

ALISIO - A STEAM EDUCATIONAL PROJECT BRINGING EARTH OBSERVATION TO CANARY ISLANDS CLASSROOMS

Sara González Pérez^{1,2}, Carlos Colodro-Conde², & Álex Oscoz Abad²

¹*Departamento de Didácticas Específicas, Universidad de La Laguna (Spain)*

²*Departamento de Espacio, Instituto de Astrofísica de Canarias (Spain)*

Abstract

In December 2023, the Canary Islands launched their first satellite, ALISIO-1, into space. Since then, it has served as a testbed for innovative technologies to monitor both the short- and long-term effects of climate change in the region. Inspired by this mission, the ALISIO Educational Project was created to introduce secondary school students across the Canary Islands to the analysis of satellite imagery and its relevance in understanding and addressing real-world environmental challenges. Designed as a comprehensive STEAM initiative, the project integrates multiple areas of knowledge (science, technology, engineering, arts and mathematics) while promoting the simultaneous development of scientific thinking, eco-social awareness, and critical reasoning. This paper presents the design and preliminary outcomes of the first implementation of the ALISIO Educational Project, which aims to impact on students' scientific competence, awareness of climate and environmental issues, and motivation toward STEAM disciplines.

Keywords: *STEAM education, project-based learning, secondary school, teacher training, sustainable development.*

1. Introduction

Contemporary society operates in a highly technological environment that requires not only the acquisition of scientific knowledge but also the development of analytical, creative, and problem-solving competencies that enable individuals to address complex issues with social and environmental implications (García et al., 2017). In this context, STEAM (Science, Technology, Engineering, Arts and Mathematics) educational approaches have gained increasing relevance by promoting active, interdisciplinary methodologies focused on solving real-world problems (Oliveros-Ruiz, 2019; García-Bullé, 2021). Among the methodologies that facilitate the implementation of this interdisciplinary approach, Project-Based Learning (PBL) stands out. This methodology enables students to address real-world problems through processes of inquiry, experimentation, and scientific communication (Domènech-Casal, 2019; Santillán-Aguirre et al., 2020).

In this regard, the educational use of emerging technologies opens new possibilities for the development of innovative STEAM learning experiences. One particularly promising approach is the use of Earth observation images obtained through optical instruments installed on orbiting satellites. These resources allow students to analyse environmental and territorial phenomena from a data-driven scientific perspective, supporting the development of both digital and scientific competencies. In particular, scientific instruments such as the DRAGO space camera developed by IACTEC-Espacio (Oscoz, 2021) represent examples of advanced technology that can be incorporated as educational resources to bring students closer to scientific research and the analysis of global environmental challenges.

Furthermore, contemporary science education cannot be separated from the environmental challenges facing society. Education for Sustainable Development (ESD) promotes the formation of a critical and responsible citizenship capable of making informed decisions and actively participating in the search for solutions to environmental problems (Sterling, 2001; Wals, 2014). Integrating real environmental issues into educational processes encourages students to develop the knowledge, attitudes, and values necessary to support environmental conservation and the development of more sustainable societies (Vilches & Gil, 2012).

Within this context, the present study describes the design and implementation of a STEAM educational activity aimed at secondary school students that uses satellite Earth observation imagery as a teaching resource to develop research projects related to the Sustainable Development Goals. Through a

project-based methodology, students analyse environmental phenomena using spatial data and develop scientific communication outputs, thereby fostering critical thinking, ecosocial awareness, and the development of STEAM competencies within an interdisciplinary learning environment.

2. Objectives

The main objectives of the ALISIO Educational Project are:

1. To promote interdisciplinary STEAM learning by integrating science, technology, engineering, arts, and mathematics within a multidisciplinary framework connected to real-world challenges.
2. To develop students' scientific inquiry and critical thinking skills through the application of the scientific method in the analysis and interpretation of satellite imagery and environmental data.
3. To raise awareness of climate change and environmental sustainability, encouraging students to examine local and global environmental issues affecting the Canary Islands.
4. To support teacher training in Earth Observation and Copernicus data, enabling educators to incorporate satellite-based research activities into their classroom practice.
5. To foster students' scientific communication and collaboration skills through the preparation and presentation of research results in a student conference format, including scientific posters and oral presentations.

3. Methods

The ALISIO Educational Project follows a STEAM educational approach, supported by inquiry-based learning and Project-Based Learning (PBL) methodologies, in which teachers and students participate in training experiences and research-oriented activities. To evaluate the impact of the program, a mixed-methods assessment strategy was applied, combining quantitative and qualitative approaches to analyse both teacher professional development and student learning outcomes.

The ALISIO Educational Project was implemented through a teacher training phase followed by a classroom research phase carried out with secondary school students across the Canary Islands. A total of 9 secondary education centres and 29 teachers from schools located on different islands of the archipelago (Tenerife, Gran Canaria, La Palma, and Fuerteventura) participated in the program. Due to this geographical dispersion, the training sessions were conducted online to ensure accessibility and participation from all islands.

The project is implemented through three sequential phases. In the first phase, secondary school teachers receive specific training on the use of Earth observation data and on the educational implementation of the proposed activity. In the second phase, these trained teachers implement the project in their own secondary school classrooms, guiding students through research activities based on the analysis of satellite images. Finally, in the third phase, a student conference is organised, where participating students present the results of their investigations in the form of scientific posters or oral presentations, following formats commonly used in academic conferences. The following subsections describe each phase of the project in greater detail.

3.1. Phase 1 - Secondary school teacher training

The first phase of this educational project focuses on teacher training, which serves as the foundation for subsequent classroom implementation. This phase consists of four synchronous online sessions, each lasting two hours, delivered via videoconference. The sessions are designed to provide both a strong pedagogical framework and practical skills in the context of Earth Observation and satellite data analysis. In addition, teachers have access to a Moodle platform containing supplementary resources to support self-directed learning. At the start of the training, participants complete structured questionnaires with both open- and closed-ended questions designed to elicit their prior knowledge, expectations, and motivation regarding the integration of STEAM and space science into their teaching practice. This assessment allows for a tailored approach, ensuring that the professional development responds to teachers' needs, builds confidence, and fosters reflective engagement with the content. The following subsections describe the contents of each section of this first phase of the project.

3.1.1. Session 1 – Introduction and pedagogical framework. The first session began with a welcome and included an initial questionnaire designed to assess participants' motivations and prior knowledge. This session introduced the educational framework of the project, highlighting its alignment with secondary education and its connection to the United Nations Sustainable Development Goals (SDGs). The main objectives of the initiative were also discussed. Teachers were introduced to the expected project deliverables, particularly the preparation of a scientific poster. This included an overview of its structure,

components, and communicative purpose. The session concluded with a discussion on how the project could be implemented in secondary school classrooms.

3.1.2. Session 2 – Scientific context and introduction to Earth observation. The second session began with an introduction to the Instituto de Astrofísica de Canarias (IAC) and the IACTEC-Space division research group. Participants learned about some of their key scientific and technological projects to provide context and motivation for the day's activities. This was followed by a brief explanation of the electromagnetic spectrum. The session included a practical activity titled "Observing the Earth from Low Earth Orbit," which demonstrated how satellite imagery is obtained and utilized. At the end of the session, teachers created their user accounts in Copernicus Browser (Kovács, 2026), the platform used for accessing and analyzing satellite data.

3.1.3. Session 3 – Tools and data exploration. The third session emphasized the practical applications of the Copernicus Browser, particularly in the context of STEAM-based learning for students. Participants were introduced to the platform's key functionalities and interactive tools, showcasing how satellite imagery can be effectively utilized for educational purposes. For instance, students can use the Copernicus Browser to analyze land use changes over time, fostering discussions about environmental science and geography. They can visualize deforestation impacts by comparing historical and current satellite images, prompting inquiry-based learning. Another example involves investigating urban heat islands by examining temperature differences in various city areas through thermal satellite data. This application not only engages students in real-world data analysis but also integrates principles from science and math. Overall, the session provided teachers with practical strategies to incorporate the Copernicus Browser into their curriculum, enhancing students' understanding of environmental observation while developing critical skills in analysis, interpretation, and problem-solving across multiple disciplines.

3.1.4. Session 4 – Questions, review, and consolidation. The final session focused on addressing questions and resolving technical difficulties. It included a review of the main tools presented during the training and introduced additional web-based resources related to Earth Observation and environmental analysis. At the end of the training program, teachers completed a final questionnaire to evaluate their experience.

3.2. Phase 2 - Implementation of the project in participating schools

In the second stage of the project, teachers implement the initiative in secondary classrooms, guiding students through inquiry-based project using satellite data. Students work collaboratively, applying the scientific method to investigate environmental phenomena and communicate their findings through scientific posters. The posters are expected to describe the context of the studied issues or phenomena, the mathematical tools that were used, the reference satellite imagery, a representation of the obtained data and the conclusions of the research, linking them with the SDGs and proposing solutions when applicable.

To support learning and reflection, an accessible evaluation rubric is provided to both teachers and students, enabling self-assessment and formative feedback. At the outset, students complete questionnaires on motivation, expectations, and prior knowledge, while end-of-project surveys capture their satisfaction and perceived learning outcomes.

3.3. Phase 3 - Student conference held at the IACTEC headquarters

At the institutional level, each participating school selects its best research project and poster, which then advances to a semifinal evaluation by an academic panel. The top project from this stage is invited to deliver an oral presentation at the final student conference, held in person, while the semifinalist teams present their scientific posters. To support formative assessment and skill development, teachers use an observation rubric to evaluate students' performance, including the development of linguistic competence and their ability to defend scientific work effectively before their peers.

Additionally, a brief peer-assessment questionnaire is administered, in which teams evaluate the finalist projects presented by other schools, providing constructive feedback by highlighting strengths and suggesting proactive improvements. This structure replicates the dynamics of a real scientific conference, enabling students to communicate research, receive feedback, and engage critically with the work of peers across the Canary Islands, reinforcing both scientific reasoning and collaborative learning.

4. Discussion

At the time of writing the present document, the ALISIO Educational Project is overgoing phase 2 ("Implementation of the project in participating schools"). Preliminary feedback points to a significant

positive impact on both teachers and secondary and upper-secondary students. For teachers, participation has provided specialized training in space technologies and their applications, enhancing their understanding of Earth observation, the electromagnetic spectrum, and space missions. This knowledge broadens their pedagogical repertoire, equipping them with tools to present complex scientific content in accessible and engaging ways. The use of digital platforms such as the Copernicus Browser serves as a powerful didactic resource, enabling teachers to integrate real-world data into inquiry-based learning activities.

Questionnaire responses collected before the training phase revealed that teachers were particularly interested in learning new methodologies, techniques, and resources to complement and expand their knowledge. Some expressed a desire to convey to students the joy of conducting scientific investigations connected to their local environment, while others sought practical strategies to use satellite observation data to foster critical and scientific thinking. After the training, teachers reported significant changes in their perception of satellite imagery as a classroom resource. One commented that the experience “opened a window to learn how to use a tool I had never tried before, which offers many learning possibilities,” while a visual arts teacher noted that it “completely changed my perspective, because until now, in Photography classes, we primarily work with artistic photography.”

For students, collaborative engagement in research projects fosters rigorous data collection and analysis using satellite imagery, alongside cross-referencing with other sources. This approach strengthens digital literacy and evidence-based reasoning, core components of scientific thinking. Working in teams also develops communication and collaboration skills, as students negotiate ideas with peers of diverse abilities and perspectives. Presenting their results—first to classmates and then to an external panel—enhances oral and written communication, argumentation, and the ability to defend conclusions. Moreover, analyzing environmental changes in selected areas with respect to the United Nations Sustainable Development Goals (SDGs) helps students connect global objectives to local, real-world problems, reinforcing understanding of global challenges and motivating practical, sustainable solutions.

The anticipated strengths of the project include the integration of STEAM and sustainability education, promotion of inquiry-based and project-based learning methodologies, and the creation of authentic scientific experiences through conferences, poster presentations, and peer-assessment activities. While challenges such as motivating teachers to adopt innovative approaches, ensuring equitable access to quality digital resources, and managing the logistical demands of student and teacher participation in the in-person conference remain, the combination of hands-on training, collaborative research, and structured evaluation is expected to yield meaningful pedagogical transformation. Teachers gain confidence in applying space-based technologies in the classroom, while students develop scientific curiosity, critical thinking, eco-social awareness, and competencies that extend beyond traditional disciplinary boundaries.

5. Conclusions

Based on its comprehensive methodology, the ALISIO Educational Project is expected to have a substantial impact on both teachers and secondary and upper-secondary students. The innovative integration of STEAM education with sustainability, coupled with a structured sequence of teacher training, student research, and presentation phases, provides a framework likely to foster scientific curiosity, critical thinking, and evidence-based reasoning among students.

Teachers are expected to benefit from specialized training in space technologies and the use of advanced educational tools such as Copernicus Browser, thereby enhancing their pedagogical repertoire and confidence in implementing inquiry-based and project-based learning strategies in the classroom. Similarly, students are expected to develop key competencies, including digital literacy, teamwork, scientific communication, and the ability to analyze real-world environmental phenomena through satellite imagery, connecting local observations with global sustainability challenges.

The inclusion of structured evaluation tools—such as self-assessment rubrics, peer-assessment questionnaires, and observation rubrics for oral presentations—supports reflection, feedback, and skill development, ensuring that both teachers and students engage meaningfully with the project. The design also anticipates the creation of authentic scientific experiences through conferences and collaborative activities, promoting cross-institutional interaction and the exchange of ideas.

Overall, the ALISIO Educational Project is expected to offer a transformative educational experience, providing a well-grounded and innovative framework for fostering scientific literacy, eco-social awareness, and the development of competencies essential for students to engage proactively with the challenges of the 21st century.

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