Outer space in the classroom… – how to introduce astronomical phenomena in physics lessons?

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Abstract. Can one block give different shadows? When do the solar and lunar eclipses occur? Why do we see only one side of the Moon? How can we find distant planetary systems? These are sample research problems that will be posed during the workshops. We will solve them by building a model of a given phenomenon. We will use simple materials (modeling physical phenomena) and a smartphone or tablet.

Introduction

The three-body problem is one of the oldest problems in physics and has been the subject of scientific research since Newton's time. This involves modeling the motions of a three-body system - such as the Sun, Earth, and Moon - and how their orbits change and evolve under the influence of each other's gravity. Combining this with observations of these objects in the sky, one can ask about the phases of the Moon or the phenomenon of a solar or lunar eclipse. Noticing how important a role the shadow plays in these phenomena, you can easily introduce other astronomical issues in physics lessons (for example: the discovery of exoplanets)

Theoretical framework

Astronomy does not exist as a subject in Polish formal education. Its elements are introduced during physics lessons. One of the issues is the Moon as a companion of the Earth. The lesson should discuss the rotations of the Moon and its consequences, as well as the mechanism of solar and lunar eclipses. In my school practice, I implement this content using the IBL method. By performing model experiments, my students look for answers to the questions: Why do we see the Moon in different phases?; Why do we only see one side of the Moon?; When do solar and lunar eclipses occur?

It is known that during an eclipse, the shadow cast by celestial bodies plays an important role, which is naturally related to using this model to search for planetary systems around other stars (so-called exoplanets). This way, we can introduce a transit method. This method involves observing changes in the brightness of a given star as a planet passes in front of its shield. To illustrate this, my students build a model of such a binary system. Using smartphones, they observe

the decrease in the brightness of their model star and thus know that an object periodically obscures its discs - just like it happens in the Universe.

Methods and findings

The workshop program is based on the assumptions of constructivism - according to this approach, knowledge is actively constructed in the student's mind in the process of his interaction with the surrounding environment. To help students independently construct a picture of the world based on modern scientific knowledge, you should be allowed to act like a discoverer, which is why the IBL method is used. This method enables participation in activities such as observing physical phenomena and drawing conclusions based on them, formulating and verifying hypotheses, building simple physical and mathematical models, independently designing and performing experiments, and analyzing results.

Ideas for developing students' interests and competencies related to science, engineering, and space during physics lessons were taken from the ESERO program. The ESERO Space Education Offices were established on the initiative of the European Space Agency ESA. They were created to introduce space topics to primary and secondary schools and to inspire young people to choose engineering or science-related careers in the future. In Poland, the coordinator of ESERO is the Copernicus Science Center (CNK). The second program coordinated by the CNK in Poland is the Young Exporers Club (KMO). KMO means meetings, engaging activities, and atmosphere. Children and teenagers can experiment together under the supervision of their guardians. Thanks to this, they gain knowledge on their own. There are several hundred clubs of this type operating throughout Poland and abroad, and the basis of each of them is experiment - both its content and the method of execution. Participants work with the IBL method daily. It is worth adding that each of these programs has a rich database of experience scenarios.

Conclusion

The workshop aims to show how to introduce issues related to astronomical phenomena in physics lessons in an interesting and innovative way. It is worth adding that the phenomena of shadow, penumbra, solar or lunar eclipse, and transit, which will be presented during the workshops, often appear in teaching physics and elsewhere, and the latter fascinate students especially.

This workshop contains elements of Inquiry-Based Learning. This script was based on the materials ESERO and KMO program. Both programs are coordinated by the Copernicus Science Center and will be presented during the workshop.

References

[1] M. Čepič and D. Sokołowska (Eds.), *Inquiry based learning to enhance teaching* (e-book), University of Ljubljana, Faculty of Education, 2020.
Available at: https://www.3diphe.si/files/2021/12/3D_volume1_v1_MC.pdf

[2] D. Klus-Stańska, Konstruktywizm edukacyjny - niejednoznaczność, kontrowersje, dylematy, *Problemy Wczesnej Edukacji* **51**(4) (2020) 7-20.

[3] W. A. Mitchell et al., Science for the Next Generation: activities for primary school, *Science in School* **10** (2008) 64-69.