Education and Heritage in the era of Big Data in Astronomy
Proceedings IAU Symposium No. 367, 2020
R. M. Ros, B. Garcia, S. R. Gullberg, J. Moldon & P. Rojo, eds.
doi:10.1017/S1743921321000326

Construction of correspondences between the sky we see and the heliocentric model: problem-based learning in 7th grade of elementary school

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Abstract. We present the results of the implementation of a didactic sequence based on the formulation and resolution of astronomical problems by seventh grade elementary school students from the Autonomous City of Buenos Aires, Argentina. Its objective is to generate a meaningful understanding of the heliocentric model of the Solar System from the systematization of topocentric observations of the sky, either direct or mediated by resources such as diagrams, Stellarium software and tables, which we correlate with the parallel globe, other models with specific material and the Solar System Scope software. Throughout the sequence we address topics such as the diurnal and annual movement of the Sun, the night sky, astronomical ephemeris, Moon phases and eclipses. These are developed in parallel to the sphericity of the Earth and the concept of motion in science. For each of these topics we start from its recognition. We then implement strategies to guide students towards a possible description from the local point of view, and then extend it to other locations on the surface of the Earth. We encourage them to explain their ideas about the possible links between these topocentric observations and the corresponding relative positions of the celestial objects as seen from an external point of view to the Earth. These ideas are then contrasted with geocentric and heliocentric models. Here we highlight the integrative instances in which the students formulated problems in small groups and shared them for their resolution. Thus, motivated and challenged by the collaboration between peers, they became the protagonists of their learning.

Keywords. problem-based learning, elementary school, topocentric and external models.

1. Formulating and solving problems

The transversal axis of the teaching sequence proposed by the teacher (first author) is based on the construction of spatial skills that give relevance to the position of the observer (Gangui & Iglesias 2015; Longhini 2014). A problem is a new situation that a group needs to solve and for which it does not have a direct or routine strategy that leads to the solution. However, the techniques and skills necessary to solve it are previously exercised (Kaufman & Fumagalli 1999). Each problem and solution are the students' own elaborations. For this short presentation we selected and translated three examples:

Problem 1. Imagine that we take two photos of the same object throughout a day. In the first the shadow was short while in the second it was longer than the first one. The

Figure 1. (a) Screenshot of the Solar System Scope software for Problem 3. (b and c) Photographs taken by students while explaining their answers.

next day I showed them to my friends Florencia and Martin. Florencia told me that the first photo had been taken at 5:00 p.m. and the second at 11:00 a.m. On the other hand, Martín told me that the first photo had been taken at 1:00 p.m. and the second could have been at 9:00 a.m. or 6:00 p.m. Who is right? How did you find it out? *Martin is right because when the shadow is shorter, the Sun is higher and at 1 p.m. the Sun is high. On the other hand, when it starts to go down at around 6 o'clock, it is lower, so the shadow is longer. It could also have been at 9:00 because it is the other extreme.*

Problem 2. If I am in China and my flight leaves at 12:50 p.m. on December 1 (the flight lasts 13 hours and there are 14 hours difference), it arrives in Mexico City at 11:50 a.m. The flight is from west to east, in the same direction as the planet's rotation.
When did I arrive in Mexico? *December 1st.*
How could the plane land before the day and time it took off? *Because the two locations are in different time zones. When the plane leaves China, in Mexico it is 10:50 p.m. November 30. After a 13-hour flight, he arrives in Mexico at 11:50 a.m.*

Problem 3. In this photo (Figure 1.a) we see that the Sun is in the center and the planets around it. It is June 10, 2046.
What planets could be seen by day from Earth? *Venus and Neptune could be seen.*
And at night? *Mars could be seen.*
If the Moon is smaller than Mars, why do we see it larger in the sky? *The smallest sphere is the one in front, the Moon, but since it is much closer than the sphere that symbolizes Mars, it looks bigger* (Figures 1.b and 1.c).

2. Comments

The implementation of this teaching sequence allowed the students to approach astronomical phenomena that were initially unknown to them. In a challenging and motivating context, they managed to construct knowledge that progressed from their initial natural conceptions towards models closer to those scientifically valid. With the appropriate modifications, we think this experience could be applied to other educational contexts.

References

Gangui, A. & Iglesias, M. 2015, *Didáctica de la astronomía: actualización disciplinar en Ciencias Naturales: propuestas para el aula.*, Paidós.

Longhini, M. 2014, *Ensino de astronomía na escola: concepções, ideias e práticas*, Átomo.

Kaufman, M. & Fumagalli, L. 1999, *Enseñar Ciencias Naturales. Reflexiones y propuestas didácticas*, Paidós.

https://doi.org/10.1017/S1743921321000326 Published online by Cambridge University Press