Invited Lecture

A crystallographic learning path for high school students: building a diffractometer using programmable Lego© bricks

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Robotics in education is a powerful tool for presenting scientific concepts as well as for building interdisciplinary activities for high school students in STEM [1-2]. Crystallography is only shortly mentioned in school curricula. The interdisciplinary nature of crystallography allows to show how scientific problems can be addressed using different skills and points of view. We engaged a group of high school students in a learning path focused on crystallography and with the aim of building a working replica of a powder diffractometer using programmable Lego© robotic sets. For obvious reason, a red laser was used as light source, and a diffraction grating replaces the crystal powder. The learning pathway is divided in four phases following an already tested scheme used for other robotic learning pathways [3]. The first step is the presentation of the project and of the scientific topic using a frontal lesson followed by an open discussion on the task. In the second step, the students visit research laboratory and meet experts in the field. The third phase is the software and mechanical building of the robot including its test activity and improvements. Finally, the students are involved in the demo testing, writing the report and presentation of the work in public dissemination event.

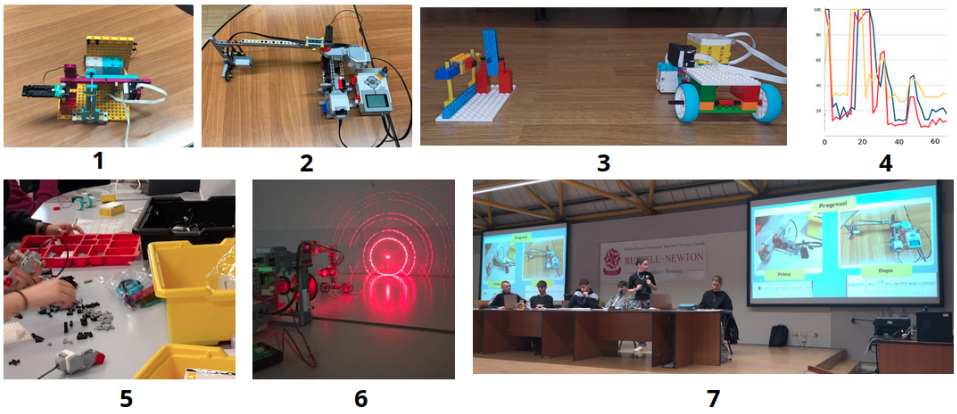

Figure 1. Diffractometer realization: Three different diffractometers (1-3) acquired diffraction intensity, building phase (4-6), presentation final public event (7).

In the implementation of the pathway, six students (four male and two female) divided in three groups have been hosted at CNR-ICCOM and CNR-ISC for a stage of 30 hours between October and December 2023. The opening lectures have been dedicated to the importance of the crystallography for the advancement of the science, the optics of diffraction and the difference and the similarity between the real and the model diffractometer. Three diffractometer configurations have been realized (Figure 1) based on light sensors and motors available in Lego kits. In the final public event, the students had fun operating their robots and explained the results obtained to the audience present at the public demo.

*[1] Tiribilli, B., Basso M., Quercioli F., Vassalli M. (2019) Physics Education **54**, 065013. https://doi.org/10.1088/1361-6552/ab3e25*

*[2] Danahy, E., Wang, E., Brockman, J., Carberry, A., Shapiro B., Rogers, C.B. (2014) Int. J. Adv. Robot. Syst. **11**, 27 https://doi.org/10.5772/58249*

[3] Ienco, A., Tiribilli, B., D'Errico, C., Torreggiani, A., Biasini, V., Gualtieri, S., Galizia, P. (2024) New Perspectives in science education – 13th edition pp. 363-369 Florence:Filodiritto Editore.

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