Orientation and Attitude!

Metadata

General Info

Title

Orientation and Attitude!

Short description

You don't have to be on another planet for the ability to orient yourself well to be an advantage. Nevertheless, orientation training is an important unit in astronaut training. Sometimes, however, it is already helpful if you can orient yourself well on Earth. Helpful for this is also the ability to estimate distances well. In the school context, estimating different quantities plays an important role.

Keywords

Estimation, rollover calculation, vectors, heights, distances, correlation, error estimation, trigonometry, astronaut training, rockets.

Educational Context

Context

Student centered problem-based learning, interdisciplinary activities, collaboration

Age

Secondary level, the appropriate age level depends on the particular task (from the set of astronaut training tasks) and can be chosen flexibly.

Prerequisites

None.

Lv. Of difficulty

Varies with task at hand.

Duration

3 hrs max

Educational Objective

Create an educational framework with the goal to challenge our students and start the process of inquiry-based learning. The applicability of this approach extends to many subjects in the STEAM arena.

Cognitive Objectives

The focus lies on problem-based learning.

Affective

Promoting group work.

Psychomotor

Depends on task at hand.

Subject Domain

A whole range of topics can be subsumed under the heading "Orientation training". The concept is therefore not limited to STEAM lessons.

Big Ideas of Science

Scientific problems often pose a great challenge to human ingenuity. Getting unnecessary complications out of the way is at the heart of scientific inquiry. Working together on a problem, acquiring the necessary background knowledge, critically examining the answers obtained, and presenting the results in an appealing manner are the cornerstones of scientific work.

Subject Domain

There is an obvious connection to physics, but any other STEAM topic can be implemented just as well within this framework. The estimation of heights is clearly related to trigonometry.

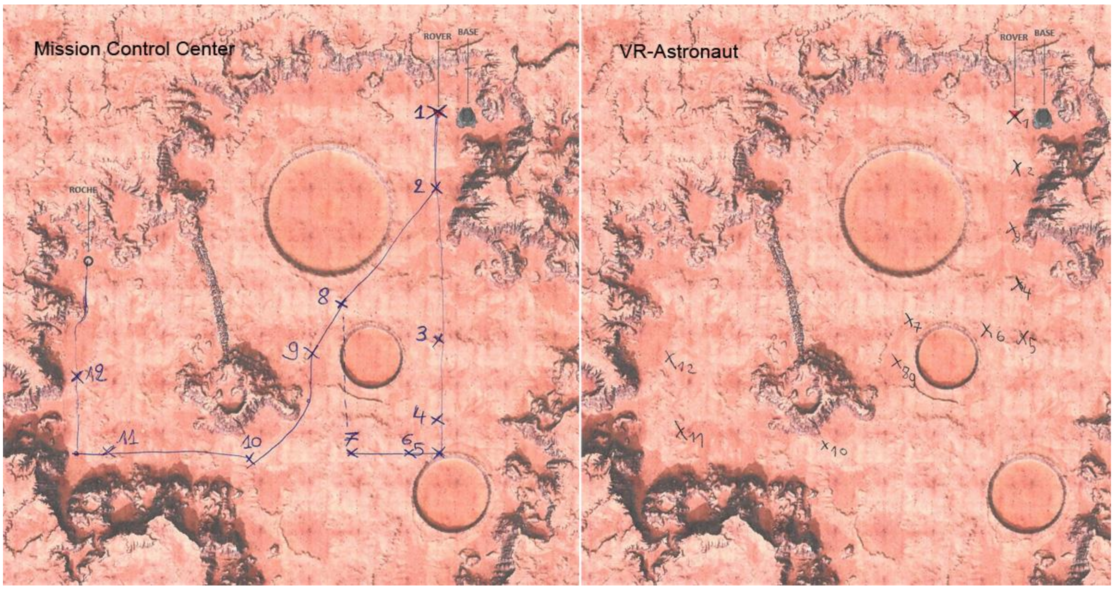
Orienting & Asking Questions

The year is 2048, and we are on a mission to Mars, exploring the terrain with our Mars rover. The expedition approaches a critical point and suddenly all navigation systems on board fail. Reaching our destination now depends entirely on your skills - and on various coincidences!

Now let's simulate this situation. The Austrian Space Forum has been working on simulations of Mars expeditions for many years. Visit the Forum's website to get a first impression of astronautical Mars simulations: https://oewf.org/en/amadee-20/

You will get a good overview of the activities if several school teams work together and each team is responsible for working out the crucial information from the expedition website about the process of a simulation experiment and bringing everyone else up to speed in a short time.

For example, team 1 can present the information of the experiment "SHARE", team 2 can present the information of the experiment "EXOSCOT" and team 3 can provide the information of the experiment "MEROP". The description of all these real simulation experiments can be found on the website:
https://oewf.org/en/amadee-20/



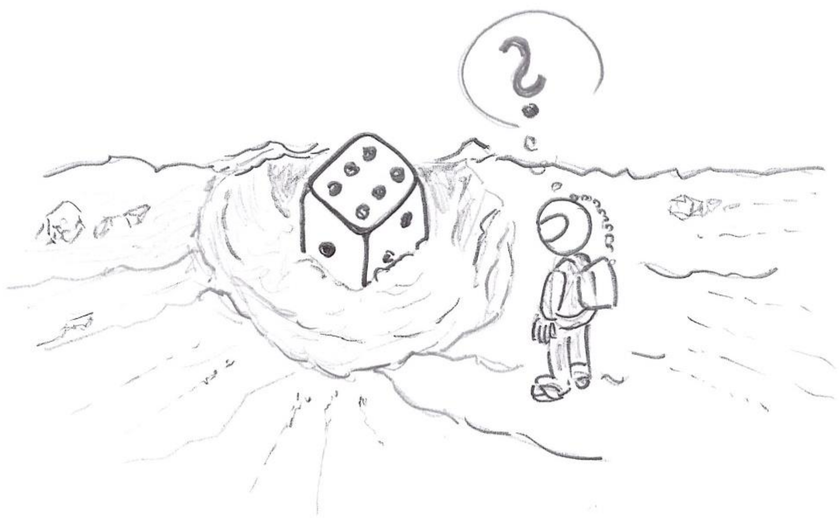
Map of a person in the Mission Control Center, who made a cross every 30 seconds where he thought the vehicle was in comparison to the map of an VR-astronaut (SHARE)

Hypothesis Generation and Design

Let's come back to the year 2048 and our mission. Just now, the control instruments of our Mars rover have failed. It is to be feared that the achievement of our goal depends on how many random events will have an influence on our further way.

What influences on the success of our mission can you think of, and how might your guesses be tested in an experiment?

How could you simulate a coincidence that was supposed to catch you off guard? Discuss these questions with your team!



Planning and Investigation

Now plan your own investigation.

For this experiment you need an outdoor area. You will also need two coins and three dice to simulate chance. Chance will gradually lead you to a goal. Since the navigation systems on board have failed, everything now depends on how well you can estimate distances and cardinal directions.

Choose a starting point in the open area so that you have enough space in all possible directions. Then determine your next target coordinates with the following routine:

First, determine how far you need to move from the starting point.

1) Roll a number with the first die.

2) Roll a number with the second die.

3) Roll a number with the third die.

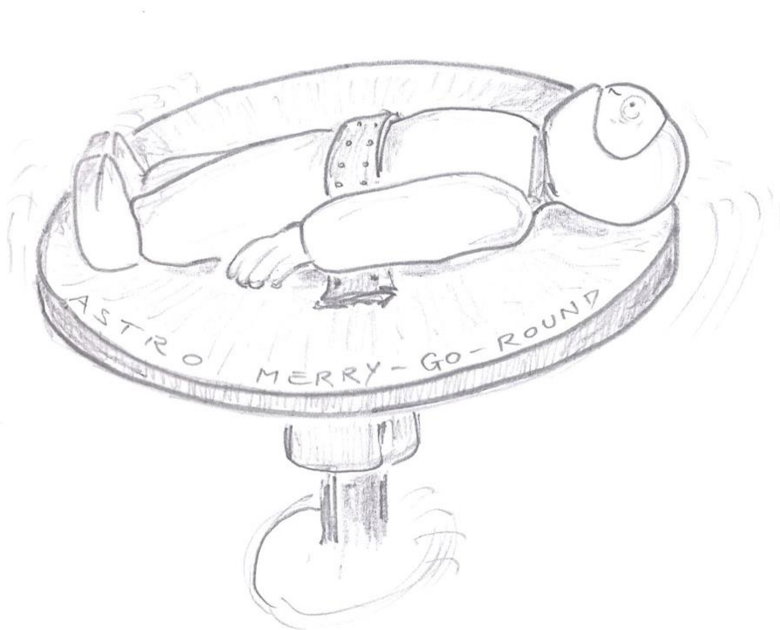
4) Multiply the three numbers (in your head, of course, since all the equipment on board has failed). The result is the distance in meters you have to walk.

Now use the two coins to determine which direction you need to go. The direction is then determined with the help of the following table:

The first die shows ...	**The second die shows...**	**Your direction will be:**
heads	heads	North
tails	heads	South
heads	tails	East
tails	tails	West.

Now walk the randomly determined distance in the determined direction. Now walk the randomly determined distance in the determined direction. This is how you reach your new destination coordinates. These target coordinates are now the starting point for the next target point to be determined. Repeat the above routine (rolling the dice and tossing coins) to determine your next target point. Each time you determine new distances and directions using the dice and coins, write down the result on a piece of paper.

Repeat the coordinate determination x times (you can determine first freely the value for x). So you will move across the outdoor area. Chance will determine where you will eventually end up.



Analysis & Interpretation

After a certain number of cycles (the number x) you arrive at a destination point. How far are you from your first starting point?

Now take the notes from before (about the respective distances and directions) and calculate how far you should theoretically be from the starting point. If you are not yet able to do this calculation, you can also trace the path to scale and thus determine the theoretical target coordinates.

Investigate the following question: Does it matter in which order you join the individual sections to get to the final end point?

Now enter the result of the analysis here:

Distance from the original starting point to the final destination.

Measurement in the field: ______________

Calculation and drawing on paper: ______________

Deviation between reality and calculation: ______________

If you have the necessary knowledge to perform the following analysis, then accept the next challenge as well. You can also acquire the necessary knowledge through research and self-study! A good starting point for your efforts can be found here:

LINK to an introduction “Create scatter plots!”

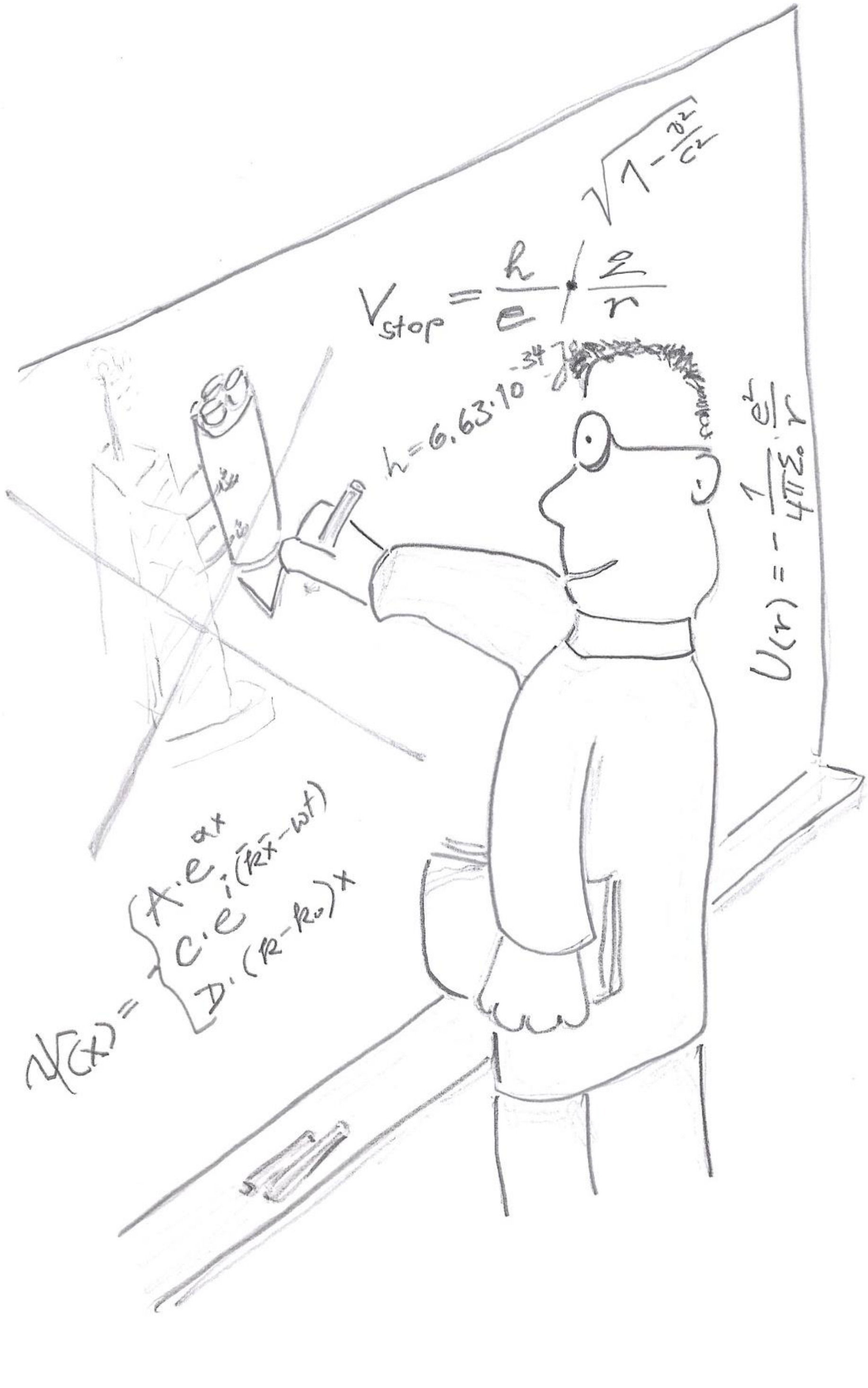
shorturl.at/nuNYo

For this purpose, you can also conveniently use the "Tableau" tool, which is described in more detail in the tools sector of the LaSciL platform.

So, here is your next challenge and the next level on your way to becoming a champion:

Investigate whether there is a correlation between the number of path segments (this is the number x you initially chose freely) and the deviation (between the target point actually reached in the open terrain and the theoretical target point calculated on paper).

To do this, you need a lot of data and collaboration with the other teams is beneficial to continue working together on a problem.

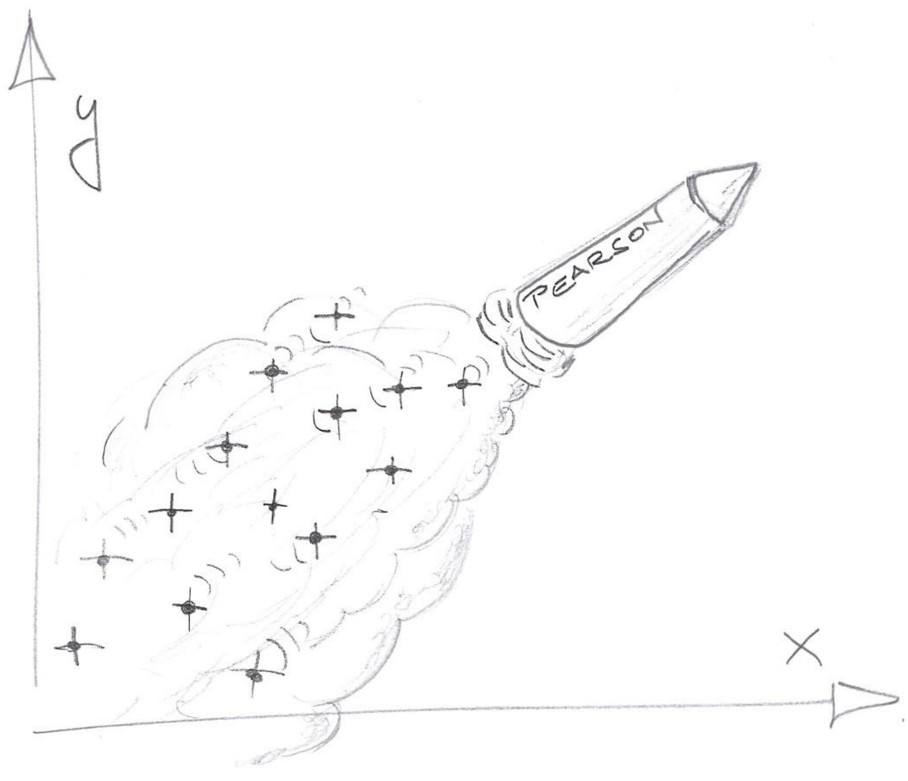


$V_{stop} = \frac{h}{e} \cdot \frac{c}{r}$
$\sqrt{1-\frac{v^2}{c^2}}$
$h = 6.63 \cdot 10^{-34}$
$U(r) = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}$
$\psi(x) = \begin{cases} A \cdot e^{\alpha x} \\ C \cdot e^{i(kx-\omega t)} \\ D \cdot (k-k_0)x \end{cases}$

Conclusion & Evaluation

My guess would be that there may indeed be a correlation between the number of sub-segments of the path and the deviation between calculation and reality. Why could this be plausible? Did your experiment actually show a correlation? How else could you extend the experiment to explore other important questions?

I'm looking forward to your report!



Background Information for the Teacher:

It can be beneficial to tie the beginning of the activity into a story. The overarching arc for the story is the need for orientation in unknown terrain. The Austrian Space Forum can provide such a background for analog astronaut training. The Austrian Space Forum website has a lot of information on which experiments are related to astronaut orientation skills in simulated Mars expeditions, such as SHARE, EXOSCOT and MEROP: https://oewf.org/en/amadee-20/

The concept is very flexible and can be further pursued in the following teaching topics:

- Learning to estimate heights and distances.
- Estimation and rollover calculation of the flight altitude of a model rocket.
- Determination of the moon diameter with the help of a coin (and the Intercept theorem of geometry).
- Ballistics and physics. Where is our rocket likely to hit?
- Estimations and calculations (using trigonometry) of building heights.
- Orientation during a cross country race.
- Finding coordinate points in the plane geometry or the geometry of the spherical surface (spherical coordinates).
- Error estimation.