Light source (flashlight, phone, LEDs) Sound source (iPad, radio, mechanical clock that ticks) Paper tube (size of paper towel roll) Various surface for light (Mirror, opaque, translucent, clear) Various surface for sound (piece of carpet, hard surface like a tile, soft surface like padding)
Timeline and Preparation	These are approximate times that can be shortened or extended based on student engagement, interest, and additional inquiry. **Minds-on** 20 minutes **Experience 2A, 2B** Engineering design 200 minutes **Consolidation** 80 minutes
Safety Considerations	Depending on the building projects that are chosen, review safety guidelines before using tools (saws, scissors, glue gun, etc.). Refer to these safety resources Safety in Elementary Science and Technology (STAO) Safe Activity Foundations in Education Document (SAFEdoc) Science and Technology, Grades 1-8 (OCTE) Ontario Curriculum Program Planning – Health and Safety If doing the experiments with sound where students use their sense of hearing, remind students that the ear is a sensitive organ that needs to be protected from loud noises (be gentle with your friend's ear). If doing experiments with light where students use their eyes to make observations, remind students that the eye is a sensitive organ that needs to be protected from bright lights (be gentle with your friend's eye and where your flashlights).
Opportunities For Assessment	**Potential examples:** **Assessment FOR Learning** ● Classroom discussions with initial prompts

	Assessment AS Learning ● Review of design ● Small group discussions, giving each other peer feedback ● Student self-assessment using the criteria for success (see Learning Goals section above). **Assessment OF Learning** ● Design book reflections ● Discussions with the teacher ● Presentation of design, reflections and next steps for the design Appendix A: Assessment Checklist and Rubric Suggestions has sample rubrics that could be co-created with students. Information to fill these rubrics can be collected through verbal conversations with the students, student presentations (synchronous/asynchronous), observation of the students, journals, notes, design books, and sometimes in the final product as mentioned above. It is also possible to use the "I Can" statements from the section above: Learning Goals / Success Criteria.
Instructional Strategies and Adaptability	Strategies from the following documents have been embedded throughout the activities. ● Culturally Relevant & Responsive Pedagogy ● Aware of universal design and differentiation Learning for All UDL (p.13), DI (p.17) ● Strategies to help new language learners Supporting English Language Learners A practical guide for Ontario educators Grades 1 to 8 For example: ● Giving student voice and choice ● Pulling from students' lived experience ● Building vocabulary collaboratively ● Offering visuals to support language learning ● Using assistive technology to access texts ● Offering multiple ways of showing understanding ● Doing assessment and evaluation by using conversations and observations to accompany the process and products

Additional Supporting Resources	**Light pollution** Light pollution primer from Let's Talk Science Light pollution - Earth Day Dark Sky - Light Pollution Effects on Wildlife and Ecosystems **Noise pollution** Noise pollution - National Geographic Noise in our environment Ontario Government For Whales Noise is Pollution too) **Misconceptions in science** http://amasci.com/miscon/opphys.html **Careers** CareersInTrades.ca Career Profiles - Let's Talk Science Ashley Noseworthy, CEO/Founder of Edgewise Environmental **Safety** Safety in Elementary Science and Technology (STAO) Safe Activity Foundations in Education Document (SAFEdoc) Science and Technology, Grades 1-8 (OCTE) Ontario Curriculum Program Planning – Health and Safety **Fundamental Concepts** https://www.dcp.edu.gov.on.ca/en/curriculum/science-technology/context/fundamental-concepts
Cross-Curricular Opportunities	**Language:** Oral and written communication (questions to the expert, hypothesis/observation/conclusion, presentation of the design). **Math:** Measurements while doing designs, builds and experiments **Social Studies**: Use the social studies inquiry process to investigate some issues and challenges associated with balancing human needs/wants and activities with environmental stewardship in one or more of the political and/or physical regions of Canada (B2)
Future Opportunities / Next Steps	**Next Steps:** ● Continue with Experiences 3 and 4 ● Overall next step: Students start a "Lights Off Campaign" at their school to

	help with energy conservation and do an energy audit in their school. Check out Canada Ecoschools for resources.

Appendix A: Assessment Checklist and Rubric Suggestions

Assessment Checklist and Rubric Suggestions

These are samples of rubrics that could be co-created with students.

Information to fill these rubrics can be collected through verbal conversations with the students, student presentations (synchronous/asynchronous), observation of the students, journals, notes, design-book, and sometimes in the final product.

Experience 2: Design with Test and Review

Next steps ***Prochaines étapes***	**Meeting Expectation (Level 3)** ***Répond aux attentes (Niveau 3)***	**Exceeds expectation (Level 4)** ***Dépasse les attentes (Niveau 4)***
	The student identifies the desired outcome for their design *L'étudiant identifie le résultat souhaité pour sa conception/design*	
	The student uses the vocabulary appropriately *L'élève utilise le vocabulaire de manière appropriée*	
	The technological-design process shows signs that new knowledge was used to improve on the design *Le processus de conception technologique montre des signes que de nouvelles connaissances ont été utilisées pour améliorer le design*	
	The student communicates their design for different audiences (e.g., peers, experts, community members) and in a variety of ways (oral, visual, and/or written forms) with considerable effectiveness. *L'étudiant communique sa conception pour différents publics (par exemple, pairs, experts, membres de la communauté) et de diverses manières (formes orales, visuelles et / ou écrites) avec une efficacité considérable.*	

Experience 2 (Optional): Coding

Next steps ***Prochaines étapes***	***Meeting Expectation (Level 3)*** ***Répond aux attentes (Niveau 3)***	***Exceeds expectation (Level 4)*** ***Dépasse les attentes (Niveau 4)***
	I can design a plan before starting to code I can write, read and alter existing code I can modify my code when the outcome is not what I expected (troubleshooting) I can use the related vocabulary appropriately Grade 4. I can write code that produces different outputs	
	Je peux concevoir un plan avant de commencer à coder *Je peux écrire, lire et modifier le code existant* *Je peux modifier mon code lorsque le résultat n'est pas celui que j'attendais (troubleshooting/dépannage)* *Je peux utiliser le vocabulaire associé de manière appropriée* *4e année. Je peux écrire du code qui produit différentes sorties*	

Experience 2: Self-evaluation

Self-evaluation for design and re-design (4= My best effort, 1 = Little effort)	
Were my sketches clear enough for others to understand?	4 3 2 1
Did I include written suggestions on my rough sketch?	4 3 2 1
Did my product do what I designed it to do?	4 3 2 1
If I worked with others, how well did I cooperate?	4 3 2 1
If I worked with others, how would I rate my contribution to the product?	4 3 2 1