D6.1 Didactic unit and video game

[Develop an educational program for schoolchildren (10–13-year-old) through the use of a video game expressly developed to address and raise awareness about the problem of marine litter, to increase ocean literacy and encourage conservation-attitudes towards ocean protection]

Document Information

Grant Agreement no. 101112812	
Call ID	**HORIZON-MISS-2022-OCEAN-01**
Project Name	**Preventing, Avoiding and Mitigating Environmental Impacts of Fishing Gears and Associated Marine Litter**
Project Acronym	**NETTAG+**
Project Website	**https://nettagplus.eu/**
Deliverable ID	**6.1**
Work Package Reference	**WP6**
Due Date of Deliverable	**31/10/2024**
Submission Date	**07/11/2024**
Dissemination Level	**PU - Public**
Lead Partner	**USC**
Participating Partners	**N/A**

Quality information and Revision History

Version	Authors	Date
1	Gillian B. Ainsworth, Pablo Pita, Antia Campos, Javier Seijo, Sebastian Villasante	06/11/2024

Summary NETTAG+ Project

NETTAG+ aims to provide a portfolio of three innovative smart and sustainable solutions to address the negative impacts of abandoned, lost or otherwise discarded fishing gear (ALDFG) on marine life and habitats. NETTAG+ will be based on synergistic activities between the fisheries industry, scientists and NGOs to develop three solutions to PREVENT, AVOID and MITIGATE the harmful impacts of ALDFG.

NETTAG+ will PREVENT marine litter derived from fisheries activities, AVOID loss of fishing gears, and MITIGATE harmful impact by removing existing ALDFG. These three solutions will jointly contribute to reduce ALDFG and marine pollution, namely by: reducing the introduction of hazardous chemicals and microplastics originating from ALDFG; reducing ghost fishing, bycatch and entanglements of sensitive or endangered species on ALDFG; and improving mapping, tracking and recovery technologies to retrieve ALDFG.

NETTAG+ aims to upgrade and upscale the integrative preventive approach that started in the previous NetTag project, and aims to replicate it in Mediterranean regions, providing the fisheries industry with three smart and environmentally-friendly solutions to reduce ALDFG and prevent the environmental impacts of fishing gears. The three solutions will be developed to maturity (TRL 7-8) by the end of the project, and will be tested, validated and demonstrated in real conditions in Atlantic and Mediterranean countries, namely Portugal (PT), United Kingdom (UK), Spain (SP), Italy (IT), Croatia (HR) and Malta (MT). NETTAG+'s ambition is to change the paradigm of the fisheries industry, aspiring to transform the societal perspectives about the role of fishers as Guardians and Cleaners of the Ocean. NETTAG+ will empower the sector to take effective actions to address marine pollution, promoting their role as key actors to tackle marine pollution.

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

Contents

Figures

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Executive Summary

This report consists of the NETTAG+ marine litter didactic unit and video games. Deliverable 6.1 results from Task 6.2 Civil Society Outreach: Developing effective communications actions and products for general public, school kids and media of WP6 Dissemination and Communication; more specifically activity iv) Develop an educational program for schoolchildren (10–13-year-old) through the use of a video game expressly developed to address and raise awareness about the problem of marine litter. As support material for teachers and educational managers, a didactic unit will also be developed. The approach will be participative, cooperative and practical. The groups of schoolchildren, guided by teachers, will be able to understand the importance of conservation of the Ocean in a fun and entertaining way. Recent research highlights the potential of educational games and multimedia technologies as effective tools for teaching children about marine litter and environmental issues.

The didactic activity is presented in such a way that pupils will learn about the marine litter problem including learning new vocabulary and ideas that will be consolidated whilst playing the games. The objective of the games is to encourage pupils to learn information in a fun but realistic way about some of the sources and types of marine litter derived from land, impacts of ghost gear and associated problems for the oceans. The games also aim to help pupils 'learn how to learn' as they will develop skills and abilities that are crucial to the learning process and that can be transferred to other learning contexts. A novel component of this approach to stimulate individual thinking and group discussion and debate about potential solutions to resolve and prevent problems associated with marine litter and ghost gear. The impact of this activity can be measured through quantitative metrics relating to downloads of the materials and qualitative assessment of children's progress in learning about the marine litter problem.

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

1 Introduction

Every year, around 11 million metric tons of plastic reach the ocean that should have gone to landfill or another waste management centre, but end up in the ocean instead. This is equivalent to a garbage truck of plastics entering the ocean each minute. This marine litter is transported to the sea by the wind, rain, sewage and rivers. Another source of ocean plastic pollution is from fishing gear which has been abandoned, discarded or lost at sea (also known as "ghost gear" because they are largely made of plastics and once lost at sea they can float around the oceans for years unintentionally trapping and injuring or killing marine animals). It is estimated that ghost gear makes up about 50% to 70% of all floating macroplastics (plastics over 5mm in size). An additional smaller amount of marine litter comes from maritime activities, for example litter thrown overboard from sea vessels.

Because marine litter comes in all shapes and sizes, it affects both shallow and deep parts of the ocean. Some of it floats on the water surface and is carried by sea currents; some can remain suspended in the water column while heavier items can sink and settle on the seafloor. The presence of this type of pollution in the ocean has serious consequences for marine life. Plastic waste and marine litter can be mistaken for food and ingested by various animals, from the smallest (e.g. seahorses, shrimps and fish) to the largest (e.g. sharks, dolphins, whales and even seabirds that hunt for fish), thus entering the marine food chain and potentially reaching humans when we consume seafood. Furthermore, plastics can form into tangles of waste that trap or injure animals. Because a large part of this waste ends up on the seafloor, it can also cause damage and destruction to marine habitats. Some of the litter returns to land on the tides and accumulates on beaches and coastal areas, so litter not only contaminates the aquatic environment, but also the terrestrial environment.

For humans to be able to reduce the amount of marine litter that pollutes the ocean requires significant changes to people's behaviour. For example, stopping the production and use of single-use plastics (like plastic bottles, take-away containers, cups and straws) and committing to waste recycling all over the world.

Preventing and eliminating pollution of our oceans and waters, in line with the EU Action Plan Towards Zero Pollution for Air, Water and Soil, is part of the EU Mission 'Restore our Ocean and Waters by 2030', to which the NETTAG+ project contributes. Actions such as developing communities of practice, ocean and water literacy, outreach, awareness raising and

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

participatory approaches, education and training are recognised as contributing to achieving the Mission objectives.

This report consists of the NETTAG+ marine litter didactic unit and video games. Deliverable 6.1 results from Task 6.2 Civil Society Outreach: Developing effective communications actions and products for general public, school children and media of WP6 Dissemination and Communication; more specifically activity iv) Develop an educational program for schoolchildren (10–13-year-old) through the use of a video game expressly developed to address and raise awareness about the problem of marine litter and ghost gear. As support material for teachers and educational managers, a didactic unit will also be developed. The approach will be participative, cooperative and practical. The groups of schoolchildren, guided by teachers, will be able to understand the importance of conservation of the ocean in a fun and entertaining way.

The outputs from this deliverable will contribute to achieving Sustainable Development Goal 4 Ensure Inclusive and Equitable Quality Education and Promote Lifelong Learning Opportunities for All. More specifically, the outputs will contribute to achieving Target 4.7 Education for Sustainable Development and Global Citizenship. Furthermore, the outputs will contribute to achieving two UNESCO Ocean Decade Challenges, including: Challenge 1 Understand and beat marine pollution; and Challenge 10 Change humanity's relationship with the ocean.

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

2 The NETTAG+ marine litter didactic unit and video games

Research suggests that integrating educational video games and multimedia technologies into environmental education can be an effective strategy for promoting sustainable behaviours and ocean literacy among young schoolchildren. Video games have been found to increase student engagement and motivation compared to traditional teaching methods (Shaffer 2006; Ashinoff 2014; King 2022). Video games can help children to think like innovative professionals (e.g. engineers, urban planners) and to think and learn about real world problems and their solutions (Shaffer 2006). Rossano and Calvano (2020; 196937) propose that environment and sustainability education 'demands to experience sustainability' and that to integrate sustainability principles into people's everyday lives it is necessary to merge practice and theory. The use of gamified applications and multimedia technologies has demonstrated positive effects on children's learning outcomes and self-reported actions related to marine conservation (Rossano et al. 2017; Leitão 2021).

'Transformational' video games are increasingly being developed with the intention to change players in some way where those changes persist beyond the gaming experience such as education or learning games; social good games or games for change; and empathy games (Culyba 2018). For example, educational/learning games typically target students (often children) both in and out of a classroom setting while social good games try to raise awareness about a societal issue and empathy games are often centred around evoking an emotional response in players (Culyba 2018). Pro-social games have been found to have a positive influence on players' social behaviours in other settings (Ashinoff 2014).

Recent research highlights the potential of educational games and multimedia technologies as effective tools for teaching children about marine litter and environmental issues. Studies have shown that such games can significantly improve children's understanding of marine litter causes, impacts, and potential solutions (Rossano & Calvano 2020; Hartley et al. 2015). These approaches can enhance ocean literacy, promote environmental attitudes, and foster ecological skills among young learners (Rossano et al. 2017; Leitão 2021).

The NETTAG+ marine litter didactic unit and video games are intended to be used with school pupils aged between 10-13 years old in a classroom setting under the guidance of teachers, preferably in the context of a curriculum on environmental education specifically relating to the oceans. The didactic activities and games are designed as a pedagogical tool to develop pupils' learning, cognitive and social skills (Ashinoff 2014).

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

2.1 The didactic unit

The didactic unit describes the protocol for teachers to refer to when implementing the video games as a pedagogical tool in a classroom setting with school pupils aged 10 to 13 years old.

The protocol consists of a document which contains the following sections:

1. Introduction to the activities
2. Objectives
3. Participants
4. Focus
5. Context
6. Requirements to play
7. Procedure
8. Experience record

The activity is presented in such a way that pupils will learn about the marine litter problem whilst preparing for and playing the games. For example, teachers can use the information presented in the Context section to teach pupils new vocabulary and ideas that will be consolidated whilst playing the games. Furthermore, players can take on different characters (e.g. fishers, divers) which enable pupils to understand the perspectives of different groups of people who are affected by marine litter or who are trying to solve the marine litter problem. During the final part of the activity: the experience record, pupils will individually answer a small set of questions designed to stimulate individual thinking about the marine litter problem and possible solutions. Teachers can also use the questions in a group discussion to encourage the pupils to deliberate and debate different aspects of the problem and collectively identify potential solutions.

The didactic unit has been developed in English and will be translated into Croatian, Italian, Maltese, Portuguese and Spanish.

The didactic unit document is attached in English as Appendix A.

2.2 The video games

2.2.1 Game concept

The objective of the games is to encourage pupils to learn information in a fun but realistic way about some of the sources and types of litter derived from land, impacts of ghost gear and

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

associated problems for the oceans. The games also aim to help pupils 'learn how to learn' as they will develop skills and abilities that are crucial to the learning process and that can be transferred to other learning contexts. Appropriate social skills are essential for success in education and other settings which are highly social experiences. The games are played in teams where players are encouraged to interact collectively to mitigate pollution of the oceans and are also pro-social since different levels of the games encourage the players to help wildlife and nature that are negatively affected by marine litter and ghost gear.

Four games were developed for the NETTAG+ project. These games are primarily designed to be played by schoolchildren aged 10 to 13 years in classrooms on a personal computer with teacher supervision. The games depict generic scenes of marine coastlines, habitats and marine life that can be found in the study countries.

Each game has a different storyline and objective. The games involve different levels of difficulty so players can progress from the lowest level (Game 1) to the highest (Game 4) as they learn how to play and develop the skills and knowledge required to collect the points needed to progress. Pupils are organised into teams of four players and take turns to complete the four games.

Game 1 Drones

Players control a drone which collects drift nets and must remove as many as possible from the sea. The drone will need to recharge its battery, so it must return to the ship and park. Each item removed from the sea will add more points to the scoreboard. This game is played by four players in split screen mode. The player who removes the most nets wins.

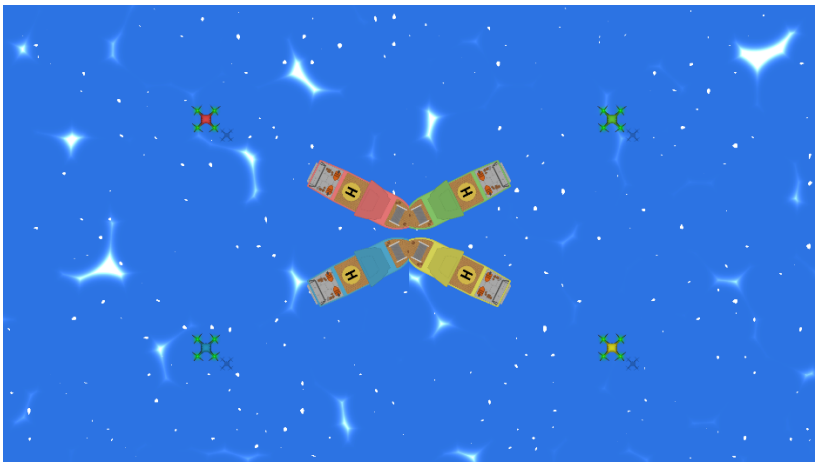

Figure 1. Screenshot of Game 1 Drones.

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

Game 2 Divers

Drift nets are not only on the surface of the water, but now players also assume the role of divers who have to tackle drift nets on the seabed. To do this, players must capture the drift nets with the help of a mobile hook and deliver them to a roving vehicle that passes through the screen randomly. This game is played by four players in split screen mode. The one who removes the most nets wins.

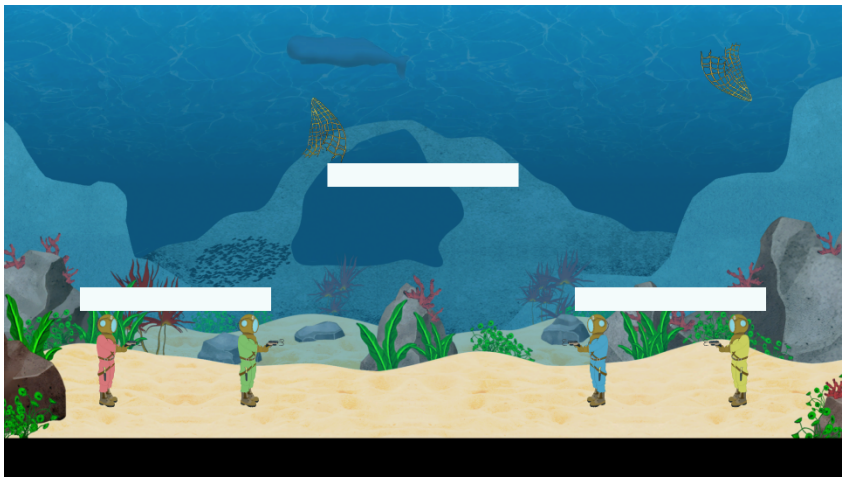

Figure 2. Screenshot of Game 2 Divers (white spaces represent placeholders).

Game 3 Microplastics

This game aims to address microplastic pollutants in rivers. There is a network of rivers (one river per player) and a factory in the centre that is emitting microplastics into the rivers. Players' mission is to neutralize the microplastics before they reach the sea using a "cannon" that shoots anti-plastic balls. To do this, players must shoot cannonballs of the same colour as the pollutants. The winner is the one who manages to undo the most pollutants.

Game 4 The Race

The last game is a classic multiplayer game. It involves a race with drones in which players must be careful not to collide with each other otherwise they lose time. If they go off the track, there will also be a speed penalty. When players encounter litter, they must decide whether to stop and collect it (they will be rewarded with points) or to continue without stopping (which will allow them to make better time). At the end of the race, the player with the most points wins not the one who arrives first.

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Specifications for playing the games include four gaming controls (one main controller and three standard controllers), a Windows personal computer (PC) with Core i5, 8/16 GB RAM, Nvidia 1080 graphics card or higher, and a large screen of about 50 inches to facilitate proper viewing in the classroom. Once the game has been launched, players can choose from the available languages (Croatian, English, Italian, Maltese, Portuguese and Spanish).

Figure 3. Images of game controllers required to play the games on a personal computer. The image on the left shows the main controller which includes a USB Bluetooth drive that allows up to 3 additional controllers to connect to the same PC. The image on the right shows the standard controller. 1 main controller and 3 standard controllers are needed to play the games.

2.3 Use and dissemination of the didactic unit and video games

2.3.1 Accessing the materials

Given the extent of the marine plastics and ghost gear problem as described in the Introduction, it is essential that people change their behaviour regarding the production and use of plastics in society across the world. Research shows that engaging with younger generations on environmental issues can help to promote pro-environmental behaviours and decision-making throughout their lives. The NETTAG+ project aims to engage with young children about the marine litter problem to raise awareness about the negative impacts of litter and ghost gear on the marine environment and marine life to stimulate pro-environmental attitudes and behaviours and problem solving to find solutions regarding their prevention, reduction and mitigation.

The games and didactic unit as well as a pdf describing specifications for playing the games will be available for teachers to download from the NETTAG+ website for use in the schoolroom setting. In addition, as the games require standard gaming controls which are increasingly prevalent in modern homes, parents can also download them for play at home in groups with

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

family members or friends, allowing for widespread dissemination and reach across schools and households.

2.3.2 Dissemination plan

NETTAG+ has allocated resources within the project budget to implement the following dissemination plan:

1. First, we will trial the didactic unit and video games in one school in each of the five study countries. Key educational stakeholders could be invited to attend these presentations to encourage uptake of the materials across the school system in each country.
2. To further promote their distribution, the didactic unit and video games will be freely and publicly available to download from the NETTAG+ website (https://nettagplus.eu/resources/). A short teaser video and social media package will be shared with project partners to support the promotion of the video game via email (e.g. newsletter), social media and news media releases. Since English, Portuguese and Spanish are widely spoken in many countries across the world, it is anticipated that the materials can have a wide international reach.
3. In addition, throughout the duration of the project (until May 2026), NETTAG+ partners will make the didactic unit and games available for members of the public to play with during NETTAG+ stakeholder events (e.g. Clean Ocean Day, Long Night of Research). The materials will also be made available through relevant European Union events and platforms promoting the management of marine litter (e.g. BlueMissionMed), projects, school programs, environmental interpretation centres, etc.

2.3.3 Measuring impact

Impact can be measured in the following ways. A quantitative measure will be provided via Google Analytics that will be employed to capture metrics relating to the downloads (e.g. number of visitors by country, region, language etc.) which will enable NETTAG+ partners to monitor the reach and interest in the materials as well as the success of our dissemination program. Second, the activity involves a didactic unit specifically developed to reveal children's progress in learning about the marine litter problem through a series of questions included in an experience record which is completed after playing the games. The experience record can be repeated over time for teachers to qualitatively measure the maturation of ideas as the children playing are exposed to more learning and experiences about the subject matter.

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

3 Novelty

The didactic activity involves a set of four video games which can be played on a computer in the classroom. The games involve different levels of difficulty so players can progress from the lowest level (Game 1) to the highest (Game 2) as they learn how to play and develop the skills and knowledge required to collect the points needed to progress. Each game has a different storyline and objective. The aims are to present several challenges relating to marine litter and ghost gear which players can discuss with each other and tackle individually or collectively in the games: retrieving fishing nets from the surface of the ocean; retrieving ghost gear and preventing animals from being trapped in ghost gears; reducing the amount of microplastics that reach the oceans; and collecting litter from the land thereby preventing it from reaching the oceans, beaches and coastlines. By enabling students to experience these problems through experimental scenarios and by taking on the role of different stakeholders (e.g. divers, citizens, racers), we also intend to stimulate individual thinking as well as group discussion and debate about potential solutions to resolve and prevent these problems. These games incorporate instant feedback loops where players can immediately see where they've gone wrong and how to fix it, making the games powerful in a learning environment (King 2022).

Additionally, the didactic unit includes an experience record which teachers and parents can discuss with the children (players). This involves activities whereby players: learn new vocabulary and ideas about marine litter; discuss what they thought about the different challenges they had to tackle in the games, and the roles they played (e.g. divers, citizens, racers); and discuss what the games represent and the consequences of marine litter to marine life and habitats, the marine environment (oceans, beaches and coastlines), and humans. These games and the experience record are designed to stimulate discussion and debate about real life problems regarding marine litter, and for pupils to individually or collectively identify possible solutions to reduce and prevent litter from entering the marine environment.

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

4 References

Bonny, L. H., R. Thompson, C. and S. Pahl (2015). "Marine litter education boosts children's understanding and self-reported actions." Marine Pollution Bulletin **90**(1-2): 209-217.

Brandon, K. A. (2014). "The potential of video games as a pedagogical tool." Frontiers in Psychology **5**: 1-5.

Culyba, S. (2018). The Transformational Framework, ETC Press.

De Aguilera, M. and A. Mendiz (2003). "Video games and education: Education in the Face of a "Parallel School"." Computers in Entertainment **1**(1): 1-10.

King, N. (2022). Create Games that Solve Problems. A guide for Going Beyond Serious Games. Australia, Chaos Theory Games Pty. Ltd.

Leitao, R. (2021). Gamification and ocean literacy in early secondary education. PhD, Loughborough University.

Rossano, V. and G. Calvano (2020). "Promoting Sustainable Behavior Using Serious Games: SeAdventure for Ocean Literacy." IEEE Access **8**: 196931-196939.

Shaffer, D. W. (2006). How Computer Games Help Children Learn. New York, US, Palgrave Macmillan US.

Veronica, R., T. Roselli and G. Calvano (2017). Multimedia Technologies to Foster Ecological Skills. International Conference on Advanced Learning Technologies.

Veronica, R., T. Roselli and G. Calvano (2018). A Serious Game to Promote Environmental Attitude. Smart Education and E-Learning. V. L. Uskov, Springer International.

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

5 Appendix A: Didactic Unit

Didactic Unit

An educational program for schoolchildren (10–13-year-old) through the use of a video game expressly developed to address and raise awareness about the problem of marine litter, to increase ocean literacy and encourage conservation-attitudes towards ocean protection

Funded by the European Union

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

Authors: Gillian B. Ainsworth, Pablo Pita, Antia Campos, Javier Seijo, Sebastian Villasante
CRETUS | University of Santiago de Compostela

Video games

This work has been conducted in the framework of the project NETTAG+ preventing, avoiding and mitigating environmental impacts of fishing gear and associated marine litter, coordinated by Sandra Ramos of CIIMAR with support from the European Union Horizon Europe Program, Grant No. 101112812 (NETTAG+).

Santiago de Compostela | October 2024

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

1 Introduction

This activity presents an educational program for school pupils (10–13-year-old) in Croatia, Italy, Malta, Portugal and Spain through the use of a video game expressly developed to address and raise awareness about the problem of marine litter and ghost gear. This didactic unit is intended to be used as support material for teachers and educational managers. It is accompanied by a set of four educational video games that encourage pupils to learn information in a fun but realistic way about some of the sources and types of litter derived from land, impacts of ghost gear and associated problems for the oceans. The approach is participative, cooperative and practical. The groups of pupils, guided by a team of scientific disseminators, will be able to understand the importance of conservation of the ocean in a fun and entertaining way. The materials are available in Croatian, Italian, Maltese, Portuguese, Spanish and English and can be freely downloaded from the NETTAG+ website (https://nettagplus.eu/resources/).

2 Objectives

This activity involves a set of four video games that can be played on a computer in the classroom. The games present several challenges relating to marine litter and ghost gear which players can discuss with each other and tackle individually or collectively in the games: retrieving fishing nets from the surface of the ocean; retrieving ghost gear and preventing animals from being trapped in ghost gears; reducing the amount of microplastics that reach the oceans; and collecting litter from the land thereby preventing it from reaching the oceans, beaches and coastlines. By enabling students to experience these problems through experimental scenarios and by taking on the role of different stakeholders (e.g. divers, citizens, racers), we also intend to stimulate individual thinking as well as group discussion and debate about potential solutions to resolve and prevent these problems.

Each game has a different storyline and objective. The games involve different levels of difficulty so players can progress from the lowest level (Game 1) to the highest (Game 4) as they learn how to play and develop the skills and knowledge required to collect the points needed to progress. Pupils are organised into teams of four players and take turns to complete the four games.

Game 1 Drones

Players control a drone which collects drift nets and must remove as many as possible from the sea. The drone will need to recharge its battery, so it must return to the ship and park. Each item

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

removed from the sea will add more points to the scoreboard. This game is played by four players in split screen mode. The player who removes the most nets wins.

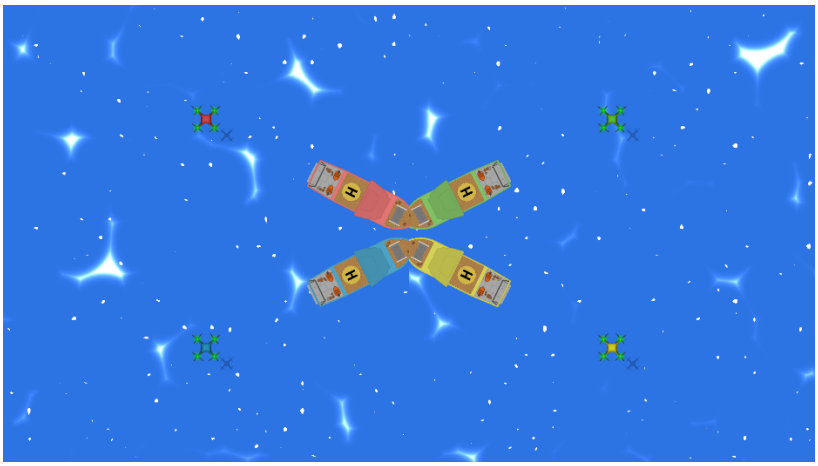

Figure 1: Screenshot of Game 1 Drones.

Game 2 Divers

Drift nets are not only on the surface of the water, but now players also assume the role of divers who have to tackle drift nets on the seabed. To do this, players must capture the drift nets with the help of a mobile hook and deliver them to a roving vehicle that passes through the screen randomly. This game is played by four players in split screen mode. The one who removes the most nets wins.

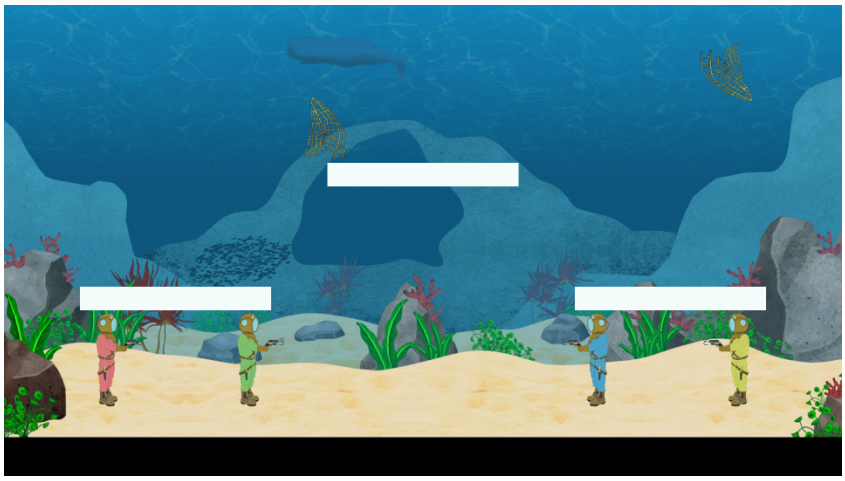

Figure 2: Screenshot of Game 2 Divers (white spaces represent placeholders).

Game 3 Microplastics

This game aims to address microplastic pollutants in rivers. There is a network of rivers (one river per player) and a factory in the centre that is emitting microplastics into the rivers. Players'

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

mission is to neutralize the microplastics before they reach the sea using a “cannon” that shoots anti-plastic balls. To do this, players must shoot cannonballs of the same colour as the pollutants. The winner is the one who manages to undo the most pollutants.

Game 4 The Race

The last game is a classic multiplayer game. It involves a race with drones in which players must be careful not to collide with each other otherwise they lose time. If they go off the track, there will also be a speed penalty. When players encounter litter, they must decide whether to stop and collect it (they will be rewarded with points) or to continue without stopping (which will allow them to make better time). At the end of the race, the player with the most points wins not the one who arrives first.

3 Participants

The activity is aimed at school children in primary education aged 10-13 years old. It consists of an educational session guided by scientific educators with a duration of 1.5 hours with each class.

4 Focus

The focus of this activity is predominantly participatory, cooperative and practical. The group of pupils can achieve the desired objectives in a fun and entertaining way.

5 Context

Every year, around 11 million metric tons of plastic reach the ocean that should have gone to landfill or another waste management centre but end up in the ocean instead. This is equivalent to a garbage truck of plastics entering the ocean each minute. This marine litter is transported to the sea by the wind, rain, sewage and rivers. Another source of ocean plastic pollution is from fishing gear which has been abandoned, discarded or lost at sea (also known as “ghost gear” because they are largely made of plastics and once lost at sea they can float around the oceans for years unintentionally trapping and injuring or killing marine animals). It is estimated that ghost gear makes up about 50% to 70% of all floating macroplastics (plastics over 5mm in size). An additional smaller amount of marine litter comes from maritime activities, for example litter thrown overboard from sea vessels.

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Because marine litter comes in all shapes and sizes, it affects both shallow and deep parts of the ocean. Some of it floats on the water surface and is carried by sea currents; some can remain suspended in the water column while heavier items can sink and settle on the seafloor. The presence of this type of pollution in the ocean has serious consequences for marine life. Plastic waste and marine litter can be mistaken for food and ingested by various animals, from the smallest (e.g. seahorses, shrimps and fish) to the largest (e.g. sharks, dolphins, whales and seabirds that hunt for fish), thus entering the marine food chain and potentially reaching humans when we consume seafood. Furthermore, plastics can form into tangles of waste that trap or injure animals. Because a large part of this waste ends up on the seafloor, it can also cause damage and destruction to marine habitats. Some of the litter returns to land on the tides and accumulates on beaches and coastal areas, so litter contaminates all parts of the marine environment (oceans, beaches and coastlines).

For humans to be able to reduce the amount of marine litter that pollutes the ocean, we all need to change our behaviour. For example, we need to stop making and using single-use plastics (like plastic bottles, take-away containers, cups and straws), stop losing fishing gear, regularly clean up oceans, beaches and coastlines to remove litter and ghost gear, and commit to waste recycling all over the world.

6 Requirements to play

- The game medium is a Windows personal computer (PC) with Core i5, 8/16 GB RAM, Nvidia 1080 graphics card or higher, equipped with a large screen of about 50 inches to facilitate proper viewing in the classroom.
- Four XBOX wireless gaming console controllers (1 x 4 players): one should include the Bluetooth repeater to connect the others. The wireless game controllers facilitate usability and sharing between the different players on the team.
- Video game (downloaded from: https://nettagplus.eu/resources/)
- Once the game has been launched, players can choose from the available languages (Croatian, English, Italian, Maltese, Portuguese and Spanish).
- 1 copy of the experience record for each pupil

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Figure 3: Example of equipment requirements for playing the games including a large screen, and XBOX gaming console handsets, including a main controller (left) which includes a USB Bluetooth drive that allows up to 3 additional standard controllers (left) to connect to the same PC. 1 main controller and 3 standard controllers are needed to play the games.

Scoring system.

Each player will add points for their team. At the end of the game, we will see a screen where all their scores will be displayed.

Figure 4: Example of game scoreboard in English.

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

7 Procedure

Begin by reading the introductory information presented in the section 'Context'. This can be used as an exercise in learning new vocabulary and ideas.

Organise pupils into teams of 4 players.

Play the four games. Throughout the games, players can experience different perspectives by playing different roles, such as fishers collecting lost nets from the ocean surface and returning them to boats (Game 1); divers collecting lost nets underwater (Game 2); citizens preventing microplastics from reaching the oceans (Game 3); and citizens racing to collect as much litter as possible before it reaches the ocean (Game 4).

Before moving on to the experience record, discuss the games with pupils to ask what they thought about the different challenges they had to tackle, and the roles they played. Discuss what the games represent and what are the consequences of marine litter to marine life and habitats, the marine environment (oceans, beaches and coastlines), and humans.

To conclude the activity, ask pupils to individually answer the questions in the experience record. Then use the questions to stimulate discussion and debate with the whole group about real life problems regarding marine litter, and to collectively identify possible solutions to reduce and prevent litter from entering the marine environment.

8 Experience record

1. Describe the objective of playing the four video games.

2. Draw some of the objects of marine litter you encountered in the games.

3. What is the origin of the marine litter you encountered?

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.

4. Explain how these objects can end up in the ocean.

5. What are the consequences of this kind of litter in the ocean for marine life?

6. Describe 3 solutions to prevent, eliminate or reduce marine litter in the marine environment (oceans, beaches and coastlines).

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No. 101112812 (NETTAGPlus).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA).
Neither the European Union nor the granting authority can be held responsible for them.