Boletim da Sociedade Astronômica Brasileira, **36**, no. 1, 9-10

Planetary transit experiment as an educational tool for the playful teaching of Astronomy

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Abstract. The Cometa Nordestino outreach project aims to popularize Astronomy in public schools through hands-on activities. One of the main tools during these activities is the "Planetary Transit" experiment, which simulates the detection of exoplanets by observing the decrease in a star's brightness when a planet passes in front of it. The experiment uses a lamp, spheres, an LDR sensor, and a buzzer to demonstrate the phenomenon. After the presentations, quizzes were applied to assess the students' learning. The results showed that over 50% of students from four schools achieved maximum scores, indicating the effectiveness of the practical approach to teaching.

Resumo. O projeto de extensão Cometa Nordestino tem como objetivo popularizar a Astronomia em escolas públicas por meio de atividades práticas. Um dos principais recursos durante as atividades é o experimento de "Trânsito Planetário", que simula a detecção de exoplanetas ao observar a diminuição do brilho de uma estrela quando um planeta passa em sua frente. O experimento utiliza uma lâmpada, esferas, sensor LDR e um buzzer, para demonstrar o fenômeno. Após as apresentações, quizzes foram aplicados para avaliar o aprendizado dos alunos. Os resultados mostraram que mais de 50% dos estudantes de quatro escolas obtiveram pontuações máximas, indicando a eficácia da abordagem prática no ensino.

Keywords. Extension, Planetary Transit, Education.

1. Introducion

In the educational sphere, there is an ongoing search for playful approaches that spark students' interest and capture their attention. Thus, investing in new teaching methodologies, such as experimental activities, can engage students by offering an innovative perspective and a new way of learning (Silva Jr, 2015). However, teaching astronomy in public schools remains a challenge, where teachers often face difficulties in motivating students and making the content more accessible.

Scientific outreach initiatives are essential for disseminating knowledge and bringing science closer to society, especially in the field of Astronomy, which naturally stimulates curiosity. These projects, through their activities, have the ability to make complex topics more accessible, complementing formal education by offering practical and interactive experiences that are often not included in classroom settings (Langhi & Nardi, 2009). In addition, these actions can stimulate interest in scientific careers and reduce scientific illiteracy. In this way, initiatives focused on scientific outreach contribute significantly to the popularization of science and the strengthening of the dialogue between academia and society. In this context, the Cometa Nordestino outreach project aims to foster scientific vocation in public basic education schools through itinerant actions to popularize Astronomy and Astronautics.

As part of the project, the Planetary Transit Experiment was developed as an educational tool to enrich Astronomy teaching through practical and playful activities. This experiment simulates the Planetary Transit method, widely used in Astronomy to detect exoplanets. The method consists of observing the passage of a planet in front of its host star, resulting in a periodic decrease in stellar brightness, which can be measured when there is alignment between the star, the planet's orbit, and the observer's line of sight. The first exoplanet discovered via transit was done by Konacki et al. (2003), since then more than four thousand exoplanets were detected by this method[1], therefore, standing out as an effective technique in Astronomy and serving as a tool for scientific outreach. Figure 1 shows the setup of the experiment, as well as some images taken during its presentation in schools.

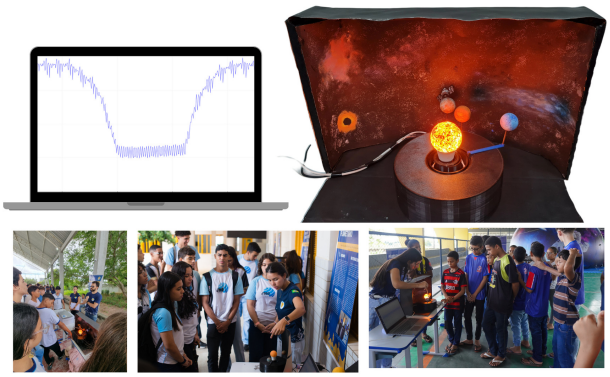

Figure 1. Images of the Planetary Transit Experiment. The upper left and right panels show the simulated light curve of a photometric transit and the planetary transit experiment, respectively. The lower panels show photos taken during the presentation of the experiment during the project activities in schools.

2. Metodology

To simulate this phenomenon, we used a 6.5 W LED bulb with an E27 socket, a gear system model [2] with three attached spheres driven by a 40 RPM motor, an Arduino circuit equipped with a

[1] https://science.nasa.gov/exoplanets/discoveries-dashboard/

[2] https://hackanexoplanet.esa.int/exoplanets-in-motion/

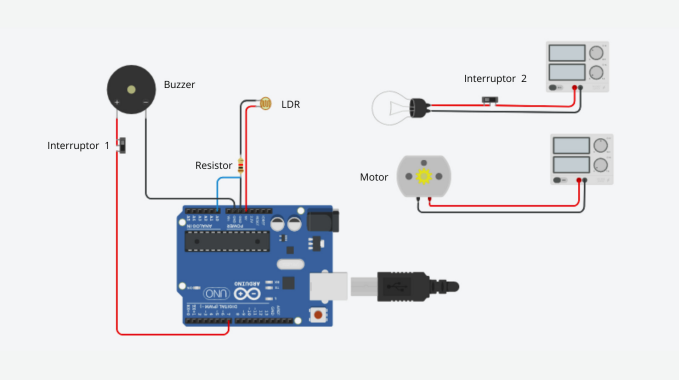

Figure 2. The schematic circuit of the experiment.

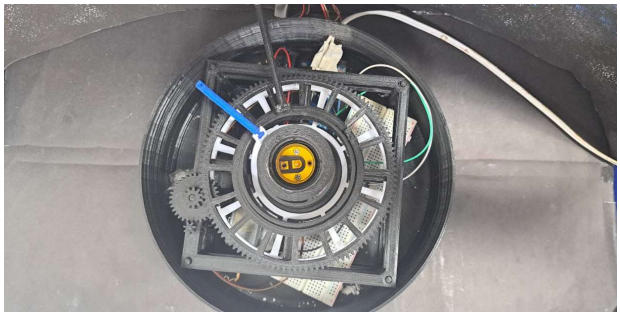

Figure 3. Round box housing the circuit and gear system.

buzzer, and an LDR sensor (Light Dependent Resistor) aligned with the bulb and connected to a monitor, see Figure 1. The bulb, spheres, and LDR represent the star, the planets, and the observer, respectively. As the spheres pass between the lit bulb and the LDR, they periodically block part of the light collected by the sensor. The result of this blockage over time, i.e., the simulated light curve, can be visualized on the external monitor. Additionally, all the signals collected by the sensor are transmitted to the buzzer, which emits sounds of different frequencies during the spheres' passage, enabling visually impaired students to experience and understand the phenomenon in an auditory way. Thus, the experiment presented allows a phenomenon culturally explained visually to be also explained audibly, making the approach more accessible. The schematic circuit used is shown in Figure2.

Finally, to facilitate the transportation of the experiment to schools, a round box was designed and printed in 3D, in which the Arduino circuit and the gear system were housed, see Figure 3.

3. Results

After each presentation, a quiz was applied to evaluate the understanding of the concepts covered during the activities. This approach allowed the measurement of the level of knowledge acquired by students in four schools in different cities in Rio Grande do Norte. In the missions conducted in São Gonçalo do Amarante and Natal, students individually answered 6 and 5 questions, respectively. In São Gonçalo do Amarante, 53% of the students correctly answered all the questions, while in Natal this percentage was 54%. In the missions conducted in Extremoz and Macaíba, due to the larger number of students and the time constraints, a different method was used. After the presentations, the students were divided into two groups and answered the quiz collectively. Using this method, 90% of the students from

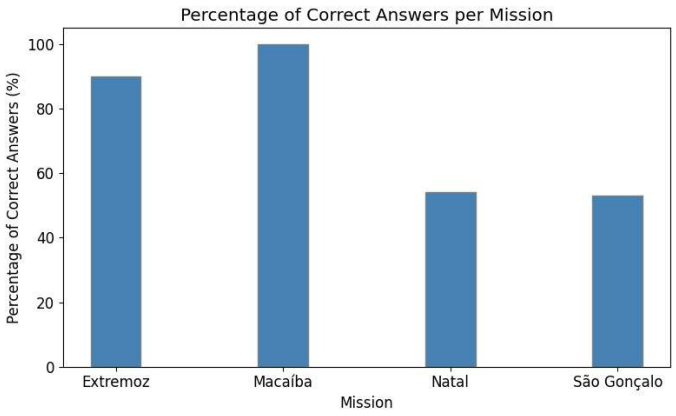

Figure 4. Percentage of correct answers obtained by students in quizzes applied in 4 schools from the metropolitan region of Natal.

Extremoz achieved the maximum score, while in the school in Macaíba, this rate was 100%. These results are summarized in Figure 4.

4. Conclusion

Based on the results obtained from the different missions, it was concluded that the Planetary Transit Experiment proved to be a promising tool for teaching the Planetary Transit technique. Furthermore, it is evident that the application of the quiz significantly influences the students' performance, as the accuracy rates in schools where the quiz was conducted individually were lower than those in schools where the questions were conducted collectively. This discrepancy may suggest that collaboration among students improves the learning and assimilation of concepts, especially in scientific activities. In summary, the presented study emphasizes the importance of differentiated teaching strategies, adapted to the context and target audience, to maximize learning in science outreach initiatives.

References

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