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How to introduce pre-service teachers to mathematics and science subjects by using a HO in primary classes

Initial Teacher training program

The program runs for five 3-hours sessions in teacher training institute and one-day work in primary schools.

1. Trainee teachers discover the Human Orrery throughout a preliminary set of activities developed by the educators. The focus is on **the enactment process**.

2/3. A science course followed by a mathematics course tackling the main physics, mathematics and astronomy concepts that are/could be engaged when using the HO. Training activities in these two sessions are grounded in theoretical frames from **mathematics and science education**.

4/5. In small groups, trainees **design learning activities using the HO for one primary class each**. Once the learning goal is chosen, prep materials are conceived along with observation grid in order to allow the after-implementation analysis.

One-day experience in primary school: implementation and observation of the prepared activities with pupils aged 8-10 years. Each activity is conceived into **two phases using HO in the courtyard and a printed version of the HO in the classroom** connecting thus **different levels of space**. A last reflective training session takes place in the afternoon based on observations and experiences' feedback.

STEAM enacted education with a Human Orrery

The Human Orrery integrates people directly into the Solar System experience. As they engage in the walk along planetary orbits, subjects develop an understanding of the motion of the planets in the Solar System through their sensing and moving bodies. Using a STEAM approach will involve concepts in physics (velocity, forces, reference frames, etc.) and mathematics (measure, proportionality, geometry, etc.) into a tightly coordinated immersive experience.



Discover and reproduce the elliptical shape of the orbits: micro and meso spaces

Math: geometrical shape

Science: planetary orbits

Set-up:

- In the courtyard (meso space), discover the SS objects and their orbits + follow the orbit of a comet using the gardener method and estimate the position of the second focus.
- In class (micro space): draw the orbit of Saturn with the second focus given by the teacher.

Feedback: High engagement in the meso space. Difficulty to connect the same activity in meso and micro spaces. Too many differences or too high expectations ?



Relative positions in space

Math: Spatial position, alignment

Science: Movement of planets in time

Set up:

- In the courtyard, locate children in a specific configuration corresponding to a specific date; children search the observed position among different pictures using geometric properties.
- In class, confirm their choice and the date of the observation using Stellarium.

Feedback: Enhance the non-alignment of planets. Combination of different tools for planetary motions.

Measure of lengths to compare speeds

Math and Science: distance, duration, speed

Set up:

- In class, measure length of trajectories of constant duration for different planets using ropes and predict the fastest planet.
- In courtyard, observe the different speeds in the courtyard and compare to predictions.

Feedback: speed in class remains abstract and is not effectively related to lengths that are embodied throughout manipulations, whereas in the courtyard speed is enacted, which makes the link between speed and length more meaningful.



What is the age of puppets born on different planet ?

Math: units of time, euclidian division
Science: orbital period, velocity of planets

Set-up :

- Each group has a puppet (a child born on a different planet). On Earth, the puppet is 10 years old.
- Prediction in class by manipulation of small pieces of clay to understand the movement of planets + compare Earth and other planets + calculation of age by euclidian division.
- Verification in the courtyard by counting the number of turns made by each planet while Earth makes 10 turns.

Feedback: strong identification of the pupils with puppets, difficulty in computation, contentment in the validation in the courtyard.

Feedback: Quotations from trainee teachers

- *Activities with the HO enabled me to show an effective link between mathematics topics and science topics*
- *The training I received has contributed to make me more engaged in teaching interdisciplinary themes*
- *I now know better the difficulties of the pupils in relation to the knowledge at stake when learning some astronomy notions.*
- *Using the HO allows the notion of velocity to make more sense for young learners*
- *Several mathematics concepts seem now to make more sense to pupils: radius, perimeter, distance calculation, time calculation*

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