The Game Science Research Center:
a cross-institutional community for non-digital game-based learning in STEM

OGS National Institute of Oceanography and Applied Geophysics

INAF ISTITUTO NAZIONALE DI ASTROFISICA

INFN Istituto Nazionale di Fisica Nucleare

CNR IFN Istituto di Fotonica e Nanotecnologie

Game based Learning

Game-Based Learning (GBL) is an educational methodology that uses games as tools to teach concepts, develop skills, and foster interaction among learners.

It is highly adaptable across disciplines and age groups, **promoting skills** as motivation, creativity, and critical thinking.

As a member of the interuniversity **Game Science Research Center**, OGS, INAF, INFN and CNR design and produces educational, game-based learning tools for public engagement and science communication.

Board Games as Case Studies for Multi-Process Exploration

Game Design for Learning & Engagement Game design - based learning actively engages students in constructing scientific representations. **(CNR)**

Communicating Subject Matter Using games to introduce and discuss specific scientific concepts, making them accessible through gameplay dynamics and storytelling. **(INFN)**

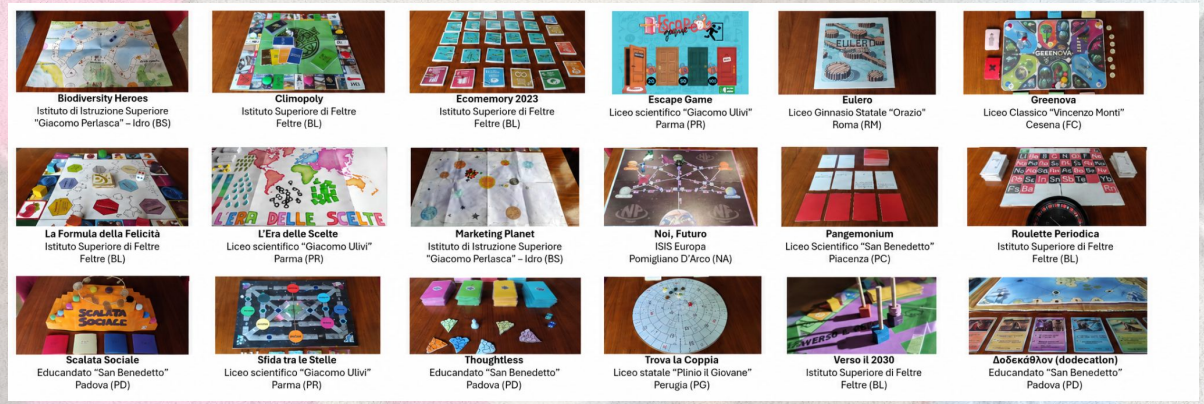
Social & Institutional Dimensions of Science Exploring the lesser-seen sides of scientific research, such as collective knowledge building, institutional roles, and research community dynamics. **(INAF)**

School Relations: Best Practices & Teacher Training Games as a collaborative tool between research institutions and schools, spanning both classroom activities and professional development for teachers. **(OGS)**

Fotonica in Gioco - The Competition

Launched by the **CNR-IFN** (Institute for photonics and nanotechnologies), this national contest challenges Italian high schoolers to design scientific board games.

Students explore cutting-edge science, translating themes like "The Secrets of Light" or "Contemporary Challenges" into compelling, hands-on play.



Participants to the 2023-2025 edition of *Fotonica in Gioco*

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Fotonica in Gioco - Learning Mechanisms

Active Construction

Students shift from passive observers of science to active model-builders, physically representing mechanics like optical pathways and photon reactions.

Game-Design Learning

Translating scientific laws into fun, interactive tabletop dynamics teaches core parameters through playtesting and systemic design constraints.

Collaborative Doing

A true "Learning by Doing" experience. High school teams develop critical teamwork, graphic mockups, and rulesets alongside scientific advisors.

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Fotonica in Gioco - Awards

The top three finalist teams receive 1,000 Euro awards to fund school travel and cultural exploration. Furthermore, winning prototypes are selected to participate directly in the prestigious Premio Archimede in Venice.

This allows student projects to escape the classroom, gaining suggestions and recognition from professional game publishers and international game designers.

From 2015: five editions, approximately 1,200 students involved, 96 games created.

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I primi venti minuti -The Challenge

Traditional public engagement struggles to make particle physics accessible. INFN's GAME project bridges this gap by mapping physical laws directly into gameplay mechanics.

A strategic board game, exploring how complex physics, primordial cosmology, and fundamental forces become active game engine dynamics.

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I primi venti minuti - Physics as Gameplay Rules

First 20 Minutes

Players must develop their own personal universe during the crucial first 20 minutes following the Big Bang.

Evolving Matter

Players must evolve their universe through various phases to successfully form protons, neutrons, and light nuclei.

The Final Goal

The ultimate objective is to build the first Helium nucleus, one of the most important elements in cosmic history.

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I primi venti minuti - Impact &Prespective

Systemic Dynamics

A strategic board game exploring how complex physics, primordial cosmology, and fundamental forces become active game engine dynamics.

Deep Awareness

Knowledge acquired through these games is learned with a deeper level of awareness (verified via questionnaires administered to players).

Creative Challenge

Beyond public outreach, translating physical phenomena into gameplay mechanics presents an exciting and rewarding intellectual challenge for researchers.

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Pixel - Beyond the Science

Astrophysics is more than analyzing space data. It is a complex social environment driven by peer-reviews, funding applications, and strategic telescope time.

PIXEL - Picture (of) the Universe, developed by INAF, simulates this reality. It allows players to experience the actual social processes behind modern science.

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Pixel - How the Game Works

Image Resolution

The primary goal is to measure astrophysical observables with increasingly higher resolution

Strategic Operations

Players manage a research center: deploying ground and space telescopes, upgrading instruments, leading teams, and securing project funding.

Scientific Prestige

The game is won by the player who accumulates the highest scientific prestige by publishing papers and making discoveries.

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Pixel - Social Dimensions of Research

Collective Knowledge

By sharing observations, players realize that science progresses through collaboration

Cooperative Strategies

Although competing for prestige points, players must actively collaborate to fund and construct major telescopes.

Institutional Realism

Players experience real-world research by applying for funds, reviewing papers, and dealing with unexpected events that happen to real scientists.

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The ON BOARD Game

Role-playing experience:

It puts players in the role of a scientific crew.

Simulating real oceanographic missions:

It fosters deep public engagement and awareness of the role of polar research.

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The Communication Gap

Scientific expeditions in polar regions are captivating to the public, yet they present unique communication obstacles:

Physical and psychological **distance** from the research settings

Abstract and **highly complex** nature of oceanographic data

Difficulty in translating polar research, which is essential for understanding climate change challenges, into accessible knowledge

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ON BOARD Core Experiences

Translating field research and vessel operations into gameplay

Oceanic Dynamics

Understanding the physical mechanisms governing heat and salt transport in polar seas.

Scientific Activities

Operating **tools** like CTD rosettes and coring equipment to collect vital climate change data.

Life on Board

Managing **cohabitation**, 24/7 shifts, and daily routines in extreme, isolated conditions.

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Realism from the Field

Game mechanics were integrated using expertise from technical staff and scientists working on the icebreaker.

Realistic use of scientific instrumentation and data collection steps.

Campaign objectives inspired by **real oceanographic expeditions**.

Simulating the **human element**, shifts, and cohabitation in isolation.

The ON BOARD Easy Project

Commitment to inclusivity

Creation of an environment where **everyone feels welcome**, respected, and valued, regardless of background.

Through s**implified-language and accessible game mechanics**, ON BOARD Easy promotes more equitable access to scientific knowledge.

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The ON BOARD Easy Project

ON BOARD Easy transforms complex operations into an intuitive roll-and-move path, where players complete research tasks by matching identical shapes, numbers, and colors between the board and their scientific tool cards.

EasyReading Font

A compensatory tool for readers with dyslexia and a facilitating font that enhances readability for everyone.

Accessible Language

Scientific concepts are rewritten in simplified language to ensure they are easily understood by players with learning difficulties.

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The ON BOARD Easy Project

Team of experts involved

Game Designers

Creating **accessible** mechanics

Technical Staff

Ensuring procedural **accuracy**

Foundation Experts

Adapting to learning difficulties

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The ON BOARD Game

The Evaluative Approach - Students and Teachers

Quantitative Data

Collected through **questionnaires**, tracking indicators such as participation, interest level, and knowledge acquisition

Qualitative Data

Gathered via **interviews** and focus groups to capture deeper nuances, personal stories, and long-term behavioral changes

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The ON BOARD Game - Student Activities

November 2024 Gameplay activity aimed at students from schools in Milazzo and surrounding areas.

Educational Objective To create an educational pathway for students, aiming to foster scientific knowledge and combat early school leaving through engaging, participatory, and stimulating activities.

May 2025 Gameplay activity aimed at students from schools in Monfalcone during the "Scienza Under 18" (Science Under 18) event.

Educational Objective To promote science education among students in the province of Gorizia through events, workshops, and projects designed to engage schools and the community.

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The ON BOARD Game - Results

>90% – High Engagement

Participants who declared they **enjoyed** the activity and the overall ON BOARD experience.

>70% – Knowledge Acquisition

Participants who stated they **learned** something new about polar science and climate challenges during the session.

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The ON BOARD Game - Results

The game helps you understand the importance of balance in an ecosystem.

Finally, for the first time, the whole class was working as a team!

I really liked the project and I had so much fun doing it! ❤️

I was struck by all the damage that humans are causing to the ecosystem…

I would have loved to talk more with the marine biologist to dive deeper into the topics.

Until this activity, I didn't even know that ice cores existed!

The ON BOARD Game - Teacher Activities

September 2025

Teacher training course on Game-Based Learning, certified on the Ministry of Education's S.O.F.I.A. system (Operating System for Training and Refresher Initiatives for School Staff).

Educational Objectives

To equip teachers with innovative teaching tools that foster the development of transversal skills alongside cognitive abilities, consolidating the role of game-based activities in education.

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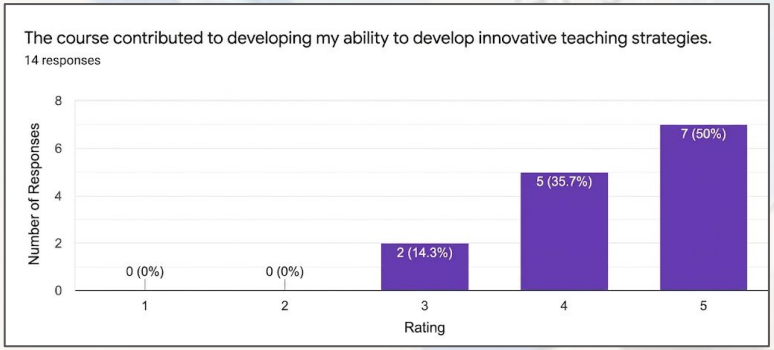
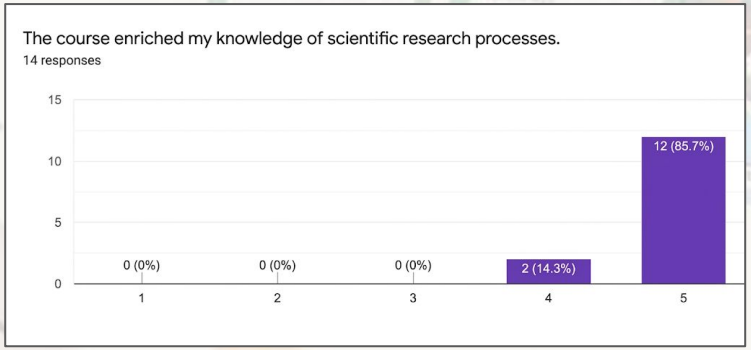
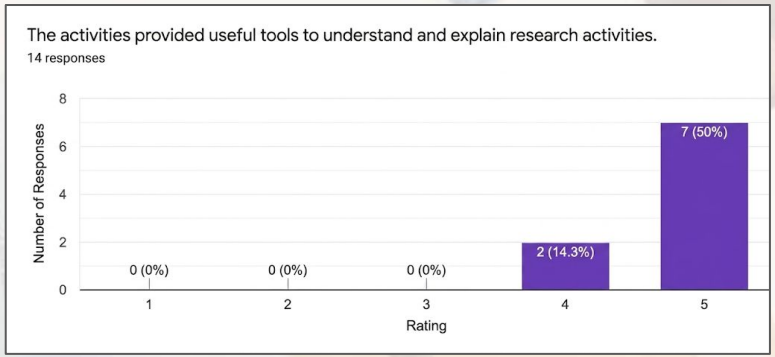
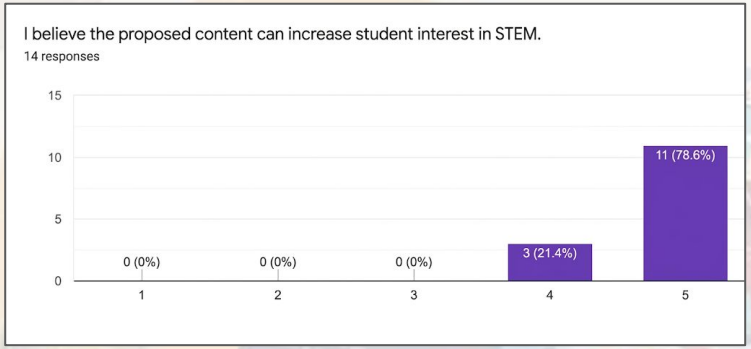
The ON BOARD Game - Results









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Conclusions – The Value of ON BOARD

Equitable Access

Breaking communication barriers creating **inclusive environments** where everyone feels valued.

Scientific Literacy

Understanding data collection protocols required to study oceanic processes.

Global Engagement

Highlighting the **essential value of polar expeditions** for climate change knowledge.

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Other educational resources from OGS

IMPATTO is an educational board game where strategy, research, and sustainability intertwine to safeguard the future of the planet.

Fish N' Ships is a card game created to educate players about the marine ecosystem and the sustainable management of its resources. Also available online: https://fishnships.it/

Pelagos Sanctuary is a strategic and cooperative board game dedicated to protecting the marine environment in the heart of the Mediterranean. Players will have to create and manage their own ecosystem, mitigating threats related to human activities and promoting biodiversity to protect whales, dolphins, and seals.

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Thank you for your attention!

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