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Peer-reviewed Astronomy Education Activities

Light Play

A tinkering workshop to create a collective artwork with light

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KEYWORDS

light, tinkering, art, creativity, lighting source

CATEGORY

<QuerySet [<SciCategory: Other>, <SciCategory: Physics>]>

AGE

6 - 14

LEVEL

<QuerySet [<Level: Middle School>, <Level: Primary>]>

TIME

multiple days

GROUP

Group

SUPERVISED

Yes

COST

Medium Cost

SKILLS

<QuerySet [<Skills: Asking questions>, <Skills: Communicating information>, <Skills: Constructing explanations>, <Skills: Engaging in argument from evidence>]>

TYPE OF LEARNING

<QuerySet [<Learning: Fine Art focussed>, <Learning: Fun activity>, <Learning: Other>, <Learning: Problem-solving>, <Learning: Project-based learning>]>

MATERIALS

Materials to play with light

The materials with which the students will build the sculpture should be easily accessible throughout the entire workshop. The materials should also be divided physically into the categories listed below so as to encourage an initial consideration of the behaviors of different materials in relation to light.

- A set of salvaged materials that create **shadows or patterns**, for example: graters, strainers, baskets, grids, and nets of any kind;
- A set of **light-coloring materials**, for example: colorful soap bottles, plastic bottles and containers, colorful notebook covers;
- A set of salvaged materials that **create light reflections**, for example: mirrors, sequin fabrics, mylar , silver paper, reflective sticky paper.

Image: materials to be used for the light sculptures

Materials to create the collective installation

Each pair of students or small group of students participating to the workshop should have:

- a cardboard box (size: about 40x40x60 cm) to be opened on the two larger sides, one of which is covered with a translucent sheet (tracing paper);
- an adjustable clamp lamp;
- Translucent paper to build the screen. We have often used baking paper, but recently we have been using tracing paper, which is much easier to fix and more durable though less economical.
- Other useful tools: hot glue gun and hot glue, wire cutter, hacksaw, scissors, utility knife, paper tape

To make the sculptures kinectic, building a moving installation, each pair of students or small group of students should have:

- a DC electric motor with a reduction with about 4-6 revolutions per minute (gear motor);
- battery holders and batteries suitable for powering the motor. Motors powered between 3 and 6 V, 2-stylus (AA) battery holders are fine;
- alligator cables (2 per box).

NOTE: In case the motors are difficult to find, it is possible to recycle electonic toys. It is also possible to move the objects through sticks and simple mechanisms, as in a shadow teather.

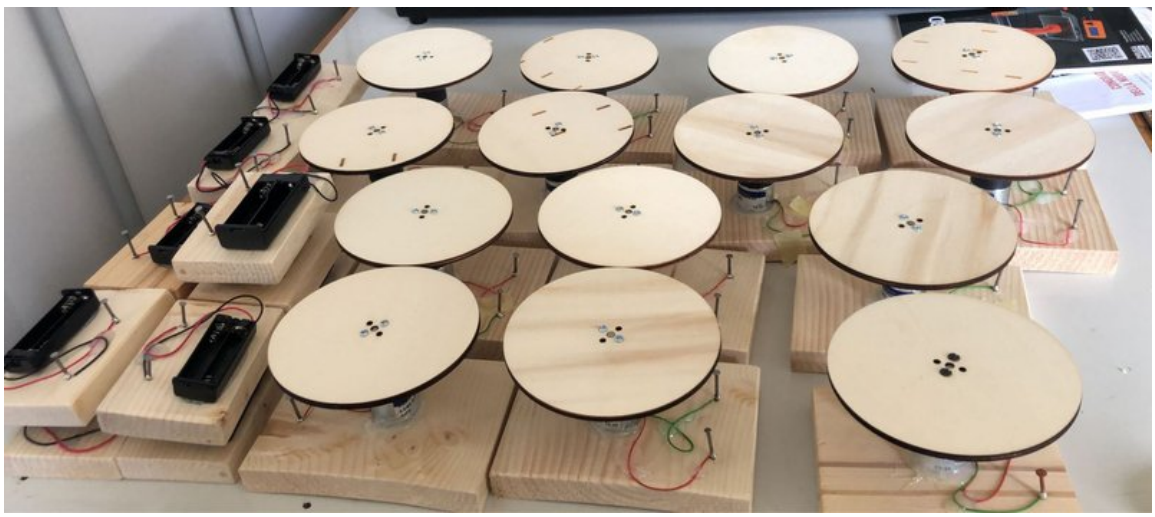

Image: motors to be used in the artistic installation

GOALS

Tinkering as an educational practice does not and cannot have structured and fixed learning goals. The goals will change depending on children's curiosity and thoughts.

Following Tinkering learning dimension framework (https://www.exploratorium.edu/tinkering/our-work/learning-dimensions-making-and-tinkering), with this workshop we should be able to notice changes in:

- Initiative & Intentionality
- Problem Solving & Critical Thinking
- Conceptual Understanding
- Creativity & Self-Expression
- Social & Emotional Engagement

LEARNING OBJECTIVES

This workshop deals with scientific exploration of light and materials and, together with other significant experiences, can lead to a deep conceptual understanding of the interaction between light and materials (reflection, light filter, light and shadow).

BACKGROUND

With this activity, participants will have the opportunity to experiment and play with light and become familiar with its interactions with different objects.

Interaction of light with objects

Participants will have a chance to experiment interactions of light with different objects, paying particular attention to different types of materials (opaque, reflective, semi-translucent).

Light, opaque objects and shadows

Students become familiar with the idea of shadow, noting that an object's shadow is larger when the object is closer to the light source because it actually manages to block more light. In facilitating, one may work by taking it to the limit by bringing the object so close to the light that it completely obscures it because it is blocked, or, conversely, so far away that there is virtually no shadow.

Light and reflective objects

Properties of reflective objects and materials are also highlighted and participants can discover how reflections and caustic images can be manipulated and can interact with colored lights. Materials could include sheets of mylar (such as Easter

Egg or commercial snacks wrappers), reflective fabrics, mirrors, sequins, and other reflective objects. In this case, the different behaviors of flat reflective surfaces (mirrors) and sequin fabrics can be noted. Children notice that in the former case the beam of light ”stays whole” when reflected while in the latter case it is chopped or divided depending on where the light hits the sequin fabric.

Light and semi-translucent objects

Participants experiment how to create various colors and colored shadows by filtering light through gels, clear plastic wrap, plexiglass scraps and other translucent objects. A colored filter is a type of material that lets through only one ”color” of light. For example, a red filter lit by white light lets through only red light. Students sometimes divide light into two parts by applying two different filters. It is very interesting to see what kinds of shadows are cast on the screen.

Light and reflection

Through these interactions with light and different objects, students will experiment how light rays change direction, following specific geometrical paths, when they reflect off a surface (reflection).

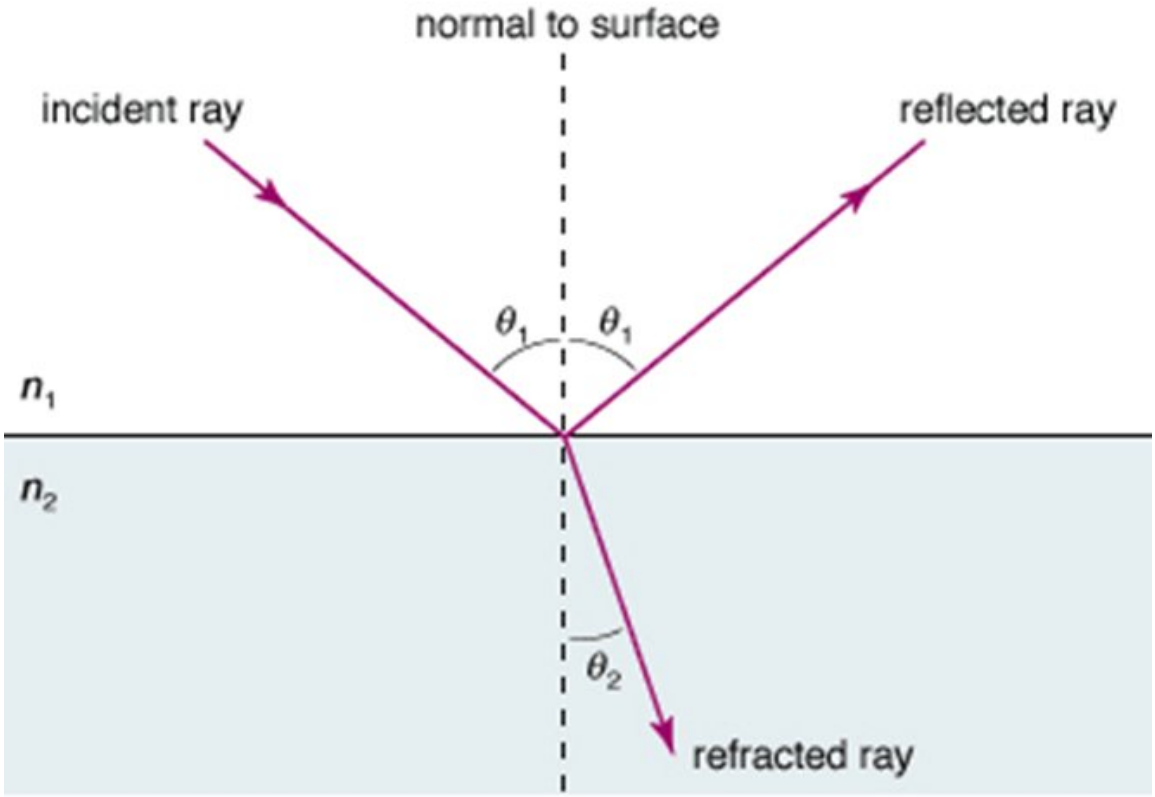

Image: law of reflection. Source: Encyclopedia Britannica

The law of reflection states that, on reflection from a smooth surface, the angle of the reflected ray is equal to the angle of the incident ray.

FULL DESCRIPTION

With boxes of the proposed size we recommend that you have the students work in pairs. You can create larger settings and build groups of three. Space management is an important key to the success of the workshop as well as giving yourself a relaxed time frame and facilitating the session without imposing your own ideas.

Experiment with light sculptures

You can start by showing the students how different materials create interesting light reflections or shadows and then encourage them to experiment. After participants have experimented for a while with a limited number of materials, we can introduce the full set of materials and start with the actual workshop by asking participants to build a scene made of lights, called **light sculpture.**

It is usually helpful to show a simple example to give an idea of the possibilities for the activity. The example should suggest the complexity and goals of the project without becoming too convincing or complicated. We don't want participants to be intimidated by the example or simply want to replicate it. It is often best to start with an example that could easily be improved.

Calculate to spend at least two hours allowing free experimentation and to resume the activity several times by re-launching the students own ideas. Encourage experimentation through trial and error as much as possible. It is important that participants have enough time to dwell and understand the different phenomena, the relationships between the light source, the object interacting with light and the screen, by testing their own ideas. The activity is designed for explorers who will grapple with the complexity of shapes, sizes, depth, position and geometry of shadow and reflections. It is also crucial for the teacher/facilitator to support the effort of the participants and intervene in moments of frustration without offering immediate solutions but stimulating them to shift their point of view, to observe the work of others in search of innovative solutions, to reformulate their problem so that they can approach it in a new way.

Using the electric motors it is possible to make these sculptures kinectic or in case the motors are difficult to find, the objects can be moved using sticks or other simple mechanisms as in a shadow teather.

Image: some examples of the light sculptures

Building the artistic installation and sharing

When each group has completed their box, we ask them to move it off the tabletop (or wherever they are building) and add it to the common installation. This operation could be tricky so consider having the kids build the light plays so that they do not need to move it in order to make a common installation (e.g., at school we usually have them build on tables set in a circle or semicircle). Let's take some time to admire the boxes all together and the effect of lights and shadows as a whole.

We then ask each pair to say something they are particularly proud of or a problem that proved particularly challenging, and what they did to solve it. We often start the conversation by asking each group to come up with a name or title for their moving scene. Try to get each participant to tell something about the experience.

Some classes used the light play in a more narrative way in which each installation became a scene of a story.

Image: An artistic installation of Light Play during a Teachers Professional Development (front and rear views).

EVALUATION

Evaluation should take into account the fact that this activity is not only limited to the acquisition of knowledge but also involves the development of soft skills. Therefore, it is essential that the assessment process reflects this twofold nature.

To **evaluate the soft skills** developped with this workshop, we suggest to construct a personalized assessment grid from this document.

The group, in this workshop, works similarly to a research team, sharing information, solutions and points of view. Therefore, both the contribution of the individual and of the group should both be taken in account and evaluated.

To **evaluate the learning objectives,** we suggest to have a guided class discussion. Students should discuss with confidence about the different learning objectives.

Possible guiding questions for this class discussion:

a) How does light move? Does it go straight ot follows different paths?

b) What happens when the light shine on the mirror? and on the sequin? Why? Together with dedicated experimentation they can come up with a modelization of the phenomenon.

c) What is the difference between opaque, translucent and transparent objects? What did you notice?

d) What happens if we point a light source towards an opaque object?

e) What happens to the shadows if we move the light source away from them? What if we bring it closer?

Try to promote discussion and comparison of ideas between peers.

CURRICULUM

This activity can be employed in many curricular subjects, such as: Science; Physics; Technology; Art; Language.

ADDITIONAL INFORMATION

For more information about the STEAM-Med co-design project : Read this Link

This activity is available in other languages: Link (to be provided soon).

FURTHER READING

For more tinkering ideas, read the book The art of tinkering, by Karen Wilkinson, and Mike Petrich

CITATION

Sara Ricciardii; Stefano Rini; Fabrizio Villa, 2023, *Light Play*, astroEDU, 2312

ACKNOWLEDGEMENT

Based on the work of the Tinkering studio at the San Francisco Exploratorium. Our set up designed for Public Primary Schools in Italy has been revised by teachers in Italy and NAEC in the Mediterranean Region.