Extended Partnership

Return

multi-Risk sciEnce for resilienT commUnities undeR a changiNg climate

Spoke TS3 *– Communities' resilience to risks: social, economic, legal and cultural dimension*

WP 6 *– New models of education and communication for resilience to risk*

TK 6.4 *– Innovative tools and strategies for risk education: design*

TK 6.9 - *Executive planning of piloting activities based on the developed tools and technologies*

Deliverable 6.9

Executive Planning for the Development of a Videogame for Disaster Risk Reduction Education and Designing of its Educational Experimentation

Document versions:

Authors	Actions	Date
Stefano Scippo, Sebiana Albergamo, Diego Fabiani, Stefano Cuomo (UniFi)	First drafting	12/03/2025
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1. Introduction

RETURN is a three-year project funded by the European Union – NextGenerationEU (National Recovery and Resilience Plan – PNRR, Mission 4 Component 2, Investment 1.3 - D.D. 1243 2/8/2022, PE0000005). RETURN (Multi-risk science for resilient communities under a changing climate) brings together 26 partners, including universities, research institutions, companies, and the Department of Civil Protection. The goal is to strengthen research on environmental, natural, and anthropogenic risks at the national level and promote its participation in strategic European and global value chains.

In other words, the project aims to improve the understanding of environmental risks, whether caused by natural phenomena or human activities, and to assess how these risks are connected to the effects of climate change. This understanding is, of course, directed toward improving risk prediction and developing methodologies to prevent or mitigate them.

Among the 26 partners, the University of Naples Federico II serves as the Hub, coordinating all activities, which are structured into eight Spokes. Each Spoke addresses a specific thematic area and is further divided into different Work Packages (WPs), which, in turn, consist of multiple tasks. The Laboratory of Educational Technologies at the University of Florence is primarily involved in WP6 of Spoke 3.

Spoke 3 focuses on the social, economic, legal, and cultural dimensions of resilience that human communities can develop in response to environmental risks. Within Spoke 3, WP6 aims to design, test, and validate new models, strategies, and tools for risk education and communication.

Education and communication are the two main areas of WP6. The Laboratory of Educational Technologies is responsible for the educational aspect, while a research group from Sapienza University of Rome, coordinated by Professor Francesca Comunello—who is also the WP leader—handles the communication aspect.

The Laboratory of Educational Technologies is specifically responsible for two tasks within WP6.

The first of these tasks is titled “Innovative tools and strategies for risk education: design.” This task focuses on designing tools and strategies for risk education. The initial step involves conducting a review of scientific studies addressing the following question: *What role do Extended Reality and immersive digital environments play in training teachers, students, and the general public on environmental risks?* The deliverable for this Task 6.4 was submitted by 31/12/2024, under the title:

“Report on innovative methodologies based on immersive digital environments for vicarial experiences in protected environments, to develop a better knowledge of the risks and effects associated with dangerous events in a diachronic and spatial perspective.”

The task includes a second deliverable (D6.9) titled *“Executive planning of piloting activities based on the developed tools and technologies,”* which is presented in this document. This deliverable concerns the design of a pilot training program aimed at primary school teachers in training, focusing on education for hydraulic risk reduction. This training program is based on a video game specifically developed within the RETURN project by a company selected through a cascade funding call, called Whitesock srl.

Based on the knowledge acquired through the scoping review and the implementation of the design outlined in this deliverable, the next task within WP6, under the responsibility of the Laboratory of Educational Technologies, will involve validating the implementation and assessing the effectiveness of the tools (video game) and the innovative educational strategies developed.

The ultimate goal of the final task in the project is to develop guidelines for effective and inclusive education in risk reduction.

2. Implementation strategy

2.1. A quasi - experimental study on a Game- based training activity

The scoping review conducted in the first deliverable (Scippo et al., 2024) highlighted that the analyzed literature generally does not provide specific educational frameworks for using XR technologies in Disaster Risk Reduction Education (DRRE). Instead, it mainly focuses on learning objectives related to knowledge and survival skills. Therefore, it seems appropriate to broaden the perspective to an education on uncertainty, aimed at developing complex competencies that encompass not only knowledge and skills but also attitudes such as risk perception.

Indeed, psychological research has shown that risk perception is a crucial determinant in adopting protective behaviors, both in the prevention phase and during a hazardous event (Slovic, 1987; van Valkengoed & Steg, 2019). Moreover, simulated personal experience has proven effective in strengthening this perception (Bonaiuto & Ariccio, 2020). This executive planning builds on these findings to design and validate a training intervention aimed at raising awareness and educating future primary school teachers. Specifically, the intervention seeks to enhance their knowledge of risk management—particularly hydrological risk—and improve all the factors known to influence risk perception (Theodorou et al., submitted).

The training intervention is targeted at students enrolled in the Educational Technologies laboratory, within the five-year Master's Degree program in Primary Education Sciences at the University of Florence. The selection of hydrological risk as the primary focus was influenced by the geographical context of Tuscany. The laboratory consists of in-class simulation activities, enriched by a custom-developed video game designed to support flood risk prevention education in primary schools. The activities and the video game are structured to provide immersive experiences, increase awareness of climate change, and convey key knowledge about hydrological emergency management.

The intervention will be the subject of a quasi-experimental study that aims to answer a research question regarding its effectiveness in improving knowledge and factors related to risk perception. Specifically, these dependent variables will be measured through a knowledge test on hydrological risk and validated/adapted self-report questionnaires suitable for an Italian population. These questionnaires will assess the following dimensions: flood risk perception (Miceli et al., 2008; Miceli et al., 2010), pro-environmental orientation (Dunlap et al., 2000; Prati et al., 2011), biospheric and altruistic values (De Groot & Steg, 2007; Bonaiuto et al., 2024), climate change awareness (Lawson et al., 2019), expected response efficacy (D'Amico et al., 2023), and negative emotions (Watson et al., 1988; Terraciano et al., 2003).

The expected outcomes include improvements in attitudes related to risk perception and increased knowledge of the topics covered in the training among participating students. The focus on attitudes is based on pedagogical literature, which has demonstrated that teachers' attitudes significantly influence students' performance and personality development (Blazar & Kraft, 2017; Ulug et al., 2011).

This study, whose executive planning is presented here, assumes that primary school teachers with better knowledge of risk reduction and a more functional perception of risk will, in turn, be able to promote similar knowledge and attitudes among their future primary school students.

2.2. Resources for innovative teaching

Having established the objectives of the training program for pre-service teachers, the selection of teaching activities relies on two types of resources: on the one hand, ideas and best practices drawn from the literature

on education for hydrological risk reduction; on the other, a video game specifically developed within the Return project by a company (Whitesock srl) selected through a cascading call. The video game will be discussed in more detail in Section 3 of this deliverable. In this section, it is important to recall some key sources from the literature on education for hydrological risk reduction, which have inspired the design of the laboratory and, therefore, serve as resources for the innovative teaching to be implemented in the next project task.

First of all, it should be noted that the theme of Disaster Risk Reduction Education (DRRE) entered the international debate with the United Nations declaration of the International Decade for Natural Disaster Reduction, which began in 1990. Since then, international attention on the subject has steadily grown, and since 2014, the number of publications on DRRE has increased, albeit with a limited number of scholars dedicated to this topic and a significant lack of studies assessing the effectiveness of the designed strategies (Canlas & Karpudewan, 2023). Within this debate, the Sendai Framework for Disaster Risk Reduction 2015-2030 (ADR Center, 2015) recognizes the crucial role of education and risk awareness in disaster reduction. This international framework encourages the adoption of participatory and inclusive teaching methodologies that actively involve students in the learning process. Kagawa and Selby (2012) also advocate for an educational approach that is "interactive, experiential, and participatory." Furthermore, international literature highlights that risk education should be adapted to different cultural and social contexts, taking into account local perceptions and the specific characteristics of each community (Amri et al., 2018; Rahma et al., 2023).

In Italy, Piangiamore (2018) argues that educational activities should respond to the needs of all school stakeholders, including role-playing games that stimulate group reflection and active citizenship skills. In this perspective, schools are encouraged to engage in dialogue with families, local authorities, the productive sector, the third sector, and volunteer organizations, thus building a solid connection with the community. From a didactic standpoint, the scientific method should be promoted through investigations, reflections, and experiments that help students understand the processes used by researchers, assess risks, and choose the safest actions. In this regard, technology can play a significant role: digital technologies can facilitate learning and the creation of digital artifacts, while extended reality (XR) simulations can offer immersive and safe experiences for disaster management training (Caballero & Niguidula, 2018; Yoshida et al., 2016; Hsu et al., 2013). Learning about these topics must be meaningful and contextualized to foster a deep understanding of concepts (Bandecchi et al., 2017). Additionally, interdisciplinarity is a key element, connecting content to various disciplinary fields and employing different forms of language (scientific, linguistic, artistic) to provide a more comprehensive view of natural risks.

Therefore, schools are recognized as a fundamental context for risk education, making it essential for teachers to have specific skills and knowledge. Active learning, central to this approach, materializes through direct experience, manipulation, and play, stimulating observation and interaction with the environment. The goal is to develop transversal skills such as critical thinking, cooperation, empathy, openness to different opinions, and the ability to argue effectively. Students must acquire the skills to analyze their territory, identify geographic and environmental aspects, and understand the basic concepts of natural disasters, becoming aware of their role in the environment (Piangiamore, 2018).

In Italy, numerous educational projects have been developed and implemented to focus on risk reduction, particularly hydrological risk, aiming to educate responsible and aware citizens who can act appropriately in emergencies and contribute actively to the safety of their territory. For example, since 2004, Legambiente and the Civil Protection Department have promoted the initiative "Operazione Fiumi" to encourage schools to adopt river sections, monitor them, and keep them clean, providing educational materials, student worksheets, and a glossary (Bandini et al., 2011).

A few years later, in response to the 2011 flood in Cinque Terre, the educational program "Piovono idee!" was created and implemented in multiple editions by the National Institute of Geophysics and Volcanology (INGV) in collaboration with other research institutions, associations, and schools. Over time, the program evolved into a broader project linking primary and lower secondary schools, focusing on the meteorological, hydrological, and geo-environmental aspects of floods. This project goes beyond providing theoretical information and actively engages students in practical activities and role-playing games that explore the water cycle, the effects of rain on soil, the greenhouse effect, and the consequences of reckless urbanization near rivers. A key element of this project is the "Cosa rischio?" totem, which uses storytelling to immerse participants

in dangerous situations, stimulating discussions about risk assessment. Additionally, in collaboration with research institutions and schools, the INGV launched the M@Ter 2.0 project in 2015, which developed the serious game “Risk Detective” for primary schools. This game simulates an investigation into hydrogeological risk, where children learn to conduct inquiries, identify danger signals, and evaluate safe solutions through practical tests, site inspections, quizzes, and the choice of a secure lodging. An optional worksheet presents a portion of land affected by landslides and floods to reflect on the scale of risk in case of uninformed decisions (Piangiamore, 2018).

The need to involve primary schools highlights the importance of training teachers. To this end, the University of Bologna has been conducting pedagogical-didactic laboratories on hydrogeological risk within the Primary Education Sciences degree program since 2014, preparing future teachers to address these topics by combining theory and practice with scientific experiments and storytelling-based activities. Specifically, a story featuring a dog as the protagonist is used to tackle complex topics in an engaging and non-alarmist manner, with experiments simulating landslides and floods and worksheets for documenting teaching activities (Bandecchi et al., 2017).

These projects emphasize the importance and feasibility of implementing educational programs in Italy for hydrological risk reduction, starting from primary schools and, even earlier, from the training of primary school teachers. They also highlight the significance of play and technology as potential tools for this type of education.

As a result, within the Return project, a laboratory on hydrological risk reduction education has been designed for students of Primary Education Sciences, adopting a teaching approach that integrates play elements and new technologies. The design of the laboratory activities has drawn upon all the theoretical and practical resources illustrated in this section. The following section will introduce the video game developed in collaboration with Whitesock srl, which will be used in the laboratory as a valuable teaching tool for both future teachers and primary school students.

3. Design of a 3D videogame for DRRE

3.1. Concept and story

“Virivì and the Shadow of the Rain” is an educational video game that follows the adventures of Donatella, a ten-year-old girl who discovers that her city is at risk of flooding. Throughout her journey, she interacts with adults—sometimes learning from them, other times uncovering a widespread lack of awareness about safety culture and emergency management. With courage and intelligence, the young protagonist acquires and shares valuable information, helping adults overcome their uncertainties and prepare more effectively.

The game unfolds over five days (three acts) and encourages players to make responsible decisions and solve puzzles. Various characters interact with the city and capture photos of at-risk locations. The pivotal moment of the game occurs during a weather alert, offering the player the chance to put acquired knowledge into practice and turn theoretical concepts into practical skills. The game draws upon research conducted in collaboration with field experts and institutional sources, particularly the informational materials from Civil Protection, the “Io non rischio” campaign, and the UNDRR Disaster Resilience Scorecard for Cities.

The storyline is structured over five days:

- **Day 1 (Friday – The Goblin):**
  Donatella is a ten-year-old girl who performs well in school, though her best friend, Antonio, consistently gets higher grades. On her way home with her brother Pasquale, she notices a sign announcing an art exhibition and decides to enter. There, she discovers that all the paintings depict a mysterious figure. After conducting some research, Antonio realizes that the figure might be the

Munaciello, a mischievous yet benevolent spirit that could help them identify critical points in the city to prevent an impending disaster. Determined to follow the goblin's trail, the two protagonists begin taking photos to document clues that might guide them.

- **Day 2 (Saturday – Into the Woods):**
  Donatella is determined to meet the painter and follows the maps Antonio has drawn for her. When she arrives at the artist's studio, she finds a peculiar message inviting her to follow him into the mountains. Along the way, she meets various characters, including a Civil Protection officer and Maria, a hiker. Each interaction provides Donatella with valuable insights into safety measures. At the mountain's peak, she sees the goblin for the first time and takes a picture. Although Antonio cannot see the *Munaciello*, he trusts Donatella, and together, they decide to compile their findings into an album to present to the teacher.

- **Day 3 (Sunday – A Gloomy Day):**
  When a flood alert is issued, Donatella takes charge, guiding her family in adopting necessary safety measures, such as an evacuation plan and precautions for securing important items and preventing potential household hazards caused by the emergency.

- **Day 4 (Monday – False Alarm):**
  Schools remain closed due to the weather alert, which has now been lifted. A conversation unfolds within the family. Donatella's brother downplays the risks of a flood, but she reflects on the situation and realizes the vulnerabilities that should not be ignored in an emergency. Specifically, she considers what might happen to people with disabilities and the businesses most exposed to risk. After leaving home, Donatella meets a man and discusses flood risks and the relationship between institutions and citizens.

- **Day 5 (Tuesday – Long Live Donatella):**
  The next day, Donatella goes to school and, following Antonio's advice, decides to show the photo album to her teacher after class. Impressed by her work, the teacher encourages her to share it with the mayor, who happens to be his brother. Donatella gladly accepts the suggestion, only to discover, to her surprise, that the man she spoke with the previous day is actually the city's mayor. Impressed by her dedication, the mayor praises her for adopting responsible behaviors and for raising awareness about flood risks.

3.2. Gameplay and game mechanics

The game revolves around knowledge acquisition, where players interact with characters to gather information on risks and prevention strategies. This content is gradually unlocked, enhancing the understanding of flood-related hazards. Players will explore various locations in the city and capture photos of at-risk scenarios (where the *Munaciello* appears), revealing hidden details such as embankments, bridges, and vulnerable areas. The collected photos and information are then added to a photo album, which players must complete by correctly matching the pictures with the corresponding educational content.

The player can monitor the daily weather alert via a computer, earning points as rewards for staying informed and making timely decisions.

Additionally, the game features a point-based system, where points are awarded for responsible choices, interactions with characters, and the correct implementation of safety measures. These points can also be used to unlock new information and resources throughout the game.

3.3. Characters

The game includes ten characters, introduced as follows.

Donatella:

- **Description:** The main protagonist of the video game, Donatella is a ten-year-old girl with a curious and intelligent mind. Her values and determination make her particularly keen on learning crucial information about hydrogeological risk. She is proactive and resourceful, always ready to take action to protect her city from flooding.
- **Appearance:** She wears sporty attire, including an orange shirt, shorts, and a cap. She also carries a small backpack where she keeps her photo album.
- **Abilities:** She solves puzzles, collects photographs for research, and acquires important knowledge on her area of interest.
- **Interactions:** She talks to NPCs (non-playable characters), explores environments, and takes photos.

Antonio:

- **Description:** Donatella's best friend, slightly older than her. He is a very bright child with a strong aptitude for research and technology. He loves learning new things and is always ready to support his best friend.
- **Appearance:** He has short hair and a neater look compared to Donatella. He wears glasses, a light blue t-shirt, and military green pants.
- **Abilities:** He researches information online, creates maps and clues, and solves puzzles related to the city's history and geography.
- **Interactions:** He is very cooperative, provides useful advice, creates maps, and suggests directions.

Il Munaciello:

Description: A mysterious sprite that appears in key locations throughout the city, helping Donatella identify risk areas.

Appearance: A small, shadowy sprite with facial features that are hidden and difficult to recognize. It wears a dark hood and a long robe. Its figure is slightly transparent and ethereal, adding to its mysterious aura.

Abilities: Acts as the game's enigmatic guide, providing cryptic clues and revealing hidden secrets about the city. It uncovers critical locations and helps solve safety-related mysteries.

Pasquale:

- **Description:** Donatella's younger brother, Pasquale, is often skeptical in conversations, showing little concern for warnings, prevention, and staying informed. Throughout the game, Donatella helps him grow and understand the importance of these aspects for the safety and well-being of the community.
- **Appearance:** A young boy with long hair, dressed in simple and comfortable clothing.
- **Abilities:** He follows Donatella on her adventures but is not directly involved in solving puzzles.

Vincenzo:

- **Description:** Friendly but somewhat naive and unprepared. Throughout the game, he tries to fix problems by coming up with inconsistent and limited solutions. Donatella teaches him what she has learned from experts, informing and helping him improve.
- **Appearance:** A man with short, slightly disheveled salt-and-pepper hair. He wears classic and tidy clothing.
- **Abilities:** He trusts his daughter and follows her safety advice. He adopts all necessary prevention measures to protect their valuables and family memories.

Rosa:

- **Description:** A loving and attentive maternal figure with a broader perspective on the world compared to her husband. She enjoys discussing and reflecting with her family members.
- **Appearance:** She has short hair and wears gold-colored earrings. Her clothing is casual and homey.
- **Abilities:** She shares past stories related to floods. She enjoys engaging with her daughter and contributing to raising awareness about the topic.

Gerardo:

- **Description:** An eccentric and flamboyant artist, he vividly describes his paintings and provides Donatella with essential information to progress in her adventure. Thanks to him, Donatella takes a crucial step forward in her mission to protect the city.
- **Appearance:** He has distinctive mustaches and wears a hat typical of his artistic profession. His clothing, covered in paint stains and splashes on his cloak, fully reflects his dedication to painting.
- **Abilities:** He guides Donatella in her search for the Munaciello, helping her uncover new knowledge about risks and teaching her how to apply it throughout her journey.

Francesco:

- **Description:** Donatella's teacher. He loves his job, and sharing important information makes him proud of his work. He listens to and observes his students carefully, always striving to do his best.
- **Appearance:** He has short hair, a beard, and wears reading glasses. He has a watch on his wrist and wears a collared shirt under his blue vest.
- **Abilities:** A very patient and meticulous man, he deeply cares for his students. He offers encouragement and advice, serving as the game's educational guide.

Giuseppe:

- **Description:** The mayor of the city, highly attentive to safety and emergency management to ensure the well-being of the community and its citizens. He is also Donatella's teacher's brother.
- **Appearance:** A middle-aged man with short, graying hair. He dresses very elegantly and has an authoritative yet friendly demeanor.
- **Abilities:** He supports community awareness and provides advice on flood risks. He also recognizes Donatella's goodwill and congratulates her for all she has done for the city, acknowledging her courage, dedication, and sensitivity in helping safeguard it.

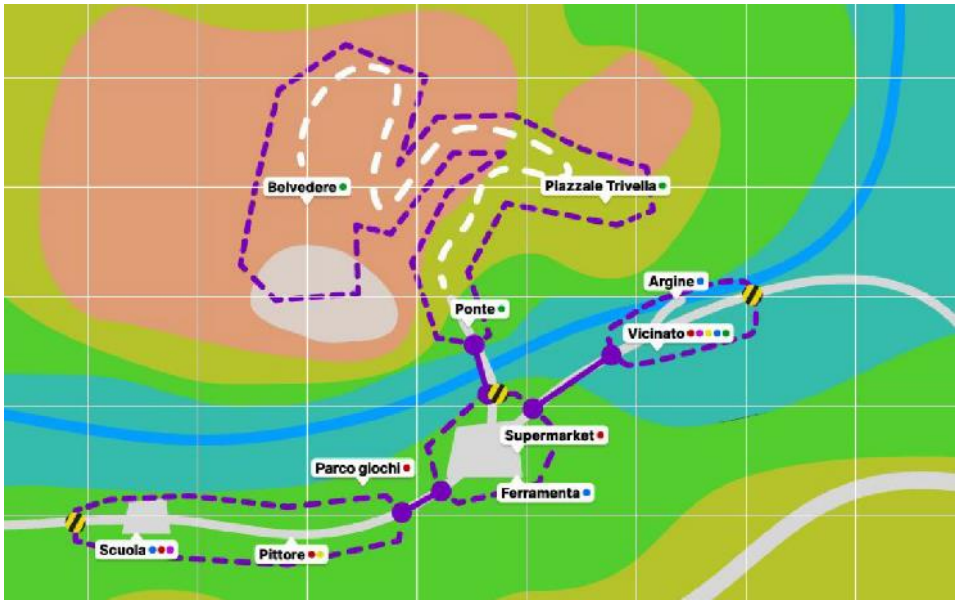
Filippo:

- **Description:** A representative of the civil protection service. He is well-informed about flood dynamics and the most at-risk areas of the city.
- **Appearance:** He wears the official civil protection uniform and cap, easily recognizable by its bright yellow color.
- **Abilities:** He provides Donatella with valuable safety information and offers practical advice on flood emergencies.

3.4. Environments

The game is set in a small village nestled among the gentle hills of the Lucanian Apennines, enveloped in an almost surreal tranquility. This village is as vibrant as its inhabitants, who are united and supportive of their community's well-being. The locals strive to preserve their traditions, which are threatened by mysterious forces seemingly awakening in the shadows of the landscape.

Within this setting, the game takes place in four specific locations: the neighborhood district, the village square, the forest, and the painter's studio, each described in detail below.



The Neighborhood District

- **Visual description:**
  Stone houses with terracotta-tiled roofs line narrow, winding streets. The windows are adorned with pots of geraniums, while the walls show signs of age with crumbling plaster. At sunset, lanterns cast a warm glow, creating shifting shadows on the walls.
- **Atmosphere:**
  A convivial place dominated by warm yet vibrant colors. The houses seem to blend with the clouds and the greenery of the surrounding mountains, evoking a sense of well-being but also hinting at latent tensions.
- **Narrative:**
  This is where interactions with secondary characters take place, uncovering mysteries to document in order to protect a city at risk of flooding and its critical points.
- **Environmental clues:**
  Each house in the district contains details to examine. Collected objects reveal fragments of the local history.
- **Social Interactions:**
  Players can talk to the inhabitants to receive side missions.

The village square

- **Visual description**
  The heart of the village, featuring an ancient well at its center and cobblestone paving smoothed by years of use. A small fountain trickles crystal-clear water, though the villagers claim it is “no longer as pure as it once was.”
- **Atmosphere:**
  A welcoming meeting place, yet filled with enigmas due to the presence of a mysterious spirit the Munaciello who appears at critical points within the small village.
- **Narrative:**
  The square serves as the focal point for collective events. It becomes a place of investigation, with hidden clues embedded in architectural details or the stories told by the inhabitants.

The forest

- **Visual description:**
  Towering trees with gnarled trunks seem to watch those who walk among them. The dense vegetation covers the ground in moss, while the air is thick with the scent of humidity and decaying leaves. Small bluish lights flicker among the trees, believed by local legends to be a manifestation of the “spirit guide.”
- **Atmosphere:**
  A calm and inviting place that might seem dangerous due to the presence of the mysterious sprite.

However, the Munaciello is a benevolent creature, guiding players toward safety and prevention through its valuable appearances.

- **Narrative:**
  The forest guards ancient secrets and symbols carved into the rocks, offering clues about the magical forces at play in the area.

The Painter's Studio

- **Visual description:**
  The studio is tucked away in a secondary street of the village, behind a stone arch leading to a small courtyard. The interior is spacious, with warm tones and strategic lighting that enhances the colors and contrasts of the paintings. The walls are covered with canvases, some still unfinished, depicting landscapes of the village and enigmatic scenes.
- Many paintings contain mysterious details, as if trying to communicate something ominous. Wooden tables are cluttered with paint jars, worn-out brushes, and sketches on crumpled sheets. Among the artistic materials, there are also peculiar objects such as feathers, small engraved stones, and burned-out candles. A central easel holds the painter's latest work—an incomplete painting that seems to portray a dreamlike vision of the village under a stormy sky.
- **Atmosphere:**
  The studio is imbued with a melancholic yet productive ambiance. The scent of paint and old wood mingles with the sound of the wind filtering through the open windows.
- **Narrative:**
  The painter's studio is a crucial place for discovering visual clues about the village's history and the supernatural forces surrounding it. Through paintings and sketches, players can notice details that are not visible in the real locations, suggesting a connection between the artist and the supernatural. The painter himself is an enigmatic character—he could be a reluctant ally or a witness to extraordinary events.

Exploration and Narrative Mechanics in the Studio:

- Players can interact with paintings and analyze them closely.
- Some hidden details (such as figures or symbols) become visible only after solving puzzles in other areas of the game.
- **Visions:** Interacting with the studio or certain objects can trigger dreamlike visions or flashbacks related to the village's past, revealing events that players must interpret.

Art Style and Tone

The game's artistic style draws inspiration from lighthearted yet expressive games such as *A Short Hike* (for its tone) and *Life is Strange* (for the depth of dialogues and character interactions). The tone balances the seriousness of the educational message with a sense of adventure, making learning enjoyable.

The themes are presented in an accessible manner for a younger audience, but with enough depth to encourage adults to reflect on emergency situations and civic responsibility.

The character and environment design reflects the unique atmosphere of Southern Italy, using a modular character creation system that allows for diversity and customization. The game world features open-world exploration, where players can interact with different locations (coastal areas, rural villages) and uncover hidden environmental risks. Abandoned buildings, eroded areas, and polluted regions serve as opportunities for risk recognition.

The game takes inspiration from environmentally focused titles like *Alba: A Wildlife Adventure* for its photography mechanics and *Return of the Obra Dinn* for its investigative approach. Specifically:

- **Colors:** Warm tones (ochre, burnt sienna, olive green).
- **Details:** Each location has unique elements that tell its story, featuring references to the folklore of the Lucanian Apennines (symbols, ornaments, and legendary objects).

- **Effects:** Light fog, wind moving the leaves, and dynamic lighting contribute to an immersive atmosphere.

Dialogue and Interactions

Players interact with various characters in the game, such as local citizens, experts, and the mayor. These interactions help gather information about local risks and the role of community engagement. Every conversation provides fundamental references on civil protection and emergency management related to floods.

The responses chosen by players influence their learning and progression in the game, earning points for the most relevant answers.

There are also specific game scenarios, such as a weather warning event, which push players to identify potential flood risks and learn immediate preventive actions.

Photograph as a Discovery Tool
Photography plays a central role:

- Players take pictures of risk areas where they encounter the Munaciello.
- The photos initially appear normal but reveal hidden details related to environmental risks once developed.
- These revealed details help raise awareness of specific environmental vulnerabilities.

Key Information Sources in the Game:

- **Citizens:** Share sightings of the Munaciello and report hazardous areas.
- **Experts:** Provide technical advice and practical knowledge on climate risks and mitigation measures.
- **The Mayor:** Grants access to special resources and restricted areas for implementing solutions.

3.4. Developement

The development of the video game integrates tools and solutions optimized for a smooth and engaging gaming experience. One of the fundamental choices concerns the game engine, with Unity selected for its versatility and optimization for mobile devices. Unity efficiently handles graphic rendering, animations, and game logic thanks to advanced plugins like TextMesh Pro for text management and Cinemachine for camera control.

From a narrative perspective, the system utilizes Articy Draft X, a tool for creating complex narrative content. With its native plugin, Articy Draft allows structured data—such as branching dialogues and narrative logic—to be imported into Unity, reducing development time and simplifying iteration. The narrative system is based on the Acterra Narrative Engine (ANE), which supports three visualization modes: visual novel, dialogue balloons, and SMS-style messages. This multimodal approach ensures a dynamic adaptation of the narrative to the game's context.

Another essential component is the system of interactable objects, designed to trigger narrative events, cutscenes, or notifications. Each interactable can initiate dialogues or events synchronized with the player's progress, enhancing gameplay interactivity. Additionally, the centralized notification system allows real-time alerts and updates with customizable options for duration and graphic style.

The project pipeline automates key processes, such as importing narrative assets, synchronizing game variables, and positioning actors in locations. This structure reduces the risk of errors and improves narrative consistency. Furthermore, third-party assets like Universal Device Preview and Graphy support cross-platform testing and performance optimization, ensuring a uniform user experience across different platforms.

In summary, the technical requirements of the video game are designed to maximize workflow efficiency and provide an immersive and personalized gaming experience.

The player's progress is tied to acquiring knowledge through dialogue and environmental exploration, making the experience both educational and adventurous.

4. Laboratory design

4.1. Spaces, timeframes and objectives

As mentioned in the introduction, to accomplish Task 6.4, a pilot activity has been designed to test a training program for primary school teachers in training, focusing on education for reducing hydrological risk. This training program is based on the use of a video game specifically developed within the Return project.

The training course will be conducted during the second semester of the 2024-25 academic year within the Educational Technology Laboratory of the Primary Education Sciences degree program at the University of Florence. Specifically, it will be a 36-hour lab involving approximately 250 students in their fifth and final year of study. The laboratory will be offered in two editions: one held during the weekdays and one on Saturdays, taking place between late April and early June 2025. Students can choose which edition best fits their schedule. Since many fifth-year students are already working in schools, it is expected that, as with other laboratories in the degree program, a higher percentage of working students will attend the Saturday edition.

The Saturday edition will be the session during which the training program for hydrological risk reduction education will be tested. The schedule includes five sessions, running from Saturday, May 10, to Saturday, June 7. The first sessions will last seven hours (from 9:00 AM to 4:00 PM), while the final session will be eight hours long (from 9:00 AM to 5:00 PM).

The goal of the Saturday edition is to equip students with the skills necessary to design effective hydrological risk reduction education programs in the future schools where they will work as teachers, using the developed video game for primary school students. As a result, the learning objectives for the lab participants include:

- **Knowledge and Understanding:** Understanding the key concepts and educational implications of game-based learning related to hydrogeological risk.
- **Ability to Apply Knowledge:** Designing an educational intervention on hydrological disaster risk reduction using the video game.
- **Autonomy in Judgment:** Developing informed evaluations based on evidence.
- **Communication Skills:** Effectively communicating knowledge and sector-specific issues.
- **Learning Ability:** Developing independent research and deepening their understanding of the subject matter.

4.2. Content and teaching strategies

The laboratory is structured into five sessions, each corresponding to a module that covers the following topics:

- **Module 1:** The memory of past floods: Engaging interest and problem awareness.
- **Module 2:** Causes and dynamics of floods.
- **Module 3:** Territorial study: Risk mapping.
- **Module 4:** Alerts and appropriate actions before, during, and after a flood.
- **Module 5:** Using the video game for hydrological risk reduction education.

The structure ensures that all essential aspects of hydrological risk reduction are covered, providing participants with the necessary knowledge and skills while fostering an appropriate risk perception of their own territory.

In the first module, participants will be introduced to the problem, which holds particular historical significance in Florence. Viewing archival footage of the 1966 Florence flood and recent flood events, such as the 2024 Valencia flood, will serve to spark interest and prompt questions about the causes and conditions that enable such disasters.

The second module will delve into flood causes, emphasizing their link to climate change. It will then explore specific factors that contribute to devastating floods, such as low urban soil permeability, buried waterways, and neglected riverbanks.

In the third module, with a clearer understanding of flood mechanisms, participants will engage in a more contextualized analysis of their own territories. They will research Civil Protection Plans for their regions (many participants are expected to be from Tuscany) and use them to identify local risks, emergency procedures, and designated safety areas, while also learning how to interpret hazard maps.

Once emergency procedures are studied, it becomes evident that understanding the alert system is crucial. The fourth module will focus on interpreting yellow, orange, and red weather alerts and the corresponding actions to take before, during, and after a flood.

This progression allows participants to fully appreciate the video game's storyline, content, and intended learning outcomes. The game mirrors the four stages explored in previous modules, presenting them in a playful and engaging manner.

Alongside content learning, participants will be guided in designing a lesson plan on hydrological risk reduction for primary school students. They will be divided into small groups of about five people, each assigned to analyze a fourth- or fifth-grade classroom setting—potentially a real classroom where a group member is teaching. The group will then develop a learning unit that defines competency goals, learning objectives, teaching strategies, and assessment methods, integrating the ideas and activities from the laboratory, including the video game.

The laboratory employs diverse teaching strategies, combining traditional lectures with game-based learning, case studies (analyzing specific classroom situations), and cooperative learning (such as the jigsaw technique). These approaches span different learning architectures: receptive, collaborative, simulation-based, and guided discovery.

5. Monitoring and Evaluation

5.1. Game Development Deliverable

The monitoring of the video game development is carried out by the working group of the Educational Technology Laboratory (LTE) at the University of Florence through a series of feedback provided to the company designing and developing the video game (Whitesock srl). The development process follows a precise schedule, outlined by a GANTT chart, which includes three key milestones: the release of the alpha version in mid-December, the beta version in early February, and the completion of the polishing phase, with the final release scheduled for late April, ensuring that the video game will be fully operational for students in the laboratory by May.

The alpha version, released on December 21, allowed for an initial evaluation of the game mechanics. The LTE team tested this version with two 9-year-old children, finding that the interface was considered intuitive and the game was well received by the children.

The beta version was released on March 2, showing significant progress in terms of quality and completeness of the educational content. Feedback is currently being processed for this version. At present, the LTE team has identified some issues that need to be fixed before the final release. These include objects that the character can pass through and some spatial orientation problems. Minor issues were also noted, such as characters stuck in a T-pose in certain scenes and objectives remaining active even after completion. Another point of discussion concerns accessibility for children with reading difficulties.

Over the next two months, work will focus on the polishing phase, during which aesthetic and functional improvements will be implemented, reported bugs will be fixed, and the gaming experience will be optimized. The final release at the end of April should ensure a solid and usable product, ready for use in the educational experimentation phase.

5.2. Research Design for the Quasi-Experimental Study

The evaluation of the project presented in this deliverable will be conducted through a study aimed at answering the following research question: Can a laboratory based on the use of a video game improve the knowledge and skills of future teachers regarding hydrological risk management and their attitudes toward risk perception? This is a quasi-experimental study with a control group, pre-test, and post-test (Cook et al., 1990). The research design is not fully experimental because participants will not be randomly assigned to the two groups; rather, they will choose based on their scheduling needs whether to attend the weekday edition of the laboratory (control group) or the Saturday edition (experimental group).

In this research design, the independent variable is participation in the game-based laboratory, as defined in the previous paragraph. The dependent variables include knowledge related to hydrological risk and its management, measured through a custom-developed test, as well as risk perception, measured using tests from Miceli et al. (2008) and Miceli et al. (2010) and its main related factors (Theodorou et al., submitted):

- **Pro-environmental orientation**, measured using a test by Dunlap et al. (2000), as adapted by Prati et al. (2011);
- **Biospheric and altruistic values**, measured using a test by De Groot & Steg (2007), as adapted by Bonaiuto et al. (2024);
- **Climate change awareness**, measured using a test by Lawson et al. (2019) and specifically adapted for this project to the Italian context through back-translation;
- **Perceived response efficacy**, measured using a test by D'Amico et al. (2023);
- **Negative emotions**, measured using a test by Watson et al. (1988), as adapted by Terraciano et al. (2003).

The dependent variables will be measured before and after the laboratory in both groups, allowing any observed changes to be attributed, with a good degree of internal validity, to the laboratory itself.

This research design will provide data to evaluate the effectiveness of a game-based approach for teaching future teachers about hydrological risk management and fostering a functional risk perception that supports the adoption of appropriate coping strategies.

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