Hanging the planets in the Sun

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Introduction

Distances in astronomy are sometimes misunderstood due to exorbitant quantities (millions or billions of km). Even when astronomical units are used, pupils experience the same problem, despite the fact that this option should lead to a different mental image.

Previous analyses have shown that the common perception yields a Solar System (SolSys) with pretty regularly placed planets, even when a table of distances from the Sun is provided.

Can an embodiment learning process with an inquiry-based and peer-to-peer approach aid in the development of a more precise mental representation of the SolSys?

Table 1: mean orbital rays (in a.u.) of the planets of the SS including the two inner dwarf planets Ceres and Pluto

Mercury	Venus	Earth	Mars	Ceres	Jupiter	Saturn	Uranus	Neptune	Pluto
0.4	0.7	1	1.5	3	5.2	9	19.5	30	39.5

Methods and findings

The activity is carried out in an informal setting. Following a warm-up, students are divided into small groups of 3-4 people and asked to represent the SolSys. They are given planet cards (dwarf or not), a long spring, pegs, and table 1 with the proper definition of an astronomical unit. They can sit on the floor, walk about, and find the most comfortable position for themselves.

Students are instructed to use a system that is as simple as feasible while remaining reliable and accurate. They can converse and exchange information and points of view while working.

The lab ends as a scientific workshop does: each group demonstrates its own strategy. The advantages and disadvantages of each strategy are reviewed with other groups. Following the group discussion, we show them the visual in figure 1.

We discuss whether or not this visual can help them and primary school students easily discover the "halving method."

The most typical response is that it could be beneficial, but it is preferable not to show students the picture and push them to deduce it from the abstract, numerical clue.

We also remind them that this method does not account for the dimensions of the planets: their schoolwork will be to recreate the SolSys in a public park at least 1 km long with the appropriate scale for their dimensions. They are then asked to assess the position of the planet Proxima Centaury 1b on the same scale.

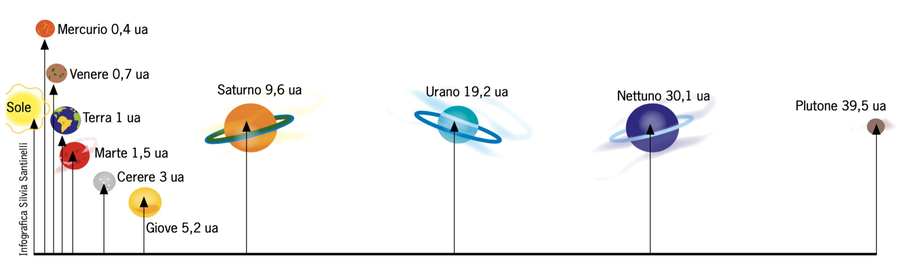
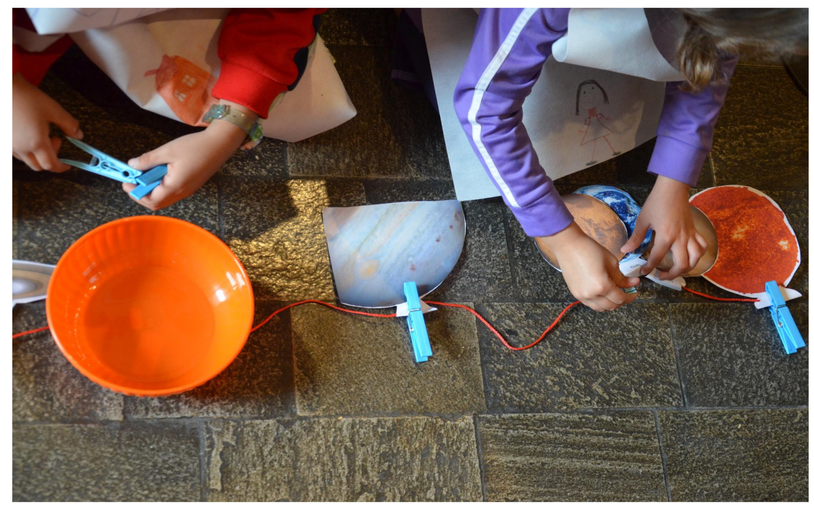


Figure 1: planets of the SolSys and their scaled distances from the Sun

The *Olmi-comics* lab

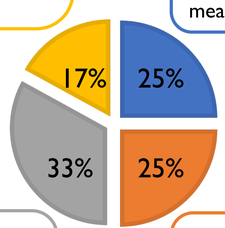
The laboratory *Olmi-comics* is born in 2003/04 with a strong constructivist inspiration, thanks to a partnership with Prof. Maria Giaele Infantino. The workshop's focal point is the construction of a SolSys representation to be hung on a piece of thread. The workshop has been replicated over a hundred times in the previous 10 years.

Students are challenged to create the representation using only two elements: an unknown length of string and the information shown in table 1. The pupils are also given cards with representations of the planets and pegs to hang on the string. They are asked to employ the simplest approach they can discover, to be as basic as possible, and to perform as few computations as possible.



On average, one group out of six realises that by bending the string in two identical halves, they may approximate the position of Uranus. Most of them continue in this manner, obtaining the positions of the remaining planets up to Jupiter. From Jupiter to the Sun, they usually use the unit technique to improve the position.

Some groups use the length of a shoe, a hand, or a few fingers (in any combination) as a unit of measurement.



Many groups adopt mixed unities, such as tiles for the outer planets and pegs or fingers for the inner planets.

Some other groups use peg or tile lengths, which are obviously a little more "universal" than any particular body part.

Conclusion

This 2-hour workshop challenges students to use their minds and bodies to portray the linear distances within the SS. In addition to astronomical content, students are exposed to a variety of interesting themes: approximation, error, precision, and simplicity. We feel that addressing these four concepts is the lab's most valuable outcome. The informal evaluation we conducted reveals a good retention in the pupils of their first steps in the scientific process and constraints.

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