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STEM
E-CONTENT
3D VIRTUAL REALTY

The Key To Global Life,
Digital Change Of Nature

Total Duration: 3-8 hours

Student's Age: 14-18 Years

Application Area:
- Waste management
- Recycling/advanced
- Engineering
- Science
- Technology.

Keywords: Upcycle, designing, digital production, engineering, electronic waste.

G4 - Mini Vacuum Cleaner Challenge

Module
- Environmental pollution
- Global Warming

G4 - English Version

Materials:
- **Pencil and paper for each student**
- **Old vacuum cleaner**
- **PET bottles (waste)**
- **Cardboard**
- **Duct tape**
- **Glue**
- **3D printer**
- **Laser cutter**
- **3D CAD software (Fusion 360, free CAD, on shape)**
- **DC motor (can be found in old defective electronics)**
- **Electronic switch (available on old broken electronics)**
- **Electrical wire (can be found in old broken electronics)**
- **Tutorial VACUUM CLEANER - from plastic bottle to vacuum cleaner.**
- **https://drive.google.com/file/d/1IpibwmsR6mB-F5u7ju7HAmoJZOGYB4UUs/view**

Notes:
- All materials to be used in the project must be made from waste materials, none of which must be bought.
- When reconfiguring devices through reverse engineering, attention should be paid to electronic and safety issues.
- The recycling of waste digital materials should follow the design cycle.

Introduction

In this activity, students learn how to recycle and re-engineer electronic waste by contributing to sustainable development, and how to reconfigure the operation of devices through reverse engineering. In this way, students can re-use waste materials and contribute to sustainable development through recycling and recycling methods. For example, students can design a mini vacuum cleaner by combining parts from waste electronics. When doing so, students can laser-cut or print parts such as a connection, holder, handle or 3D printers. When working with electronic devices, they realize the importance of electronic/safety rules, discover how the devices work and learn appling progressive work methods.

For background about e-waste and reverse engineering refer to the activity: ü S3: E-waste & DIY (Fog) machine (https://docs.google.com/document/d/19D9dgYtBNVqOmr-FFFDkfbQvvjT94aMjx5ZNCPBkPgo/edit?usp=sharing)

The aim of this activity is to learn the work principle and reconstruction of the devices through re-engineering, recycling, and advanced transformation. Students follow the design cycle to create new prototypes as a result of various trials.

The teacher starts by showing a vacuum cleaner, naming all the parts that can be found on the device with the students and explaining their functions. Students bring their own experiences to this practical activity. They'll better understand the working principle of an electronic circuit.

Considerations

- All materials to be used in the project must be made from waste materials, none of which must be bought.
- When reconfiguring devices through reverse engineering, attention should be paid to electronic and safety issues.
- The recycling of waste digital materials should follow the design cycle.

Aim of the Activity

- To increase awareness of recycling, advanced prototyping, advanced engineering. Students design and build a mini vacuum cleaner using parts of discarded electronics and other waste products. None of the parts are purchased. Specially made parts for joints and bodies can be designed and produced with 3D prints or laser cuts.
- Define environmental protection
- Explain the importance of reuse and recycling and their environmental protection.
- Apply the engineering design process
- 2D or 3D digital drawings
- Design the product
- For the students, some of the objectives of the challenge tackled in this activity are:
- To learn about electric circuits and the direction of current;
- To learn how to use batteries, small motors and (design) fans;
- To learn about the different parts of a domestic vacuum cleaner.
- To generate creative solutions to a challenging problem and work like engineers.
- To experience the importance of group work to develop creative solutions to a challenging problem
- To enhance environmental awareness, collect recycled plastic bottles and use them as the vacuum body.

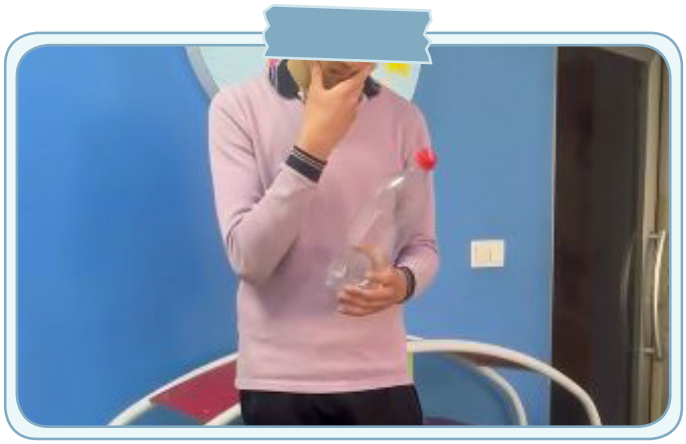
Activity Process

Before Activity

1. Collect a range of different vacuum cleaners. Take care to have at least a couple of handheld small vacuum cleaners (Picture 1).

2. To prepare for the activity the teacher guides the students investigation phase regarding the work of a vacuum cleaner, help them either with the online research and with the dismantling of a discarded device.

3. Once they understand and know which parts are essential in a vacuum cleaner, they start designing their own vacuum cleaner. The goals is to build a mini device that can be hand-held.



Picture 1. Collect the botles

Picture 2. Whatch the video

4. You can watch video in the link (https://www.youtube.com/watch?v=D5Yj7s-EU-M)

5. Read the tutorial VACUUM CLEANER - from plastic bottle to vacuum cleaner.
https://drive.google.com/file/d/1IpibwmsR6mBF5u7ju7HAmoJZOGYB4UUs/view
(Picture 2).

Let's Start

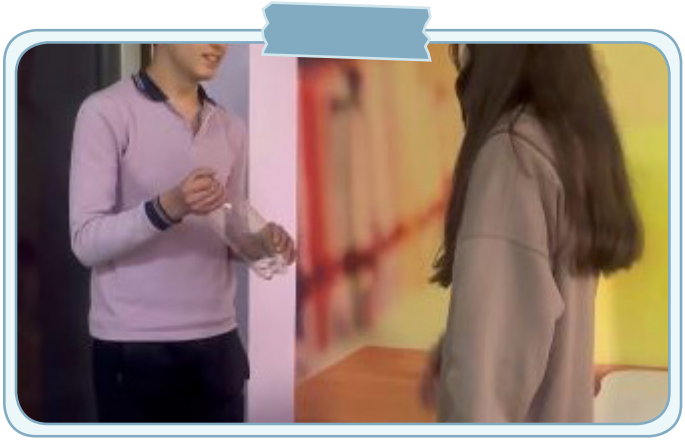
1 Discussion

1. Start the class with a discussion about recycling. Make sure students understand that ultimately, in order for materials to be recycled (e.g. old plastic bottles turned into new plastic bottles, used paper turned into new paper, etc.) the materials must be sorted somehow.

2. Show students a video about how a recycling plant works a,d show them a video on a DIY project for a vacuum cleaner.

3. Show students the materials they have available to work with. First, ask students to individually write down at least one idea for how they could build their handheld device using these materials.

4. Ask students to share their ideas with the class (Picture 3).



Picture 3. Collect the botles

2 Make it your own

5. Divide the students into groups. Let each group explore different designs, and let them record their observations. You can provide template worksheets if you wish.

6. Students can think of their own ideas, but you can also prompt them to try the following:

- Do you need a nozzle? What form should it have? How difficult is it to design a nozzle?
- How powerful should the suction be for bread crumbs?
- Have you thought of a reverse mode for the blower?
- Can you regulate the power of the blower?
- Where would you place a dust container?
- Do you need a filter?
- What electronic components are needed?
- How would you make a casing for the electronic parts?

Picture 5. Necesary materials

10. Each group should build a prototype of their mini vacuum cleaner (Picture 6)

- They should test individual parts of it as they build to make sure they are working as intended.
- The teacher should emphasize that the engineering design process is iterative. Things do not always work perfectly on the first try. It is OK if they need to revise or change their design. Even if their machine "works," they should think about how to make it better. Any changes should be logged in a worksheet.

Picture 4. Try to explore

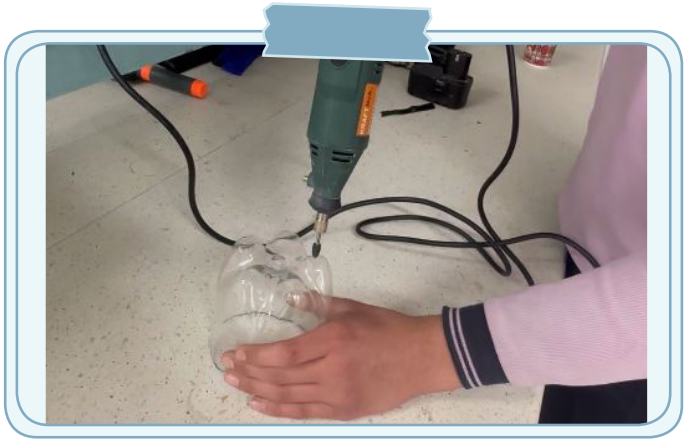
7. Let the students write down the necessary parts to build a working device (Picture 5).

- motor
- fan
- switch
- energy supply
- filter
- nozzle
- dust container

8. Students can then share ideas within their groups and agree on a single design to build. This design can be a combination of individual designs, or a completely new one inspired by other ideas.

9. Agree on some criteria to test the prototypes once they are built. Eg.

- Test performance: sucking breadcrumbs, sucking fine dust, sucking little pieces of paper.
- Test ergonomics: easy to handheld, easy to store.
- Test user friendliness: position of the switch, how to empty the dust container.



Picture 6. Prototype

11. After completing building and testing, each group should perform a final test. Compare results across the class using your agreed-upon criteria (Picture 7).
Which machine performed the best?

Picture 7. Complate the works

If you prefer to focus on learning and training the use of design software such as Fusion 360 and the capacity of following (and improving) steps from an instructables you might want to do the activity as proposed in VACUUM CLEANER - from plastic bottle to vacuum cleaner.

https://drive.google.com/file/d/1IpibwmsR6mBF5u7ju7HAmoJZOGYB4UUs/view

Picture 8. Testing

This is a tutorial on how to make a mini handheld vacuum cleaner using pet bottles and recycled mini dc motors. The techniques of laser cutting and 3d printing are used to make additional parts. All necessary templates are given, the teacher should take enough time into account for 3D printing and laser cutting (Picture 8).

If you choose this approach, you could ask students afterwards to propose adjustments and improvements on ergonomics and user friendliness.

Closure

- At the end of the study, these outputs could be obtained. Here is examples for you

Assesment

Evaluation

- Students develop and test their device. All the prototypes are displayed in class. The peer assessment is performed, the prototypes are reviewed based on the agreed criteria. The teacher evaluates them through the Rubric.

Goals	Must be Improved (1)	Medium (2)	Good (3)	Very Good (4)
Plan designing	(.....)	(.....)	(.....)	(.....)
Understanding the working of a vacuum cleaner	(.....)	(.....)	(.....)	(.....)
Understanding the electronics	(.....)	(.....)	(.....)	(.....)
The Originality of designing	(.....)	(.....)	(.....)	(.....)
Usage of designing	(.....)	(.....)	(.....)	(.....)
Total				

Links

- GirlsInSTEM. (2022). VACUUM CLEANER - from plastic bottle to vacuum cleaner. https://drive.google.com/file/d/1IpibwmsR6mBF5u7ju7HAmoJZOGYB4UUs/view
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