Mission to Mars

Summary

Age category
9 - 12 years
Topic
Data & Statistics
Geometry
Measurement
Total duration
540 minutes

Students need to build a water rocket that can be launched as high as possible.

Problems to be tackled:

Students will be challenged to build a water rocket that can be launched as high as possible. There are a lot of factors involved with water rocket launching. In this activity, we focus on the most important ones: water volume, wings and cone.

Students will be working with limited resources so they have to plan and think before they build their rocket.

Real context

Real world motivation

In the 21st century, many countries and space agencies are attempting to send probes and landers to Mars. Mars is an interesting planet because conditions on its surface may have been very similar to conditions on Earth.

The ESA (European Space Agency) sent a lander called Schiaparelli to Mars at the beginning of 2016. In October 2016, Schiaparelli reached Mars, but something went wrong with its landing. Unfortunately, the lander was completely destroyed.

This news video tells more about the incident: Schiaparelli reached Mars.

Goals

Skills

Domain-general:

- Asking questions and problem solving (e.g. controlling variables in order to find the best possible rocket design)
- Planning and budgeting
- Collecting, analysing and interpreting data (e.g. why is it important to measure something several times?)
- Reporting data (e.g. explaining what influence different variables had on rocket flight)
- Reflecting (e.g. what process did we go through in finding and producing the best possible rocket?)

Mathematics:

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- Scaling.
- Calculating averages.
- Calculating big numbers to stick to a budget.
- Measuring volumes of water.
- Working on proportions.

Science:

- Investigating the influence of different variables on the flight of the rocket.

Technology - Engineering:

- Designing and constructing a best possible (water)rocket.

Knowledge

Mathematics:

- Scale.
- Measurement of amounts of water.
- Proportion.

Science:

- 'Honest investigation' (why it is important to measure something several times, to control variables)

Technology - Engineering:

- Rocket (criteria for the best possible rocket). Wings. Cone.

Methodology

Part	Description	Timing
1	**Introduction: class discussion** Discussing space, rockets and space research with the whole class. Teacher tells students about how this activity is assessed.	45'
2	**Research of the water amount: group work** The students investigate the amount of water that is needed to launch a rocket (see worksheet) . Afterwards, each group decides how much water they will use in their rocket.	90'
3	**Planning of the cone and the wings: group work** The teacher introduces a budget for the cone and the wings, gives students a budget form, and gives 1,5l bottles to each group. Students plan the cone and the wings (see work sheet). In this stage students need A4 paper, rulers, scissors and compasses to make a plan.	45'

4	**Building a rocket: group work** The teacher approves the plans for the cone and the wings (see worksheet). The plans can be discussed in class to share ideas. Students can start building their rocket (they receive the budget after a good plan).	45'
5	**Testing the rockets: group work** When the first versions are complete, the rockets can be tested. After the tests, changes can be made. Each team can test their rocket a maximum of three times (each test launch costs money). The tests (observations, analyses, ...) can be discussed in class.	90'
6	**An extra challenge: group work** For faster teams, the teacher will give a challenge of building a solution to let the rocket land carefully (parachute). Rockets also need to be named and decorated.	90'
7	**Big launching day: class event** Big launching day: Each team launches its rocket and measures the time it takes to go up.	90'
8	**Final assessment: class discussion** Each team talks a little about their rocket, the process of inquiry and design that they executed and how they answered the questions in the worksheet.	45'

Organization

Materials

Per group:

- 1,5 l bottle
- Cardboard (thin)
- Paper
- Tape and glue
- Scissors, compasses, pens, rulers
- Play money
- Optional: Lego astronauts, something soft to use as extra weight, plastic bags and rope to build a parachute...

One for whole class:

- Bicycle pump
- A cork and a valve
- Water rocket launch station (see launch station form)

Printables

- Worksheet Mission to Mars

Grouping

- Groups consist of two to three students.
- Groups should be organized according to students' abilities, math and manual skills.

Budget

Students need to stick to a budget. This makes them plan and think, and not just create and test without thinking. Each team will receive €10,000 for planning, building, testing and optimising their rocket. Prices are:

- A4 paper for planning the wings and a cone is free
- A4 cardboard 3.500€
- One hour use of glue 1.500€
- One metre of tape 1.500€
- Test launch of the rocket 1.000€

Coaching

Useful questions

1. Introduction

- Do you think that there has been life on Mars? Do you think that there is life anywhere outside of the Earth?
- What parts do we need to make a rocket? Why are there wings and a cone?
- What do you know about space research? Have you heard about moon landings? Do you think it is wise to explore our solar system? Why do we explore space?
- About the assessment: How does a good group work? What is important?

2. Research of the water amount

- How many millilitres (ml) is a 1.5 l bottle?
- Why do we put water inside the rocket?
- What do you think will happen if we don't put any water in?
- How can we measure how high the rocket goes?
- How can we calculate an average?

3. Planning of the cone and the wings
4. Building a rocket

- In real life engineering, there is always a budget. How can you use budget wisely?
- How can we make a cone from paper?
- How many wings would be the best option?
- What is air resistance and how can we get it as low as possible?
- How do you scale your cone and wings to 1:3 (see worksheet 2)?

5. Testing the rockets

- What's happening? What do you see?
- What's the problem with the rocket?

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- Why doesn't it go high?
- What do you think you should change to make the rocket go higher?

8. Final assement

- How did your group work together?
- How did you contribute to the group work?
- What were the biggest difficulties that your group faced?
- How did the group overcome those difficulties?

Adaptations

- At earlier ages and classes with greater difficulties, the teacher can give examples of how to fold a cone, this activity can be completed without worksheet 2 or without scaling in it.
- If you have older children or a very talented group, the parachute can be made to be compulsory.
- Wings (where the wings are, what shape the wings are, how big the wings are and how many there are) Students can use this simulation to find out about wingshttps://spaceflightsystems.grc.nasa.gov/education/rocket/BottleRocket/wind_tunnel_fins.html)
- Cone (what shape, how to build, students can use this chart to find out about drag coefficient https://en.wikipedia.org/wiki/Drag_coefficient)
- Extra mass (the teacher can explain that the rocket needs more mass to fly perfectly, mass needs to be situated in the cone). It would be fun to add extra mass by adding Lego astronauts inside the cone.
- With older students, more complex simulators can be used to find out about extra mass, volume of water and much more: http://cjh.polyplex.org/rockets/simulation/

Assessment

Teacher's assessment:

Assessment takes place in a formative way, especially regarding:

- Problem-solving (e.g. the students ability to create a water rocket)
- Planning (e.g. planning the construction of the cone and wings)
- Analysing & interpreting data (e.g. conclusions concerning water amount)
- Reflecting (e.g. rethinking the process of creating the water rocket)
- Students' motivation and participation
- Group collaboration
- Presentation of project

Student's assessment:

The most important point about the assessment is that students need to know about it at the beginning of this activity. For this activity, the assessment can be carried out in many ways.

1. If there are computers or iPads at your school, a portfolio can be made that includes all the steps in this project. It could include pictures, video, text and drawings. Worksheets can be a part of this.
2. The portfolio can be made without computers, to include worksheets.

Students can also answer questions after the activity. For example:

- If you would start over what would you do differently?
- Did you use mathematics? When?
- How did your group work together?

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- What did you do for your team to succeed?
- What did others do for your team to succeed?
- What were the greatest difficulties?
- How did your team overcome those difficulties?

Tips & tricks

Regarding the testing of the rockets (tips for teacher)

If the rocket:

- Spins wildly (optimise the wings, usually three wings is the best solution)
- Doesn’t go straight up (optimise the wings, straighten the cone or balance the centre of mass, the centre of mass shouldn’t be too far back)
- If there is too much or too little water inside, the rocket will not fly optimally.

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