Special Issue for GALA 2024 Games Competition & Exhibition Book of Abstracts

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In cooperation with

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Serious Games Society

Editors: René Röpke | Kristina Risley | Mariana Rocha | Jonny-Bix Bongers

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Preface

Welcome to the inaugural collection of abstracts for the Games and Learning Alliance (GALA) Conference's annual serious games competition and exhibition. These proceedings represent a significant milestone as they provide, for the first time, a publication space dedicated solely to capturing the innovative work showcased in our annual competition and exhibition.

We proudly present the creative and research-driven contributions, with abstracts spanning a range of domains from healthcare and education to virtual simulations and collaborative learning. In line with this year's theme of "Games for Better Futures," we received submissions across three categories: Student, Academic and Business. Each submission reflects a unique approach to advancing serious games as tools for education, professional development and wider social impact.

The importance of serious games has never been more pronounced, with the ability to educate, inspire and empower players across many fields and disciplines. This collection not only celebrates the diversity and ingenuity present within the GALA community but also highlights our ongoing commitment to innovation in serious game development. To this end, each submission highlights the game's purpose, objectives, target audience and unique features.

We extend our heartfelt thanks to the authors, whose dedication and creativity bring this collection to life. We are immensely grateful to our expert jury of games researchers and designers, who generously volunteer their time each year to review submissions and play each game in order to determine the shortlist of our competition. Their dedication and expertise are invaluable in ensuring the high standards and rigorous evaluation that define the GALA conference. We are also deeply grateful to the organising committee, whose commitment and vision make this knowledge exchange and shared innovation possible.

As editors, we hope that this compilation not only highlights the current landscape of serious games research and development but also serves as an inspiration and reference point for future work.

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A Journey of Knowledge: A Serious Game Proposal for Learning about Brazilian Fauna

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Abstract. Since teaching about the characteristics of animals is a target of Brazil's National Common Curricular Base (BNCC) for Elementary Education and serious games can be used as tools during learning processes, the game "Save the Animals" aims to contribute to children's learning about Brazilian fauna. The main objective of the game is to contribute to children's learning, aged seven to ten years, through an exploration game, about the characteristics of three animals present in the Brazilian fauna: the Toco Toucan, the Jaguar and the Green Anaconda. The player's main objective is to save the three animals (Toco Toucan, Jaguar and Green Anaconda) from hunters who have imprisoned them in cages. When saving the animals, the player will be able to talk to them and learn some of their characteristics and habits. The game can be played in school laboratories (under the supervision of teachers) or at home.

Keywords: Serious Games, Environment, Endangered Animals, 3D, Education.

1 Introduction

The use of technologies in the school environment can contribute to learning and help students engage during the teaching-learning processes. Digital games can be used as tools to provide students with fun and different ways of learning [1][2].

Furthermore, digital games can be directly related to the objects of study related to Brazil's National Common Curricular Base (NCCB), a document that lists fundamental and important knowledge and skills that students in Brazilian schools must present throughout the Basic Education modality [3]. Teaching about Science, more specifically teaching about animals and their characteristics, is the object of knowledge in the second, third and fourth year of Elementary Science in Brazil [3].

Therefore, the game "Save the Animals" seeks not only to contribute to children's learning about Brazilian fauna, but also to provide education professionals with a strategy to reinforce learning inside and outside schools.

2   Game overview

The game is aimed at students aged 7 to 10 years. Children in this age group are in Elementary School and, according to the Brazil's National Common Curricular Base [3], "Living beings in the environment", "Characteristics and development of animals" and "Simple food chains" are objects of knowledge in the field of Science in the second, third and fourth year of Basic Education, respectively [3].

The game can be used in school contexts and can be played on school laboratory machines, under teacher's supervision. Furthermore, the child can extend the learning and play the game at home.

The characterizing goal of the game [4] is to contribute to students' learning about animals present in the Brazilian fauna through an exploration game.

The game is a 3D adventure in which the player, an adventurer, is exploring the Amazon rainforest and, suddenly, a Blue Macaw flies and appears in front of the player. The animal explains to the player that some of his friends, the Toco Toucan, the Jaguar and the Green Anaconda, were captured by hunters and are imprisoned in cages, inside the forest. The objective of the game is to free the animals in the cages; Interact with them and be careful not to be seen by hunters. After saving all the animals, the player must go to the largest tree in the forest, in the center of it, to end the adventure. Each released animal informs the player about some of its characteristics, so the player learns a little about each of them. Figs. 1 and 2 presents two of the application screens: the initial screen (Fig. 1) and the challenge screen (Fig. 2).

Fig. 1. Initial screen of the game (main menu).

Fig. 2. Challenge screen.

Related to the gameplay, the player can move around using the mouse (camera control) and keyboard. For the player to move forward; to the left; back and right, the player can use the directional arrows or the "W" (forward), "A" (left), "S" (back) and "D" (right) keys. To open the game pause menu, the player can click the "Esc" key (from the challenge screen). To interact with the cages and animals and to present the next sentence in the dialogue, the player can use the "F" or "Right Ctrl" keys.

The player's challenge is to free the animals and not be seen by the hunters, who surround the cage. If the player is seen by any of these hunters, the player is expelled from the place and is taken to the nearest tree with a different shape from the others.

Upon reaching the cages and escaping from the hunters, the player can interact with the cages to free the animals, interact with the animals and learn about them. This is a very important moment in the game, as it is at this point that the player learns the characteristics of the animals he has saved. Upon reaching the center of the forest, after having released all the animals in the cages, the challenge ends and, after being congratulated by the Blue Macaw, the player can play the game again or exit the application.

The game achieves its characterizing goal [4] through the player's interaction with the animals and game elements, which provide an environment that can engage the player during learning. With its use as a complement to learning, the game may have potential for application in schools and may be recommended by teachers as an extra-school activity.

Disclosure of Interests. The authors have no competing interests.

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A Sign to Remember

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Abstract. *A Sign to Remember* is a serious game that runs in virtual reality and uses hand tracking as input. In the game, the player must utilize American Sign Language (ASL) to interact with the world around them. Various clues can be found that teach the ASL signs necessary for completing any puzzles barring further progress. ASL is currently the most common form of sign language in the United States but can be difficult to learn through online resources such as mobile apps that are unable to track the user's hands. The aim of *A Sign to Remember* is to provide players with not only an enjoyable experience, but also an effective and engaging way to learn ASL. The repetition of these signs throughout the game will hopefully allow players to recall and replicate them in the real world.

Keywords: Virtual Reality, Hand Tracking, Puzzle, Educational, American Sign Language

1   Background

Technology has become an essential part of learning languages today, both for casual and more dedicated learners. However, not all languages have yet to follow this path, as there are many that are not spoken or written and thus hard to teach through commonly accessible technologies. Sign language relies on visuals that are three-dimensional, constantly moving, and very complex overall. Though one might be able to download a language learning app for Spanish or Japanese to become proficient, the same cannot be done quite as effectively for sign language, particularly when it comes to practicing what has been taught. This is where hand tracking technology shines, capturing the user's hands as 3D models that can be interpreted by programs. With this, users can receive real-time feedback on whether or not they have properly performed signs.

American Sign Language (ASL) was the best fit for attempting to implement these ideas in an application due to its prominence in the United States. ASL is used by approximately half a million people in the United States [1], many of whom rely on it as a means of communication. Making the application in virtual reality (VR) was also essential due to how synonymous hand tracking has become with VR as of late.

2   Gameplay

The player is placed into the world knowing little to nothing about the world or controls. All interactions are done with various ASL signs that have their meaning reflected in the nearby world. Only two signs are given at the start, those being the signs for "go" and "hello," allowing the player to move and talk to non-playable characters (NPCs). By talking to and observing NPCs, more signs are demonstrated that the player can replicate in certain areas to progress. Upon completing the first puzzle, the player will have opened a door to a much larger open world that can be explored at their own pace.

Currently, there are nine detectable ASL signs in the game and eighteen different objects to interact with, ten of which count towards completion. Those ten consist of watering four flower pots, shaking three trees, and feeding two horses and one sheep. A journal remains fixed at the player's side which, when grabbed, contains diagrams explaining how to do the "go" and "hello" signs. It also contains the percentage of the game that has been completed by the player thus far. Upon fully completing the game, a celebratory sound effect is played, and the journal's percentage becomes green.
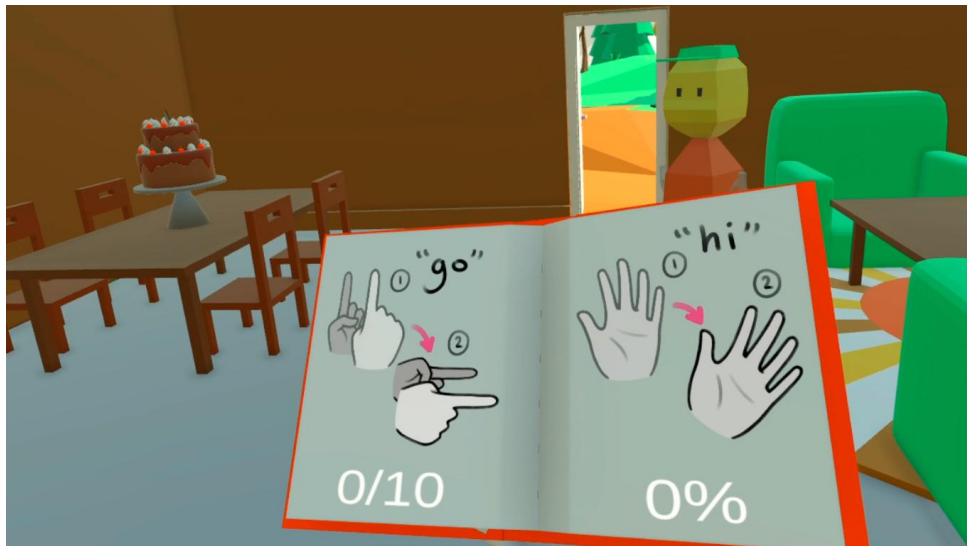

Fig. 1. In-game image of the journal's signing instructions and progress tracker. The NPC and doorway for exiting the tutorial room can be seen just behind the journal.

3   Mechanics

The OpenXR plugin is utilized for detecting hand poses, but full hand signs are often much more complex. Hand signs consist of one or more hand poses done in rapid succession, sometimes with both hands. Each hand pose, or pair of hand poses for two-handed signs, constitutes a stage, and performing all stages without allowing too much time to elapse in between completes a sign. Other details such as static hands and how long a stage must be held can be easily configured to closely replicate ASL signs.

There are a number of "holster" objects, which detect when a grabbable object has been released inside of them. One is placed on the player's hip and acts like an actual holster, carrying one grabbable object at a time while the player does the "go" sign to move around. Others verify if the deposited object is the one necessary to complete the puzzle and then perform some interaction accordingly. This is how the animals' mouths work, waiting for an apple to be released in their "holster" so that the consumption animation can play and progress can be made.

4   Goals

Though *A Sign to Remember* is more gamified than is typical for language learning applications, it is important that more players are enticed to try the game. Its primary audience is both dedicated ASL learners and casual VR players looking for a unique experience. It is not expected they will become fluent in ASL after only playing this game, but if even a single sign as simple as "help" or "water" is recognized in the real world, someone may no longer need to struggle in asking for assistance. Ideally, *A Sign to Remember* can act as a makeshift bridge between the world of the hearing and the world of the deaf.

Disclosure of **Interests.** The authors have no competing interests to declare that are relevant to the content of this article.

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Blockchain Teaching with Bloxxgame

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Abstract. Bloxxgame is a web-based blockchain simulation game with an intuitive graphical user interface. The game is designed as a teaching tool for classroom or online teaching. Bloxxgame enables step-by-step discovery and a basic understanding of the fundamental principles of a blockchain. Once players understand the key principles of a blockchain, the game becomes more playful. You can play it alone against the bots or with any number of players, with or without bots.

Key concepts like hashing, digital signatures, digital identity, tokens, wallets, transaction fees, Proof of Work, and mining are presented in an interactive format. A special and unique feature is the experience of the consensus algorithm with Proof of Work.

Bloxxgame has a sophisticated teacher cockpit with which all players can be easily managed. With seven game levels and mining and transaction robots, the teacher can set up a wide variety of dynamic learning scenarios.

Keywords: Blockchain simulation, Educational tool, Interactive learning, Cryptographic elements, Web 3

1 Blockchain Teaching

1.1 Why Blockchain Teaching is Important

Fifteen years after the launch of Bitcoin and several so-called hypes about cryptocurrencies, the topic of blockchain is no longer at the center of public interest. Nevertheless, development continues and with the steady spread of blockchain in the financial industry, supply chain, healthcare, etc., blockchain-based solutions are becoming increasingly important. Blockchain is also the foundation of Web 3, which will fundamentally change the way the internet is used in the future, regardless of industry. These developments stand in stark contrast to the general knowledge about the basic characteristics and functioning of blockchain technology.

Blockchain teaching is important because it provides students and professionals with the knowledge to understand and use decentralised technologies. Understanding blockchain principles, such as cryptographic security and consensus mechanisms, are fundamental to making decisions about the use of blockchain-based technologies.

However, blockchain teaching is challenging because it requires an understanding of various abstract concepts and how they interact.

1.2   The Objectives of Bloxxgame

Bloxxgame is the result of eight years of research and practice in blockchain teaching at university level [1], [2]. Initially based on a whiteboard model, Bloxxgame has evolved into a web-based simulation tool that mimics a public layer 1 blockchain that has some basic features like Bitcoin, Ethereum and Cardano.

The key ideas behind the development of Bloxxgame were:

— The complex mechanism of a public blockchain should be understandable for students without programming knowledge.
— The core idea of a public blockchain, the concept of a decentralised consensus mechanism, should become tangible.
— Teachers without a background in computer science should be able to teach the principles of blockchain before covering its application in industries such as supply chain, finance, healthcare, etc.
— The material should not only be taught theoretically and abstractly; students should have the opportunity to explore and test the principles.

This is the third edition of Bloxxgame which offers a versatile toolbox for teachers to develop customized lesson plans.

1.3   How Bloxxgame can be played

Bloxxgame does not have a pre-defined course of play. Teachers can use Bloxxgame as a demonstration tool before allowing students to explore it independently. In class, students can work in groups or individually, each student managing their own node. Once students have grasped the basic principles of a blockchain, the teacher can set individual practical tasks or let the students compete against each other.

You can also play Bloxxgame alone against the bots or with any number of players, with or without bots. Experience shows that it's great fun even with just a few players.

A key feature of Bloxxgame is that the playground remains accessible for as long as the teacher permits, allowing students to practice and reinforce concepts through self-study between lessons.

Each player functions as a node in the blockchain, creating transactions, building blocks, and mining coins, learning blockchain concepts—especially the consensus algorithm—through hands-on experience. Bloxxgame improves the understanding of abstract blockchain mechanisms through a didactic breakdown of basic operations such as hashing, signing, transactions and block formation.

Bloxxgame also provides user-friendly administration tools, enabling guided classroom lessons, online instruction, and independent learning.

With seven levels of increasing complexity, the teacher can tailor the lessons to students with varying levels of prior knowledge and covers both basic blockchain principles and in-depth cryptographic theory. Basic topics include creating a blockchain transaction, creating and adding blocks, and the process of transaction and block confirmation. More examples of teaching scenarios can be found in [2] and on the resource page of Bloxxgame [3].

1.4   User Interface

The graphical representation of the blockchain and the didactically designed user interface illustrate the individual cryptographic elements of a blockchain in a practical way. The playground has a graphical interface that evolves as the player progresses through the different levels, offering an increasing number of menus and features. Users can easily interact with blocks and transactions by dragging and dropping them with the mouse or using the keyboard controls. In many places, further information on transactions or blocks is displayed with a mouse over or a click.

Each box of the user interface contains a contextual help function (indicated by a '?') that provides detailed explanations of the respective elements (see Fig. 1).
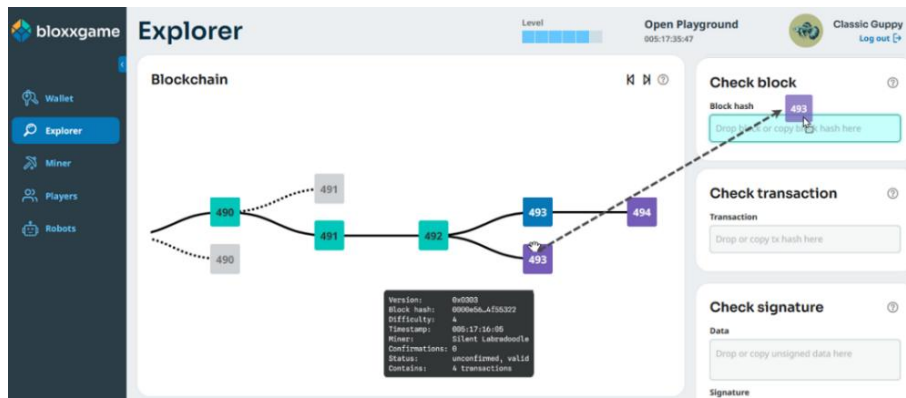

Fig. 1. The blockchain explorer is one of three user views (wallet, explorer, miner) and shows the diagram of the blockchain with information to better understand the underlying mechanism.

Disclosure of Interests. The author has developed Bloxxgame on his own responsibility and has no competing interests to declare that are relevant to this summary.

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Escape Together: A Game to Practice Collaboration

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Abstract. "Escape together" is a cooperative puzzle game, designed and developed to teach and practice collaboration skills in a safe environment. The game predefines two distinct roles: the "player" and the "instructor", and takes place in an escape room setting. The two players must work together to solve three puzzles. "The instructor" is provided with instructions on each puzzle, while the player directly interacts with the puzzles. There should be two playthroughs, with a switch of roles. A first version of the game was tested among 10 pairs, which compared the collaboration between playthroughs. The results indicated great communication, with increased effectiveness during the second playthrough. The PXI showed a great player experience compared to established games of this type.

Keywords: Collaborative learning · Collaboration · Puzzle game · Trust.

1 Introduction

Collaboration is a fundamental aspect of modern living. Despite that, most people have an ambivalent relationship to collaborating, as well as a lacking of associated skills. In the particular case of students, despite understanding its importance, they dislike it [2] and show a propensity for working alone [1]. The difficulty in communicating task division, providing healthy feedback, and building trust among team members, as well as the importance of good collaboration in all aspects of life, motivated us to seek a new approach to progress those skills. Our game, "Escape Together", is designed and developed to teach and practice collaboration skills in a safe environment.

1.1 Target Audience and Context

Our initial target audience focused on university students. Nevertheless, the target audience can be extended, given that no aspect of the game's design confines it to adult students. Given the game's cooperative nature, a playthrough by a pair is designed to take place in an isolated environment. Ideally, the pairs should not know each other well (or at all) to maximize outcomes. It can be played anywhere, depending on the context of the goal.

1.2   Game Objectives

Two players communicate to solve three puzzles. The *Instructor* is handed a manual containing instructions for each puzzle. The *Player* interacts with the software part of the game. Each puzzle is unique with a distinct theme, like detailed symbols, various decorations with intricate details, and a music puzzle. The first two are designed to enhance attention to detail by incorporating small nuances in the symbols and decorations, while the last focuses on music, and its goal is to teach sheet music reading.

Overall, the game's objectives are to strengthen communication between the players, enhance their observation of surrounding details, and teach the fundamentals of music reading.

2   Gameplay Overview

The game[1] comprises three puzzles, with two playthroughs, containing the same puzzles but with different solutions.

In the first puzzle, the *Player* is presented with a bookcase that is divided in two parts. They must place the correct books from the left side to the correct positions on the right, which form a 3x3 grid. Three books are already placed on the right and are static, leaving six slots that need filling. All books have a symbol on their spine, which differ in small details. The *Player* has to communicate to the *Instructor* which books/symbols are on the right-hand side of the bookcase, and their position. The *Instructor* is presented with a 6x6 grid of symbols. They must use the three symbols that the *Player* mentioned to find the correct 3x3 sub-grid. Once the *Instructor* has figured out the correct grid, they have to communicate the six missing symbols to the *Player* to solve the puzzle.

The second puzzle, finds the *Player* in a maze formed by four rooms, with many doors each. Rooms have distinguishing decoration, such as statues, paintings and plants, and the doors have symbols similar to each other. Based on the decoration and the number of doors, the players must find the right symbol and hence the right door leading to the next room, and ultimately out of the maze.

In the final puzzle, the *Player* is in a room with a piano and a radio. They must first tune the radio in the right frequencies to find two numbers that match two music sheets in the *Instructor's* "manual". With the correct guidance, the *Player* must play sixteen notes in the correct order. When a correct note is played, it is written into a music sheet, to indicate the progress to the *Player*.

3   Preliminary User Study

An early version was tested by 10 pairs, switching roles in two playthroughs, to assess collaboration between them. Game metrics were collected and the players' voices were recorded (with permission) to evaluate their communication. Participants could request assistance if they got stuck on a puzzle, since they were not

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[1] https://youtu.be/3UNR-alOHnE

Fig. 1. The top left image represents the first puzzle, the top right features a room in the second puzzle, and the two bottom images are from the third puzzle.

required to solve them independently. After each playthrough, they completed a survey to assess the learning goal, divided into their collaboration and trust (modified prisoner's dilemma). At the end, the participants filled out the Player Experience Inventory (PXI)[3].

Our study showed that participants communicated frequently, the PXI revealed high satisfaction scores, and the learning goal survey indicated improved collaboration in the second playthrough. The modified prisoner's dilemma corroborates these observations, as trust among participants increased.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

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IncrASTible!
The incredible Monastery of Astino

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Abstract. IncrASTible! is a serious game mobile app, which leverages Augmented Reality (AR) to offer an immersive cultural experience. Utilizing a markerless tracking mechanism, it encourages players to physically explore an ancient Italian monastery, while learning about its history across centuries. The app features five mini-games, set in a different area of the monastery and highlighted on a geolocalised map. Each mini-game has specific learning objectives and employs diverse game mechanisms. Players interact with 3D assets and the physical environment in multiple ways, either for engagement or as tools to win challenges. Non-playable characters representing historical figures convey historical information, game instructions, and feedback. Giving complete freedom to players, the technical challenges of AR tracking and registration were addressed using advanced technologies like LIDAR scanning, and the Unity and Vuforia software. Targetting primarily teenage students, incrASTible! complements informal learning with educational content which could support teachers in class.

Keywords: Serious Games · Augmented Reality · Cultural Heritage · Exploration game

1 IncrASTible! game experience

The IncrASTible! serious game was developed within a funded regional project [1], whose main objective was the promotion of the recent conservative history of the Monastery of Astino in Italy in an innovative way: the cultural offer was rethought digitally but meant to be experienced in the physical historical site. In fact, the project aimed to respond to the effects of the lockdown after the coronavirus pandemic on the local community, targetting especially teenagers.

The game is designed as an AR mobile app, which allows players to explore the monastery and learn about its rich history: it changed aspect and function over the centuries, spanning from a medieval monastery to a mental hospital in 1800, and to a farm in 1900. To communicate the evolution of the site, the serious game has been structured in five different mini-games, with different learning objectives (local history, restoration, art, heraldry), to be set in 5 different areas of the monastery (porch, bath tubs, fresco, well, and orchard), indicated on a

geolocalised map which guides the exploration (Fig. 1). Each mini-game adopts diverse game mechanisms (quiz, quest, action, puzzle), and multiple ways of interacting with 3D assets and the physical environment: both to provide engagement and immersion to players and as tools to play with and win the various game challenges. Storytelling has been based on real facts and characters, who actually lived and were connected with the monastery. Non-playable characters (NPCs) have been designed as 3D ghosts, who appear on the screen in a specific location, introduce a historical period, and give instructions and feedback to players during the gameplay (Fig. 1).

The Porch Game (1832) features architect Bianconi, who designed the transformation of the monastery into a mental hospital. Players learn about restoration and architecture vocabulary, and complete a quiz to assess their knowledge. The Bath Tubs Game (19th century) introduces Ada, a fictional character who helps players solve physics and riddle-based puzzles while telling the stories of the female patients in the Astino asylum. The Fresco Game (1239) allows players to experience the fresco technique through an action/simulation challenge, guided by Bishop Guala. The Well Game (1629) follows the tale of Monk Aurelio, who escaped temporarily the monastery and brought back the plague who devastated the area in those years. Players must reassembly 3D objects broken by the monk during his frantic escape moving in the physical space. The Orchard Game (1146) challenges players with the investigation of the mysterious murder of Bishop Gregorio, while learning about Vallombrosian symbols and heraldry.

Achievements tied to individual games and global milestones encourage players to complete the mini-games. Finally, supplementary learning content is accessible through a dedicated menu (*Professor's lessons*) and available also online [1], providing art-historical material to enhance the learning experience either individually or with the teacher in class. Although incrASTible! targets primarily teenage students, it also serves as an engaging tool for casual visitors to the monastery, offering an interactive cultural experience.
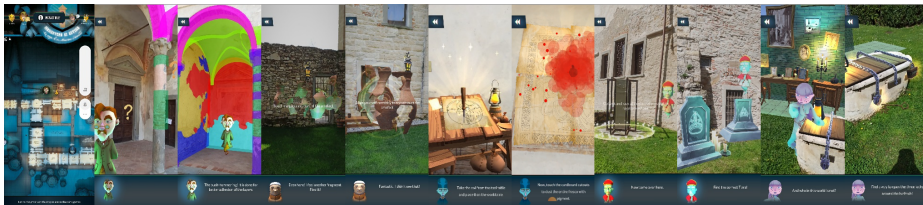

Fig. 1. Overview of the gameplay

2 Technological AR challenges

In the incrASTible! game, AR is used not only as a passive overlay of information or decoration, but as a playable and intuitive mechanism, which reacts with a

physical behaviour. The challenges to design a robust AR mobile app with such level of interactivity, while using available software libraries have been numerous. The goal was to allow the player to move freely in the physical environment, while guaranteeing realistic interaction with the virtual world.

To reach such objective, various AR approaches have been investigated. Indeed, tracking and registration are key functionalities in order to reference correctly all the virtual elements in the physical world, and make them usable. Real-time response is crucial and even more in the proposed game, where virtual elements are game elements reacting to the player's actions.

From the performed tests, beacons and QR codes resulted too intrusive, while typical AR image and model tracking technologies would have restricted player's movements to specific angles and positions. Using GPS only as in location-based games was not an alternative either for the limits in precision. Ultimately, we opted for a non-invasive, markerless AR solution using the whole area tracking. We benefited of the Vuforia *multiple area target* feature, which guarantees a much stabler tracking performance in this dynamic scenario. In fact, with its own dedicated app, the engine allows to scan an area with LIDAR sensors and then track and register assets on these reference models (see Fig. 2). This option works efficiently on areas including building walls on which anchoring AR assets; oppositely, in open featureless areas (e.g., bath tubs) tracking can be lost easily. We solved the issue by using Unity's capabilities along with ARKit and ARCore's native features: we anchored and seamlessly overlaid 3D objects onto the real environment to create the actual game mechanics.

Fig. 2. The 3D areas of the porch, the fresco, and the bath tubs games

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Inside the Router: A VR Serious Game for Teaching Network Address Translation and IP Routing

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Abstract. Inside the Router is an immersive virtual reality (VR) learning game designed to teach abstract concepts such as IP routing and Network Address Translation (NAT). Set in the familiar context of a home network, players assume the role of a home router, handling data packets and applying networking principles. Several studies have been conducted using the application to gain insights into effective design principles for learning applications in computer science education. Inside the Router leverages VR to bridge the gap between abstract computer science concepts and hands-on learning, providing an engaging, interactive environment for students aged 13 and up.

Keywords: Virtual Reality · Computer Science Education · Serious Games

1 Game Content and Objectives

The primary objective of Inside the Router is to provide learners with a hands-on, immersive experience of routing IP packets and applying Network Address Translation (NAT) within the context of a home network. Students assume the role of a home router, responsible for managing data flow through the network by identifying the source and destination IP addresses of data packets and performing necessary routing tasks [1]. This experiential learning approach enables students to deepen their understanding of network communication processes. The game supplements existing computer science curricula [4,6], building on students' prior knowledge of network components such as IP addresses, ports, and data transmission methods. By simulating the operational processes of a home router, Inside the Router allows students to apply this theoretical knowledge in a practical, engaging way. The game's core learning objectives include:

- Understanding the structure of IP addresses and ports.
- Applying Network Address Translation (NAT) to route packets correctly.
- Differentiating between internal, outgoing, and incoming network traffic.

2   Game Design

The design of Inside the Router is grounded in educational principles that align with Mayer's multimedia learning theory, in particular, the immersion and generative activity principles [8,5]. The game uses the metaphor of a pipe system to represent network pathways, making abstract networking tasks tangible and visually intuitive [2]. Players interact with data packets, represented by capsules, which they must assign correctly to their destination based on IP address information. The application employs continuous visual and audio cues to guide the player. Correct actions are reinforced with positive feedback (e.g., green flashes and sounds), while incorrect actions prompt the packet to bounce back for rerouting, maintaining the learning loop.

Fig. 1. Screenshot of the serious game Inside the Router, showing a packet, labeled with IP addresses and the tubes into which it must be sorted.

During the game the player has to follow a three-step cycle:

– Catch: Players must catch or collect the packet from the source.
– Decide: Players analyze the packet's IP address and decide on the correct routing action.
– Throw/Place: Players throw or place the packet into the appropriate tube for delivery.

At the end of each session, players receive a score based on their speed and accuracy, displayed as their simulated "internet speed" in megabits per second (Mbps). This score encourages competitiveness and motivation.

3   Application in Research

Inside the Router has been employed in several research settings to evaluate its effectiveness as well as design principles for VR serious games. An evaluation using a pre-post design was able to measure significant learning effects

through the use of the application [7]. Another study identified issues with established scales for measuring presence in fictional settings lacking reference to reality. This was done by specifically comparing the realism of the VR application to a physical replica. The learning content and tasks of the two versions were identical in this study as well. Despite the unmediated experience in the physical environment, the VR application gave participants a greater sense of presence. At the same time, it was found that the presence items about the perception of reality were ambiguous and problematic, for the fictional context of travelling into a router [3]. Inside the Router is not only an effective learning application, but also a valuable research tool from which future serious games for computer science education can benefit. The game is freely available under `https://vr.ddi.education/itr/`.

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Nutri-islands: A nutrition education game for children

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Abstract. Follow Ote's journey to improve their families' health and learn about food and nutrition along the way. Nutri-islands is a New Zealand developed nutrition education video game designed as a 2D top-down RPG for children ages 7 to 11 years old. Explore the islands and discover food items; play mini games; and bring about a healthier future. Evidence-based nutrition information is incorporated in the game through mini-games, mini-videos, mini-quizzes, and an interactive encyclopedia. Nutri-islands is developed by academics in the field of nutrition and computer science. A participatory approach with children and teachers, is used in the game design. The characters of the game are fictional, "Otepians", kiwi (bird)-like human characters. There are 6 levels of the game, with each level being a different island and theme, where players learn about different nutrients. Nutri-islands is web-based game and can be played on any computer with the mouse/mousepad as controls.

Keywords: Serious Games, Nutrition Education, Games for Health, Child Nutrition, Participatory approach.

Background. One-third of New Zealand children are overweight or obese, with higher rates among Māori and Pacific children [1][2]. Establishing food literacy and healthy habits early can reduce chronic disease and support healthy behaviors [3]. However, nutrition education in New Zealand schools is limited, with teachers lacking the necessary professional development and resources to effectively promote healthy eating [4].

Game Objective, Target Audience and Possible Context. Nutri-islands aims to create a tool that teachers and parents can use to teach children about nutrition and health in a fun, engaging and enjoyable way. Being used in the classrooms, the game aims to improve the food and nutrition literacy of children aged 7-11. Through focus groups, we found that the children at that age have an interest in games like Roblox, Minecraft and Prodigy, as well as a range of interest in food and nutrition [5]. Each level of the game consists of 4 lesson plans, with each lesson involving 20 minutes of gameplay and 20 minutes of in-class activity. However, considering the flexibility of the game scenario, the game can also be played without the need of in-class activity.

Gameplay and Mechanics. In Nutri-islands, the player plays the role of an Ōtepian child (called Ōte), a fictional character in the game. The game starts off in a distant future in a place called the Future Hub, which is the laboratory of an Ōtepian professor (called Prof. Bark). At that time, as shown in Figure 1, the Ōtepians are living in a world that is void of plant life, and the Ōtepians are troubled with chronic diseases such as hypertension, cancer, diabetes, obesity etc. Prof. Bark would like to rectify this so he created a time-machine that would allow Ōtepians to travel back to the past and change the future. Eager to improve the health condition of their families, Ōte went back to the past with Prof. Bark and they arrived at the Past Overworld, where the main game play will take place.

Fig. 1. How the Ōtepian city and people looks like in a distant future.

After traveling through the time-machine, Prof. Bark changes into a pet dog and follows Ōte around the Past Overworld providing the knowledge and direction to guide Ōte's journey in Nutri-islands. Prof. Bark would remind Ōte that choices that they make in the Past Overworld will have an impact on their families' health in the future, and thus they must be conscientious. With the guidance from Prof. Bark, the mini games and mini educational videos in Nutri-slands, Ōte learns about making better health and nutrition choices in the Past Overworld and bring about a healthier and happier future for Ōtepians. Ōte can view these changes when they go back to the Future Hub (through changes seen in the photo frames.

The nutrition topics through the different islands Ōte learns about are as following:
● Island 1 - Vitamins and minerals and their functions and deficiencies (Vitamin A)
● Island 2 - Vitamins and minerals and their functions and deficiencies (Vitamin C)
● Island 3 - Vitamins and minerals and their functions and deficiencies (Iron)
● Island 4 - Sports nutrition fuel and recovery (Protein)
● Island 5 - Sports nutrition fuel and recovery (Carbohydrates)
● Island 6 - Sports nutrition fuel and recovery (Fats)

The main gameplay takes place in the Past Overworld. Through the interactive storyline, Ōte encounters a family member from the past who is suffering from a health problem due to a vitamin or mineral deficiency. Ōte learns about the nutrition information through mini educational videos. This learning is then reinforced through mini

games that are directly linked to the nutrition information. To check the learning of the player, through the storyline of the game, Ōte is asked a question after the mini game. Ōte then gets rewarded with coins which they will be able to change for new skins for the characters or other items in the marketplace in the future hub. A new island is unlocked after the first mini game is completed, and all the 12 food items for the encyclopedia in that level have been found and collected, and thus the core gameplay loop (Figure 2) is repeated.
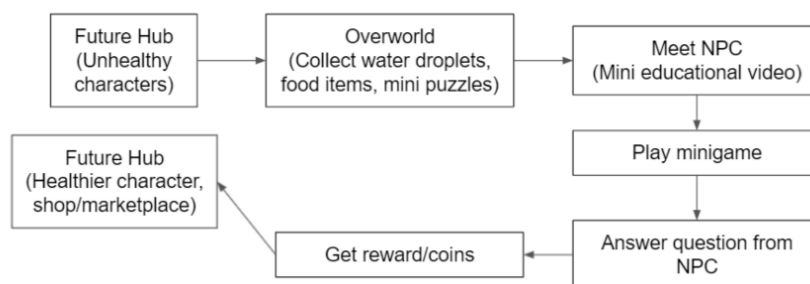
Core Loop

Fig. 2. Core gameplay loop of Nutri-islands.

Technology. We have developed Nutri-islands using Unity. We have also utilized Yarnspinner to help us craft our in-game dialogue. Our database is currently stored in the Amazon Web Services systems to enable us to easily scale, maintain and load balance our game's infrastructure.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

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PIZZICATO

A sonification game for motor behavior research

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Abstract. Learning motor skills is essential to many different aspects of life, from big movements needed for sports to small and simple movements used in the rehabilitation of stroke patients. Sonification, i.e. using sounds as feedback for actions, has been researched as a promising technique for studying motor behavior. We explore how the use of sonification can make the process of learning motor skills accessible and engaging. We posit that an interactive and gamified environment can increase the engagement in that process. Moreover, an enjoyable setting is more likely to stimulate repetition, an indispensable feature of any learning endeavor. We present PIZZICATO, a novel rhythm-based serious game that leads players to move their arms and hands to actively play music. PIZZICATO was developed in collaboration with neuropsychology colleagues, who are now starting to use it as a flexible tool for motor behavior research, both for diagnostic and rehabilitation purposes.

Keywords: serious game · sonification · motor skills · rehabilitation

Game Design

PIZZICATO was designed with four core principles in mind: (i) **player agency** – sound should be deployed as feedback to player's actions; (ii) **accessibility** – the game should be playable by anyone at home, without any custom hardware; (iii) **engagement** – players should stay engaged even after performing the same movement multiple times; and (iv) **measurability** – the game should collect meaningful data to investigate how sonification affects the learning process.

Game synopsis PIZZICATO is a rhythm game in which a level consists of music, visually accompanied by a sequence of nodes on the screen. The player's input is captured by tracking their hand and arm movements. They can pop nodes by hovering their hand over the node and pinching individual fingers together with their thumb. When a node is pinched, a corresponding sound is played. Each finger has an associated color: the color of a node indicates which finger pinch should be used to pop it; see Figure 1. At the start of a level, players get only a simple rhythm as a background track but, as they progress, this slowly builds up to a complete song. The result is a gameplay loop in which the player 'creates' music by pinching emerging nodes at the correct time and in the correct order.
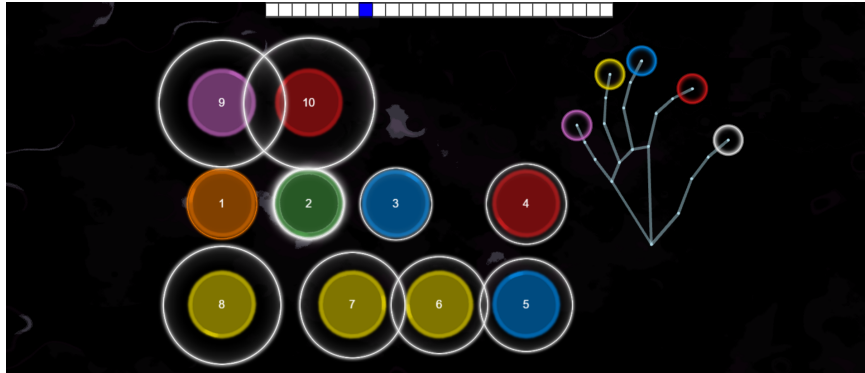
Fig. 1. A PIZZICATO level, showing various nodes to be pinched by different fingers, in a timed sequence

Core mechanics The three main game mechanics of PIZZICATO are *gesture input*, the consequent *sonification*, and other types of *feedback*.

Gesture input PIZZICATO uses a common webcam to track the player's hand, which makes it a very accessible game. This input device can recognize arm and fine finger movements, giving the game-level designer large freedom to choose what type of motor skills to require from the player.

Sonification Sonification in PIZZICATO comes from the sounds that are played whenever the player pops a node. Importantly, the sound is played regardless of whether the player does that at the correct moment or not: the dissonance between a poorly-timed sound played and the background track is in itself a form of negative feedback. Since the player should be encouraged to make specific movements in a timely manner, nodes sequentially appear on the screen in a specific location. This adds a gentle constraint on when and where the player can create sounds. Moreover, each node has a time window for which pinching is considered to be early, on time, or late. This is visualized by a slowly shrinking outer ring around the node: the ideal time to pinch the node is when the ring touches it, which is further indicated by the node changing its color to green; see Figure 1. If the player slightly delays pinching a green node, it changes to orange; and if they wait even longer, the node turns into grey and fades off.

Feedback Three types of feedback are meant to gently guide players into making the desired movements for each level, as well as to increase their engagement:

– **visual feedback**: this is given by the nodes, which sequentially appear on the screen at specified moments and locations, 'announcing' which upcoming movements the player is expected to perform. In addition, the shrinking outer ring and node color indicate when and how to interact with a node. Finally, the player's hand being tracked is also permanently visualized to let them see where it stands in the game space, as shown in Figure 1.

- **auditory feedback**: beyond the sonification discussed above, this consists of the song being played as a background track, which 'induces' the correct timing to pop the nodes, helping the player time their pinching and perceive their performance. Naturally, the song itself also helps players stay engaged, as music often contributes to alleviating boredom during repetitive tasks.
- **scoring system**: this includes a bar at the top of the screen, displaying the player's progress, which aims at increasing the sense of engagement. It indicates the amount of nodes they have already pinched on time, and the threshold to pass the level. Finally, there is a streak system that keeps track of the longest uninterrupted streak of timely popped nodes.

Level design The game mechanics described above are flexible and therefore convenient to build up the level progression of Pizzicato, by incrementally superimposing several tracks that together build up a song. Each level has a corresponding song, which consists of several layers. Each layer associates one track (e.g. beat, chord, lead, bass) to a node layout (i.e. the corresponding timed sequence of node positions), so that each node, when pinched by the player, will produce a pre-defined note of the track.

At each layer, the player is asked to play alongside a background track by pinching the nodes of that track on time. If the player performs well enough to reach the layer's progress threshold, they move on to the next layer. In that case, the track just concluded gets merged with the background track, which is then played in the new layer, where the player is challenged with a new node layout.

Levels can be designed such that the nodes follow specific patterns, for example, to assist with specific movement rehabilitation. But a level can also help investigate sonification, e.g. its effect on the rhythmic component. For this, one could concentrate nodes around the same area, or arrange them such that it seems as if they are placed at random. All this flexibility can be used to adjust difficulty, as exemplified in the Pizzicato level of Figure 1.

For each node processed during a play session, data is recorded, allowing for an accurate timeline of the player's performance to be stored. This data, made available in a CSV file, can be subsequently analyzed for research purposes.

Pizzicato can be played online[1] after granting it webcam access (tested on Chromium browsers under Windows 10 and MacOS 14). In addition, the game can also be downloaded[2] for offline deployment (Windows 10 only). A more complete publication on Pizzicato can be found elsewhere [1].

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Playing *Ta!Ti!* after 60's - a fun experience for a serious problem!

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Abstract. The World Health Organization's 'active aging' concept emphasizes maintaining health and social participation in older adults. Serious games, like *Ta!Ti!*, support this goal by improving cognitive function, coordination, and psychological well-being in frail elderly. *Ta!Ti!* is an analogue game designed to enhance coordination, symbol recognition, and attention. Additionally, a digital version of the game has been created. It features various game mechanics, including memory, dice rolling, pattern recognition, and speed matching. The game has shown promise in assessing motor coordination but it has also demonstrated to be effective in improving coordination, executive functions and reducing stress in the elderly with cognitive decline, dementia or depression symptoms. Overall, *Ta!Ti!* is considered a valuable addition to traditional therapies, offering a positive experience for elderly participants.

Keywords: Active aging, Dementia, Healthcare, Coordination.

1 Contextual Background

Over 10 years ago, the World Health Organization (WHO) proposed the concept of 'active aging', which aimed to enable older adults to achieve the goal of extending healthy lives and improving the quality of their later years through health maintenance, social participation, and life safety [1]. Serious games could be, potentially, a relevant contribution to active aging, promoting a social, safe and enriched context to stimulate elderly people. Previous scientific evidence has shown that serious game-based interventions in the health sector have proliferated in recent years because they create an appropriate environment for developing high-stakes tasks [2]. Game-based interventions have the potential to enhance cognitive function and coordination, and to improve both behavioral and psychological symptoms of diseases like dementia [3].

2   Objectives

Ta!Ti! is an analogue serious game (Figure 1), designed for an specific target audience (frail elderly individuals). It was later adapted for digital play: https://bit.ly/3Zf86tX

Learning in frail elderly benefits from strong visual support, which enhances the feedback context. While playing, there are different challenges, such as symbol (selecting corresponding figures) and lateralization recognition; manipulation tasks (grasping the paper cup to interact with the board table), body positioning (wrist/hand), and verbalisation (answering to expressive sounds). These training elements are tailored to help manage and improve cognitive functions and daily living skills in frail old people, including people with dementia. *Ta!Ti*! is focused on promoting different mental (Me) and motor (Mo) skills, such as: sustained attention Me, selective attention Me , dual tasking Mo+Me, coordination Mo, executive functions Me and communication skills Me.

Fig. 1. Analog version of *Ta!Ti!*

3   How to Play

The game *Ta!Ti!* is designed to be played in pairs, though it can also be played individually or in small groups. This serious game uses different components: 1-4 boards (all different, with a random image distribution), 1-2 paper cups, 1 bell, 20 single-sided and 15 double-sided cards, and 5 different position and sound cards.

Among the included mechanics are: (i) memory, as recalling the spatial arrangement of images enhances players' responses; (ii) dice rolling is also featured, with actions determined by the dice results (in this case, linked to the movement of paper cups); (iii) pattern recognition, where players must identify card patterns to react appropriately; (iv) speed matching is notable, as it rewards reaction speed, which increases players' concentration. Each player interacts with the board table using a paper cup. The monitor chooses a challenge card (unilateral/bilateral), and the player performs the challenge of finding the correct figure on the board table, selecting the correct hand to manipulate the paper cup, positioning (up or down) the paper cup on the figure and saying the right sound (as instructed on dice).

There are two modes of play: unilateral and bilateral. Different variables have also been included to increase the game's difficulty, allowing it to be adapted to the players' characteristics and needs. The first level is the unilateral mode without the dice: players only follow the placement information (choosing a hand; positioning the cup; looking

at the figure) shown on the challenge card (Level 1). The second level includes the dice, which, depending on the position and sound of the paper cup, requires the player to verbalize (Level 2). The third level is the simple bilateral mode, where both upper limbs need to be coordinated to move two cups (Level 3). The final level includes both the bilateral mode and the card indicating the position and sound of the paper cups (Level 4).

4   Results

Our findings suggest that *Ta!Ti!* may be effective for assessing and rehabilitating motor coordination and executive functions in frail older adults and individuals with motor and cognitive decline, including people with dementia [4]. Additionally, the game positively impacts cognitive well-being by helping to reduce stress levels in elderly people with risk of depression [5]. The elderly participants emphasized the greater relevance of the game in teamwork, stimulating reasoning, and agility of the upper limbs [6]. *Ta!Ti*! is a potential tool to complement conventional therapy, with the experience being considered very positive by the elderly individuals who participated [6, 7].

Disclosure of Interests. There was no involvement by the company "Agilidades" in the analysis or interpretation of the data collected in related research projects using *Ta!Ti!*

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Silent Trip: A Serious Game to Raise Awareness of Social Anxiety Disorder in Public Transportation

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Abstract. *Silent Trip* is a simulation game designed to raise awareness about Social Anxiety Disorder (SAD), especially in social environments like public transportation. Players navigate the complexities faced by individuals living with social anxiety, providing an immersive experience that highlights the daily challenges associated with SAD. The gameplay emphasizes the importance of mental health and encourages players to develop empathy for those who struggle with social interactions. By simulating realistic scenarios, *Silent Trip* aims to foster understanding and promote discussions surrounding anxiety management techniques. The game is not only a tool for entertainment but also serves an educational purpose, inviting players to explore the various strategies that can be employed to manage social anxiety effectively. Ultimately, *Silent Trip* aspires to contribute positively to the conversation about mental health, encouraging a more supportive and understanding approach to those affected by SAD.

Keywords: Social Anxiety Disorder, Simulation Game, Mental Health, Social Awareness, Public Transportation.

1　Game Summary

1.1　Introduction

Social Anxiety Disorder (SAD) is a mental health condition characterized by an overwhelming fear of being evaluated, embarrassed, or humiliated in social situations. Individuals with SAD often avoid social interactions, resulting in significant disruption to their daily life. According to the *New England Journal of Medicine*, SAD affects around 7-12% of the population in Western countries, and untreated cases can lead to other comorbidities such as depression and substance abuse (Leichsenring and Leweke, 2017). Research has shown that interactive experiences such as video games can enhance awareness and empathy regarding mental health conditions (McGonigal, 2011).

Silent Trip is a 3D serious game that simulates the experiences of individuals with SAD while traveling on public transportation. The game integrates educational elements, drawing inspiration from cognitive-behavioral therapy (CBT) techniques such as exposure and applied relaxation (Clark et al., 2003). By placing the player in various social environments like trains and airplanes, the game recreates the anxiety-inducing

situations that trigger SAD, including interactions with strangers and the challenges of maintaining composure in crowded public spaces. This gives players an immersive understanding of the disorder and helps build empathy for those affected.

1.2   Target Audience

The target audience for *Silent Trip* encompasses teenagers and adults aged 13-30, including those who experience SAD and individuals who wish to understand the condition better, such as friends and family members. The game is also relevant for those interested in psychological or educational gaming experiences.

1.3   Educational Objectives

The primary educational goal of *Silent Trip* is to enhance societal awareness of SAD and teach effective anxiety management techniques. By placing players in realistic scenarios, the game aims to help them comprehend the difficulties faced by individuals with social anxiety and promote supportive behaviors in social settings.

1.4   Sustainable Development Goals (SDGs)

Silent Trip aligns with SDG 3 (Good Health and Well-being), particularly in improving mental health and well-being (target 3.4). The game aspires to educate players about mental conditions like SAD and foster inclusive and supportive social environments. Additionally, by raising awareness and promoting understanding of social anxiety management strategies, the game contributes to reducing suicide rates (target 3.4.2).

2   Features and Innovations

2.1   Avoidance of Eye Contact

Players must navigate social interactions without making eye contact, simulating a common coping mechanism for those with SAD.

2.2   Anxiety Management

Players can use items such as a water bottle or a phone to reduce anxiety during gameplay. These tools are designed to mirror real-life strategies for managing social anxiety.

2.3   Sanity Bar

The character's "sanity bar" must be maintained, reflecting the character's mental state. Engaging in social interactions or failing to manage anxiety levels depletes this bar, adding a layer of strategy to the game.

2.4   Dynamic Environments

The game features two distinct maps: a train and an airplane. Each environment presents unique challenges that contribute to the overall gameplay experience.

3   In-Game Visuals
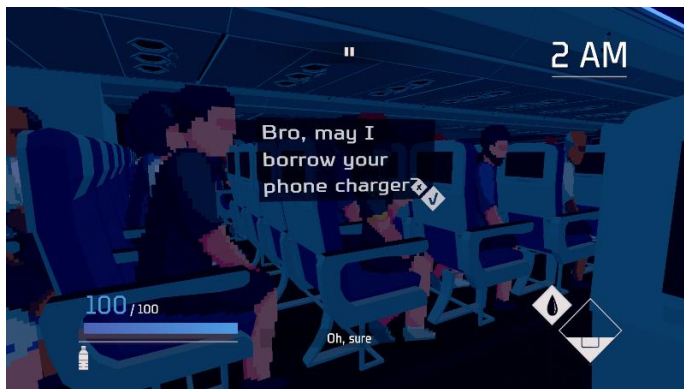

Fig. 1. In-Game View: Train Level.

Fig. 2. In-Game View: Airplane Level.

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The *Alien Bar* Game:
Puzzling Social Interaction Between Baristas

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Abstract. *Alien Bar* is a game in which a player, acting as a barista, combines ingredients to form and deliver fictitious recipes. Designed as a tool for research in teamwork and psychology, the game explores social dynamics by examining how players interact side by side, even when playing individually. The game provides a unique setting for studying cooperation, competition, and player behaviour in problem-solving contexts. Different game modes allow researchers to assess different aspects: a tutorial mode helps a player become familiar with the game controls and mechanics; a training mode helps researchers study interaction between players while completing recipes side by side, e.g., if a player values challenge or pays attention to the needs of another player; and a survival mode helps researchers evaluate how a player performs after training.

Keywords: Alien Bar · Puzzle Game · Memory Task · Social Interaction · Social Dynamics.

1   Introduction

Several studies applied videogames to examine player behaviour and experience, from social browser games [1] to online RPGs [2], suggesting that, through the immersion they convey, videogames are valuable tools to study human psychology. This paper demonstrates *Alien Bar*, a puzzle game allowing the study of social dynamics, where a player assumes the role of a barista that constructs and delivers fictitious recipes. Being the serious objective of the game to study peer interaction in a memory task, it can help researchers assess and share new knowledge about the cognitive and social processes underlying teamwork, thus guiding research in teamwork and psychology. An important *Alien Bar* characteristic is that it allows assessing how people work together in a game that is played individually, e.g., through players' discussions of how to approach the recipes and the attention given to each other's needs. Preliminary *Alien Bar* tests already

Fig. 1: Screenshot of *Alien Bar* annotated with its interactive elements.
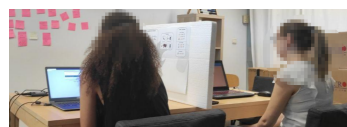
(a)

(b)

Fig. 2: Subjects playing without interacting with each other (fig. 2a) and while training together (fig. 2b).

allowed players to express themselves freely and comfortably while playing side by side, helping to turn otherwise unwieldy experiments into fun activities. The code and materials associated with the game are available online[4].

2   Alien Bar

Alien Bar is a game in which players use ingredients to form recipes, as in *Cook, Serve, Delicious!*[5] or *Overcooked!*[6], yet all the ingredients and utensils presented in *Alien Bar* have fictitious names (like *Orgeine* and *Thirpunasorec*) and the mechanics are built so that in-game tasks become memory puzzles.

The game presents an initial working station (depicted in fig. 1) positioned close to an advanced station, both accessed via directional buttons (element A). Throughout the game, a player has several orders (containing recipes) to satisfy (area B), and each recipe involves one or more ingredients or utensils to be fetched and used. Each order is endowed with a difficulty level reflecting the steps it requires. The game internally records a score increasing with the difficulty level of the delivered orders (the awarded score can also be configured).

Bowls and bottles (elements C.1 and C.2) can be clicked to provide ingredients and utensils, which can then be dragged. Ingredients can also be treated using different in-game processors (elements D.1 and D.2). To use a processor, the player places an ingredient (and a utensil if required) near the processor and clicks it. To produce a recipe, ingredients are dragged to specific zones (area E) that generate a recipe bag (element F) when clicked. A recipe bag displays its contents as a nearby description of its ingredients. After generated, recipe bags can be delivered by placing them on the balcony (area G) and clicking it. Bags, ingredients, or utensils can be discarded in a trash bin (element H).

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[4] `https://github.com/SamGomes/alien-bar` (accessed September 19, 2024)

[5] `https://www.cookservedelicious.com/yum/` (accessed September 19, 2024)

[6] `https://www.team17.com/games/overcooked/` (accessed September 19, 2024)

3   Using *Alien Bar* to study social dynamics

Alien Bar can be played in three different modes: *Tutorial*, *Training*, and *Survival*, which, if executed in this order, help assess the impact of player preferences in teamwork (fig. 2): *Tutorial* presents the easiest orders within a fixed duration, enabling each player to individually understand the game elements, controls, and mechanics; *Training* enables players to interact freely while playing any game level, also within a fixed duration (this mode is the only one to feature the button I of fig. 1 that returns to the main menu). Thus, *Training* helps researchers profile the preferences of players training side by side: players can be rated as self-focused or altruistic for paying attention to their own task or another player's needs, and can be deemed to prefer more or less challenge when choosing to train easier or harder levels; *Survival* progressively increases the game difficulty until either a maximum duration is reached or no more pending orders can be added (to the area B of fig. 1), thus helping to rate player training effectiveness. Unlike in *Survival*, orders in both *Tutorial* and *Training* are generated every time the player delivers an order; and in *Survival*, an order is generated whenever there are no pending orders, thus maintaining player engagement. A researcher can set the duration of each game mode and the maximum number of pending orders.

To be effective, an experimental process should deploy game description sheets or cards acting as a 'recipe book'. After testing with printed instructions and simplified cards, we developed a divider (the middle element in fig. 2) that can separate two players in *Tutorial* and *Survival* if positioned in-between them (fig. 2a) or assist joint training when placed in front (fig. 2b). It can also hide difficult recipes while supporting *Tutorial*. After using the explained process in preliminary tests, we were able to acquire some players' initial scores in *Tutorial*; interaction preferences in *Training*; and final *Survival* scores, which may leverage interesting future analyses.

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Umfeld
(Social Environment)

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Abstract. The prosocial serious game "Umfeld" informs about signs and support options related to intimate partner violence (IPV), addressing adults willing to reflect on their own role and potential to help. The game is a narrative point-and-click adventure, in which players have to make choices in situations with signs of violence. The objective is to gain allies in order to build up a support network in a small village community. Understanding signs and patterns of abusive relationships serves as personal protection and fosters vigilance within communities to identify and prevent violent behaviour. Increased awareness can reduce stigma and cultivate empathy for victims, making it easier for them to access help. Our game provides a safe environment for players to explore this issue and experiment with possible interventions. By illustrating the struggles and uncertainties involved in dealing with intimate partner violence, we aim to strengthen players' resilience towards challenges and failures.

Keywords: Prosocial game · Intimate partner violence · Awareness-raising · Interactive narrative.

1   Prosocial Game Theme: Intimate Partner Violence

Intimate partner violence (IPV) is a structural issue that significantly impacts society, yet it remains shrouded in taboo. This, combined with fear, shame, stigma and dependency on the abuser makes it difficult for victims to speak out and find support, while perpetrators often go unchallenged. Understanding the signs and patterns of abusive relationships, such as the cycle of abuse, not only serves as personal protection but also fosters vigilance within communities to identify and prevent violent behaviour. Increased awareness can reduce stigma and cultivate empathy for victims, making it easier for them to access help. The serious game "Umfeld" provides a safe environment for players to explore this issue and experiment with possible interventions, preparing them to act in real-life situations. By illustrating the struggles and uncertainties involved in dealing with intimate partner violence, it aims to strengthen players' resilience towards challenges and failures - thus contributing to a better future with less violence.

2   Game Description

"Umfeld" is German for "social environment". In our game, "Umfeld" is also the name of a toy village designed to resemble a German rural setting, in which a serious case of intimate partner violence happened. To protect participants with possible previous experience from an unprepared encounter with traumatic memories, the players should be informed in advance about the topic of the game. The game targets adults (neither victims nor perpetrators of IPV) who want to reflect on their own role and potential to contribute help.

The toy village is in turmoil after popular entrepreneur Timo fatally injured his wife Sabrina, following a long abusive relationship. As the villagers are in shock, they question whether they could have foreseen or prevented the crime. Players are given the power to rewind time in the "Limbo" (Fig. 1). They visit memories of villagers to help them revise their past decisions, finding that a tightly knit network of social dependencies and loyalty to the abuser helped keep the violence hidden and ongoing. The aim is to weaken these ties, to take a stand against violence and to build a new support network through awareness.
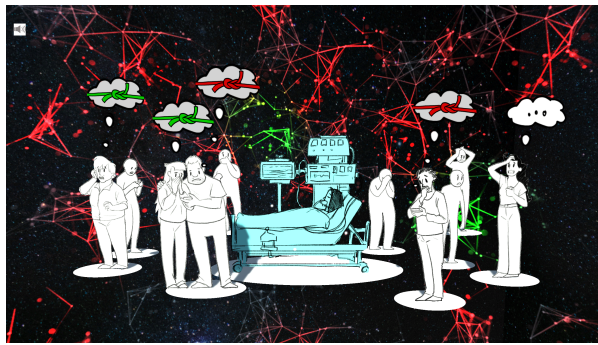

Fig. 1: The "Limbo" allows players to delve into memories of the shocked villagers (the social environment) and make them rethink by whispering decisions to them.

Each memory, presented in a cartoon style, highlights a situation with signs of violence and three options for actions to choose from (Fig. 2). After the decision, a spinning wheel determines the result, illustrating that outcomes depend on both individual choices and the reactions of others. This can be a positive outcome, strengthening the new supportive network, or a negative one, maintaining the status quo. The probability of a positive result is determined differently for each choice situation by design (visualized on the wheel) and can increase dynamically through an already established network. Individual feedback texts provide explanations for each situation as well as additional knowledge about the type of violence depicted (social, economic, psychological etc.). After playing through all the memories, an epilogue is presented that reflects the impact of the decisions on the networks in the village and presents its new possible reality.
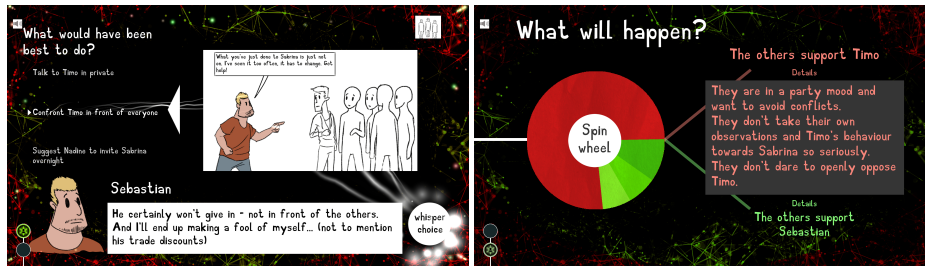
Fig. 2: Left: Choice (to confront Timo), Right: Outcome probabilities visualized on the spinning wheel (here: low chances, slightly increased by network bonus).

The game concept has been developed by an interdisciplinary team that took an approach of using 'systems mapping' to deepen their understanding of the structural aspects of the topic [3]. Several prototypes with alternative designs have been tested [2] [4] and prepared for use in workshops. More material on the project with links to game prototypes is available on the project website [1].

Game Credits. *Game Idea, Concept, Mechanics:* Lorena Müller, Ulrike Spierling, Stephan Schwarz, Jessica Laura Bitter, Michael Lurz. *Illustration, Graphics:* Lorena Müller. *Sound:* Jessica L. Bitter. *Programming:* Lorena Müller, Jessica L. Bitter, Leonie Ferdinand, Manuel Feller. *Authoring, Game Testing:* Lorena Müller, Jessica L. Bitter, Michael Lurz, Ulrike Spierling, Stephan Schwarz.

Subject Matter Expertise, Consulting: Regina-Maria Dackweiler, Reinhild Schäfer, Angela Merkle, Charlet Flauaus, Sandra Rauchstädt, Mascha Holly, Kim Cloß. *Scenario Development:* Regina-Maria Dackweiler, Reinhild Schäfer, Dirk Springenberg. *Project Initiative:* Regina-Maria Dackweiler, Reinhild Schäfer.

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Untitled Bee Game

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Abstract. Untitled Bee Game is an educational serious game for behavior change, about eco-sustainability, inspired by widespread commercial games. It puts players in control of a bee and has them sting characters who do not behave according to eco-sustainable principles. The game offers adaptive learning material in the form of a so-called learning path, to learn facts about bees, plastic pollution and detergent pollution. Adaptation of learning paths is catered by an architecture based on the MAPE-k framework that includes generative AI functionalities based on large language models and educators in the loop.

Keywords: Serious game, education, eco-sustainability, adaptation

1 Introduction

The game explores new ways of merging together commercial game mechanics (inspired by *Untitled Goose Game*[3] specifically) and educational purposes with adaptive capabilities. The game is relevant to the educational domain, particularly thanks to its adaptive capabilities, in particular within the eco-sustainability domain. The game architecture implements three modules: (i) the serious game client; (ii) the generative AI module; and (iii) the educator's dashboard. In the current version of the architecture, quizzes and readings of different levels are generated using the AI. The game then detects when the performance of a learner in a certain topic is suboptimal. In that case, adapted material with optimal difficulty is suggested by prompting an large language model (currently, ChatGPT) to produce the best difficulty prediction. Educators can always alter the suggestions by adjusting the difficulty of the next readings and quizzes. The main target audience consists of students from middle school to high school, but could also be extended to university students [2]. In fact, the first sample the game was tested with came from Italian universities. The purpose is to teach eco-sustainability facts and raise awareness about eco-sustainability issues, while catering to the needs of different types of learners. Since, by design, educators have control over what is administered to learners and how it is adapted, classes are the best context to utilize the game.

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[3] https://goose.game/

Fig. 1. A multiple choice quiz in Untitled Bee Game.

1.1 Game description

Players control a bee and have to correct the behavior of three humans who are performing activities that could be bad for the environment. A character is wasting plastic water bottles instead of refilling a thermos. Another one is using a type of detergent that is not certified as safe for the environment (e.g., Ecolabel UE). Whenever unwanted behavior is pursued by the characters, players have to sting them.

Education is achieved via *learning paths*. Learning paths are defined as "*a sequence of activities with designated goals to help students build up their knowledge or skills in a subject area*" [6]. This sequence is composed of 'nodes' also known as *knowledge elements* [6] or *learning objects* [4]. To explore the feasibility of our approach, we start from a repository of learning materials, which we call *learning map*. We include a minimal learning path in Untitled Bee Game and make it adaptive. Adaptation of content is obtained by relying on the Bloom taxonomy [1].The path is made of *learning nodes*, each of which contains several *activities* consisting of a reading node and an assessment node. We mapped the learning path onto the *game loop*, that is, the sequence of actions performed by the player in a typical play session. The game loop integrating the learning path unfolds as follows. Players complete a learning node, that is, they read a fact (e.g., how plastic garbage is polluting the environment) uttered by a flower and answer a quiz in a specific game location (e.g., asking how much plastic is not recycled globally). Performance information is stored as a binary correct/incorrect value from a multiple-choice question. Then, players perform game actions (mainly stinging humans), and finally they get back to the learning location for the next learning node. If correct stinging is performed, fish start coming to town to reflect the positive impact on the environment. When all learning nodes have been done, the learning path is complete[4]. When the first

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[4] A video is available at https://youtu.be/wNMfLPgJhDU.

learning node has been completed Educators can apply adaptations to the path. There are two possible outcomes: i) if performance (the number of correct answers) is below a threshold set by the Educator, the AI planner suggests making variations on the activity topic to pass the learning node; ii) if performance is above the threshold, the planner suggests a higher Bloom level and moves on to the next learning node in the path, which may be adapted or not. In the current implementation, adaptations are suggested according to thresholds. Educators ensure, using the dashboard with real-time learner data, that learning performance is over a certain desired threshold. The AI is always available to provide both data and adaptations for the next learning material (e.g., quizzes). By exploiting the synergy between educators (who know their class very well and can count on years of experience) and generative AI, learning objectives can be attained by performing a semi-automatic, supervised content personalization. This aligns in particular with previous literature that stresses the importance of taking into account the limitations of one-size-fits-all approaches in serious games, for education, and behavior change [5,3].

Acknowledgments

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Verbal role-playing game for the development of critical thinking

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Abstract. We created a verbal role-playing game aimed at developing the 4C skills: communication, cooperation, creativity, and critical thinking, which are predicted to be in high demand. The game fosters critical thinking, teamwork, creativity, emotional intelligence, and communication through live-action scenarios. Players are challenged to distinguish facts from opinions, analyze sources of information, consider multiple perspectives, and make informed decisions in difficult situations. Over 4 years, we have developed more than 300 educational games, played by over 300 participants from more than 35 countries. The game's mechanics are based on Harvard University's Project Zero methodology and integrate dice rolls from Dungeons & Dragons (D&D). We use AI to generate visual aids that enhance learning and creativity. The game can be applied in both educational and corporate training settings, equipping participants with critical skills for real-world applications.

Keywords: Live action game, Educational game, Creativity, Critical thinking, Emotional intelligence.

1   Introduction

In today's information-saturated world, the ability to distinguish reliable data from misinformation is crucial. Our verbal role-playing game is designed to help participants improve critical thinking, communication, teamwork, and problem-solving skills. These competencies are increasingly important for personal and professional success. The game targets individuals across different age groups and professional stages, from students to experienced professionals.

2   Target Audience and Use Context

The game is designed for a broad range of users, including:

- Schoolchildren and Students: Helping to develop analytical thinking, logic, and argumentation, crucial for academic success and real-life problem-solving.

- Young and Experienced Professionals: Enhancing decision-making abilities, creativity, and adaptability to evolving professional challenges.
- Leaders and Managers: Improving strategic thinking, complex problem-solving, and team-based decision-making.

The game can be integrated into educational settings and corporate training programs, making learning interactive and impactful.

3   Game Objectives and Integration

The primary objectives of the game are to:

- Help participants distinguish facts from opinions
- Analyze sources of information
- Consider multiple perspectives on complex situations
- Develop non-standard solutions to challenging problems
- Foster teamwork, communication, and argumentation skills

The game can be used as part of school curricula, extracurricular activities, or corporate training workshops. It fits well into subjects like history, literature, and project management, encouraging participants to apply critical thinking to real-world tasks.

4   Gameplay, Mechanics, and Interactions

The game's narrative places participants in a variety of scenarios where they need to make decisions based on the information presented. The evolution of events depends on player choices, promoting active engagement and critical evaluation.

4.1   Narrative and Gameplay

Imagine battling monsters while learning to resist fake news and cyber threats, or traveling between worlds to practice logic and teamwork. Players receive instructions, propose solutions, and collaboratively decide on their next actions. Educational tasks are embedded in the gameplay, ensuring learning through engagement.

4.2   Mechanics and Interactions

The game's mechanics are based on Harvard University's Project Zero methodology, designed to foster reflective thinking. We also integrate elements from Dungeons & Dragons (D&D), such as dice rolls to determine outcomes, which keeps the game dynamic and immersive.

5   Innovative Design Elements

We use artificial intelligence to create visual aids that are seamlessly integrated into the game, fostering creativity and critical thinking (see Figure 1). The design also promotes immersive learning, where players engage in realistic decision-making, enhancing their ability to apply skills in both personal and professional settings.
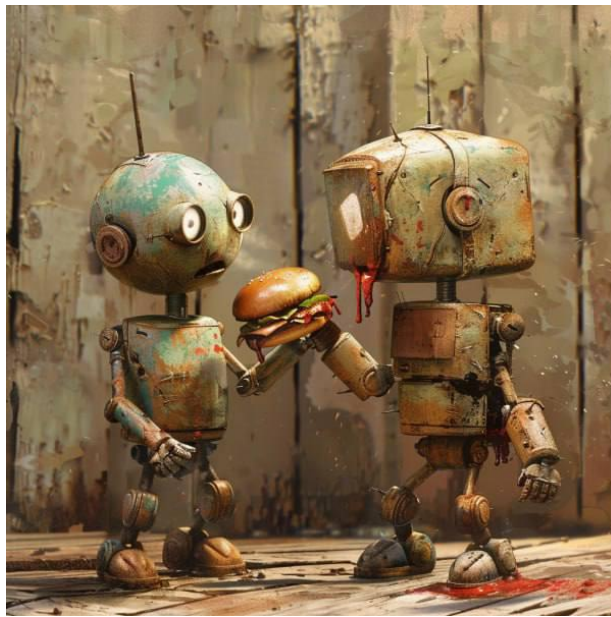

Fig. 1. Example of AI-generated illustration, organically integrating educational content to promote critical thinking and creativity

6   Results and Achievements

Over the past four years, we have developed more than 300 educational games, which have been played by over 300 children from more than 35 countries. The games have demonstrated a range of benefits:

- Improved Analytical Skills: Participants become adept at distinguishing facts from opinions and making informed decisions.
- Increased Confidence: Regular participation helps build communication skills and personal confidence.
- Enhanced Emotional Intelligence: Players learn to manage emotions in high-stress situations and communicate more effectively.
- Skill Development: The game improves critical thinking, collaboration, conflict resolution, and strategic planning. It equips participants with creative problem-solving abilities, preparing them for both personal and professional challenges.