Building creative literacy skills through cooperative and competitive gameplay: the case of *See, Hear, Touch no Evil*

JOSÉ RAIMUNDO,[1] **PEDRO CARDOSO,**[2]
MIGUEL CARVALHAIS,[3] **ANTÓNIO COELHO,**[4]
JOÃO JACOB[5]

ABSTRACT

This paper presents our research on a collaborative play-oriented framework for creative literacy, a much-needed skill to improvise solutions in today's competitive setting. Although digital media has democratised tools and resources, it also contributes to the risk of alienating one's personal creative potential, and/or replacing it with technical expertise, leading one to arrive to solutions that are not creative but simply express the affordances of the medium/ system being used.

We believe that games are able to address this issue effectively, because they are able to generate experiences focused on the exchange and articulation of knowledge between people, while being focused on problem-solving strategies.

To explore how games can be used for such purposes we present a case study – *See, Hear, Touch no Evil* –, a multiplayer, role and turn-based game where players are free to compete, cooperate or collaborate with the intent of stimulating emergent gameplay. We chose this because creative choices often call for the ability to accommodate opposing perspectives in order to trigger unexpected solutions.

[1] INESC TEC/ Faculty of Engineering, University of Porto, Porto, Portugal — joseraimundo3d@gmail.com

[2] INESC TEC/ Faculty of Fine Arts, University of Porto, Porto, Portugal — pcardoso@fba.up.pt

[3] INESC TEC/ Faculty of Fine Arts, University of Porto, Porto, Portugal — mcarvalhais@fba.up.pt

[4] INESC TEC/ Faculty of Engineering, University of Porto, Porto, Portugal — acoelho@fe.up.pt

[5] INESC TEC/ Faculty of Engineering, University of Porto, Porto, Portugal — joao.jacob@fe.up.pt

We conclude with the fact that the complex game mechanics of this game generated too much cognitive effort on players, and that empirical evidence showed that creativity can extend beyond play itself, given that criticism is accepted, something that may draw players and the audience into certain designer roles, able to build new hypotheses.

KEYWORDS

Creative Literacy;
Games, Design;
Ideation;
Collaboration;
Emergence.

1. INTRODUCTION

According to Cariani, understanding the processes that underlie the concept of emergence can help in reaching out for creative results (2008, 4). This led us to believe that if games can sustain such processes then they are also good means for cultivating creative literacy. Yet, emergent gameplay, as Bycer points out, is hard to design because it involves predicting unexpected behaviours from projected constraints, rules and mechanics (2015).

According to Bogost *et al.*, a creative approach to something also calls for accepting risks that some may be not so eager to take (2005). With this in mind, we believe that cultivating creative literacy through games can help empowering individuals to deal with the unexpected.

We chose games because, as Sicart claims (2014, 5), their playfulness can be highly engaging and useful for "expressing our being in the world". The potential that games have for teaching has already been profiled by Gee (2004). Games that provide space for questioning can help pave the way towards literacy as players can contribute with new aesthetical, ethical and socially meaningful hypotheses (Magro & Pierce 2016).

With this in mind, we are working on a framework for cultivating creative literacy, based on a set of procedures and guidelines for building games capable of building creative skills.

We have opted for a Design-Based Research methodology, since developing games for building creative literacy calls for theory and practice, sustained and refined by one another (Wang & Hannafin 2005, 6). With this in mind, we have developed a prototype of a board game in which players choose to either compete, cooperate

or collaborate[6] in a contrived environment. This prototype is our first case study (detailed in section 3), and aims to explore the following questions: *Can scarce information and challenging game settings trigger emergent gameplay? Is it possible to support cooperation and competition and still have collaborative emergent gameplay?*

1.1 WHAT IS CREATIVE LITERACY AND WHY IT IS RELEVANT FOR TODAY'S CITIZENRY

According to a Cambridge Assessment Report (2018), literacy is the mastery of abilities or processes to better understand our surroundings (e.g. language, aesthetics, etc.). In turn, creativity is a process still wrapped in mystery and in paradox, between developing something out of nothing or through constraints (Boden 2004, 11). Ribeiro bears witness for today's abundance of technical experts and for the scarcity of creators, since transferring know-how and acting according to established work practices seems to be easier than promoting an innovative *posture*.[7] Furthermore, if no one is born with expertise and know-how, should we attempt to learn or to teach for being creative? He informs us that this discussion has not yet reached consensus (2018, 194), and that current teaching practices are prone to establish rigid personalities (*ibid.,* 197). Cultivating creativity, however, can only be done by increasing the number of creative acts, make them intrinsically desirable and possibly turning those into a habit (*ibid.,* 211).

Nowadays, individuals are expected to be creative, to learn to face adverse conditions, or to improve what became ineffective, tasks once thought of to be better addressed by so called geniuses. Vygotsky counters this last statement arguing that acts of geniuses are just small drops of the creative human potential, which in turn can only be harnessed through diverse socio-cultural interaction (2004, 11). As such, we believe that cultivating a creative posture can stimulate lifelong learning, by allowing one to become open-minded, curious, risk-taker, able to understand difference and diversity, and to be attentive to their surroundings (Mohamed 1986).

[6] In a competitive game, players have opposing goals whereas in collaborative games players share these. Cooperative games alternate between competition and collaboration (e.g. the classic cooperative game is an iterative version of the prisoner's dilemma).

[7] Posture (definition): is seen here as the ways or habits through which individuals position and interact with their environment and each other. The scope of assumed postures by creators and how and why they are taken is thoroughly documented by Ribeiro (2018, 121-125).

1.2 COMPETENCES NEEDED FOR CREATIVE LITERACY

All endeavours need *motivation* to endure challenges and adversity, and learning helps raising confidence on the task at hand. As Anthropy claims, learning can be encouraged by open access to creative knowledge resources, which in turn allows for skill building and empowerment (2012, 3,7,45). Scott and Ghinea argue that motivation can be fostered by nurturing one's self-worth, by relating fantasy game activities to real world roles (2013, 1,4). Koster further asserts that motivation for learning can be found within experimental, playful and meaningful game spaces (2005, 40).

Play is explained by Nachmanovitch as a natural process for developing capabilities in a fun and rewarding way (1991, 42), while fun can be triggered by simulated experiences and by exploring this relative freedom under controlled game settings (Frasca 2007,78). Conversely, Söderberg (2002) states that effort can be a source of motivation and involvement, namely when goals transcend a single individual and aim at a greater good. With this in mind, a *playful attitude* seems to be a requirement here.

Emotional involvement seems to play a relevant role here as well, since emotions are a significant part of cognition and primordial processes for reacting to our surroundings in a more intense, motivated, and involving way. They are also key to reacting quickly when compared to cognitive assessment (Norman 2004, 13). Also, in our view, emotional reactions to a game can hint at unexpected design hypotheses. E.g. Juul (2013, 27) states that evoking positive emotions for winning can be useless sometimes when player interest resides on exploring the game's sandbox through failure. According to Bogost *et al.*, arcade game operators strive for addiction to make players feel compelled to continue, yet the author's concerns lay beyond this: it is what videogames have to say through their procedural rhetoric that counts, i.e. the meaningful ideas for discussing how and why systems work in the real world and that are able to stimulate behaviour change (2007, 46-47).

We also think that being *attentive to serendipity* can be of great value, since, according to Melo, that has the potential for gathering unpredictable information by observing into unconsidered discipline fields or seemingly unrelated subject matters (2018, 45). As such, malleable procedures and collaborative practices can be adequate for building creative literacy, as we regard them to be similar

to Melo's *six serendipity heuristics*.[8] Toop's account on 20th century music challenges seemed already aligned with some of Melo's heuristics, e.g. the ability to bypass the composer's intentions through complex and flexible algorithms that embrace chance and accident (2004, 240-241).

We envision that games can provide learning contexts for individuals with diverse socio-cultural backgrounds, something resonating with McGonigal assertion that games provide fun and inclusive contexts for individual contribution and for joint exploration to occur (2011, 97), and that by following such player, game designer, or theorist perspectives one may solve real-world problems more easily (2011, 7). This is also backed by Galloway, in the sense that he argues that the interaction-driven nature of game systems supports simultaneous individual experiences (2006, 2). For instance, serious games can stimulate critical thinking, cooperative attitudes and awareness for one's working surroundings and exploring the combination of resources as a team (Agogué, *et al.* 2015, 4, 6).

1.3 EMERGENT GAMEPLAY

The term *emergence* can occur across several disciplines and accordingly assume diverse meanings. Cariani found it to be closely related to creativity, as it implies something novel that springs from a given process (2008, 4,11). Waggoner argues that emergent gameplay raises from re-discovering and repurposing game resources beyond their designed intentions (2013, 104), and for this to occur Bycer suggests open-world and open-ended game systems to be the fitting contexts for that to happen. However, he also asserts that when everything is grounded on openness, player experiences become hard to predict and to develop (2015). Therefore, and because developing emergent gameplay is risky, we need to thoroughly test the game and assume an inquisitive posture to explore new interactive options (Sweetser, 2008, 417).

[8] Melo's serendipity heuristics are: *Unexpected Interaction, Encouraging Exploration, Guiding the Interaction, Interactor Cedes Control, Linking Information*, and *Timely Interactions* (2018, 220).

Sensors and actuators, the elements of an *actor's input/ output structure*,[9] and their diverse states are crucial for player and game system interaction, as they shape gameplay response and behaviour (Cardoso 2016, 161-166). As such, we find that having access and being able to choose amongst several combinations of such states can lead to the emergence of cooperative and competitive player behaviours, which can be correlated to Bartle's MUD[10] player types, and that according to him, although some players display propensity to act in a given way, they also attempt to explore gameplay differently (1996).

So, *collaboration* can also play a role in our study, as it can be regarded as team effort between players that share the same goals and that are therefore rewarded and penalized as a group, as opposing to competition, that consists on expressing dominance over other players. In their study, Zagal *et al.* found evidence on how distributing abilities and skills, allowing communication and sharing of resources amongst players in an open manner could stimulate collaboration in games (2006, 31). Knizia's *Lord of the Rings* (2000) is a good example of such approach because it was designed with mechanics that hit players badly from every direction should any of them decide to tackle a challenge alone, making it impossible to endure the game singlehandedly. This example can throw down the generic idea that competition is inevitable in games as it relies in active communication and timely sacrifices.

2. THE CASE STUDY OF *SEE, HEAR, TOUCH NO EVIL*

See, Hear, Touch no Evil is a three-player turn-based game, where players can collaborate or compete to accomplish their main goal: exiting the game field. They are able to do it by collecting energy that allows them to open the exit, and to collect oxygen points in order to remain operational, while defending from or attacking their enemies.

[9] Actors are every game element that is able to act in a game, including both the player and game-system. The actors' actions are what changes the game state and what makes it dynamic. An actor's input/ output structure, as described by Cardoso (2016), is comprised of *sensors, processing cores* and *actuators*. Sensors allow the detection of signals, processing cores operate and transform sensor readings to be sent to the actuators, and actuators transmit those results to the environment in specific ways.

[10] MUD or Multi-User Dungeon (definition): are role-playing, text-based, networked games supporting a wide number of players, while sustaining a virtual world for play to unfold.

The following question jumpstarted our design: *Is it possible to balance cooperative and competitive dimensions and still have collaborative emergent gameplay?* Citing Bartle (2004, 128) and Koster (2005), Rayan argues that, although player motivation is something that needs further research efforts, what appears to drive it is individual gratification and pleasure (2006, 348). As such, we have considered self-interest as a common reason to compete and to collaborate, and devised a game where exiting a level can be accomplished by assuming both postures, yet with consequences. Knowing how these postures affect players' chances to attain the goal, while having freedom to choose between them, is something we expect to do in the future.

We chose analogue prototyping as this approach lends itself to quickly test game potential, due to readily accessible materials that offer multiple possibilities, (Manker & Arvola, 2011, 280). Also, it is easier to understand the governing mechanisms behind analogue games when compared to a digital game complexity (Zagal *et al.* 2006, p.25). Plus, player attitudes were autonomous, with no supervision on our behalf (in opposition to what happens in games with a DM),[11] which heightened the consequences for the players' actions.

2.1 BASIC RULES

This game's gameplay is sustained by the elements represented in Fig. 1, taking place on a board depicting the game world which is divided into a grid of hexagon cells, with one entry point and one exit point (Fig. 2). A complementary matrix, printed in a sheet of paper, serves to record players statuses regarding their energy and oxygen,[12] ranging from zero to five slots, arranged in columns according to player (Fig. 3). An adapted six-sided dice provides random input for announcing events, set players' movement range, and appoint penalties (Fig. 4).

[11] Dungeon Master (DM) is a human agent or an automated subsystem that supervises players' actions and constrains them to a given narrative; and is required for RPG game genres.

[12] The time attribute was abandoned during development because it became irrelevant: continuous depletion of oxygen was enough to provide a sense of urgency and, ultimately, limiting the duration of each play session.

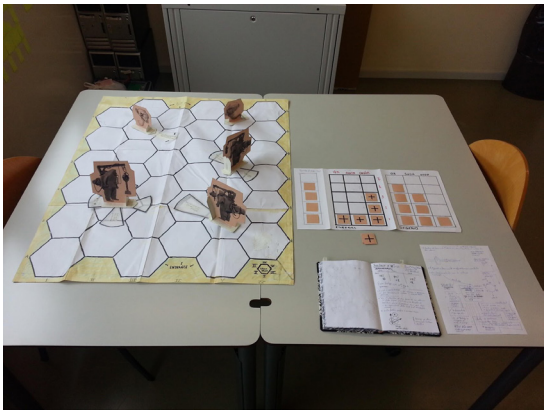

Fig. 1
Game board, complementary status sheet, avatars, enemies and development diary.

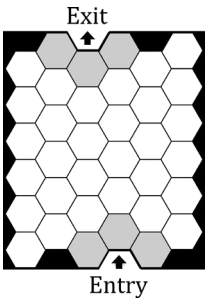

Fig. 2
Game board with entry and exit points.

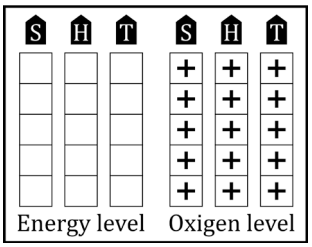

Fig. 3
Record sheet with starting levels for oxygen and energy.

Fig. 4
Dice for random input, the upper face shows V (5 in roman numerals) and E, standing for coordinates in the gameboard.

Player movement is carried along the X and Y axis depending on coordinates resulting from dice rolls (Fig. 5). There are three types of players and one enemy represented in billboard pieces (Fig. 1). Each player can perceive their surroundings according to only one sensorial modality, which is constrained in direction and range. *Sight* senses ahead, *Hearing* sideways and *Touch* in both directions (Fig. 6).[13] Enemies can sense around in all directions within a three-cell radius and they always attack when sensing someone with that area (Fig. 7).

[13] We tried to balance player characteristics (e.g. walking and aiming range) to stimulate collective strategy-finding.

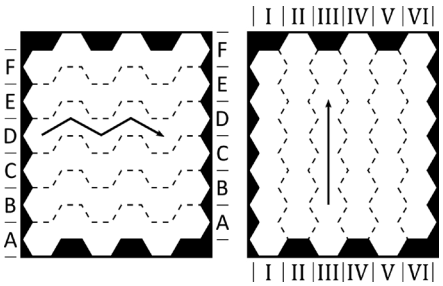

Fig. 5
Game board with entry and exit points.

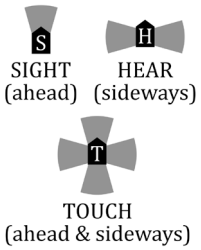

Fig. 6
Player type sensing directions.

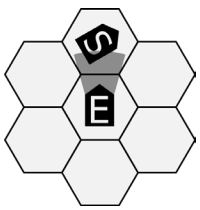

Fig. 7
Enemy sensing directions and range

Players start with no energy and a full supply of oxygen (Fig. 3). They need a full energy supply in order to exit the play area, while managing their oxygen supply that depletes one slot per four turns. If out of oxygen, their actions are disabled. Resuming play depends on donations from the other players which avatars need to be nearby – one player can transfer one of his oxygen slots to another player (Fig. 8).

Events occur when enemies, oxygen tanks or batteries are spawned and positioned randomly in the gameboard (Fig. 9). In each turn, players can walk, attack, dodge, ask for help, or alert unaware players of incoming attacks.

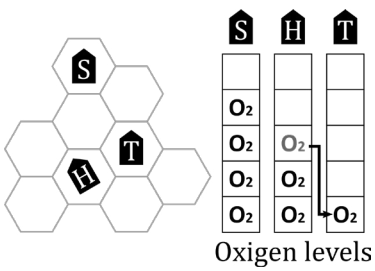

Fig. 8
Donating oxygen is only accomplished in proximity.

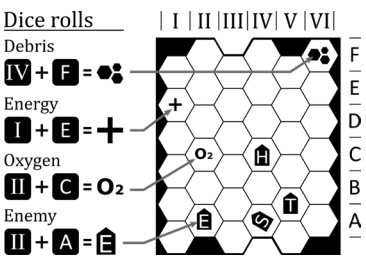

Fig. 9
Positioning events through dice rolls.

Exiting the play area exhausts players' energy supply in one shot, and activating the door depends on the value of a dice roll (Fig. 10). Exiting alone allows a player to carry three slots of energy to the next level. Conversely, holding the door open allows one to take the other players to the next level. A Player's attempt to exit alone can also be disrupted by other nearby players that toss the dice for a chance to prevent that from happening (Fig. 11).

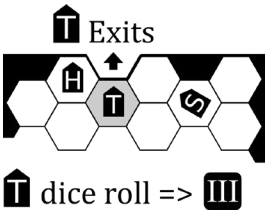

Fig. 10
Touch is able to exit.

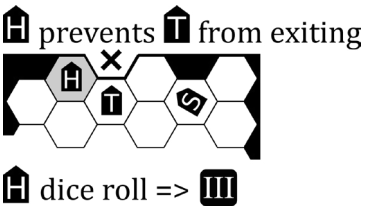

Fig. 11
Hear prevents *Touch*'s exit.

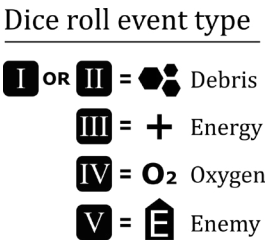

Fig. 12
Events according to dice roll.

Rounds start by determining the *event* type (Fig. 12) and determining its location (Fig. 9). If an event is *perceived* by or endangers a player, he/she takes precedence, otherwise a normal turn sequence applies: *Sight, Hear* and *Touch*. Players *move* in patterns according to their sensorial modality, and position and orient for the next round aligning themselves perpendicularly to one of the cell sides (Fig. 13). Movement range functions according to such constraints but the player can move to any position within said range.

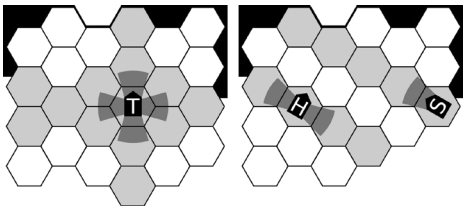

Fig. 13
Perceivable patterns according to player type.

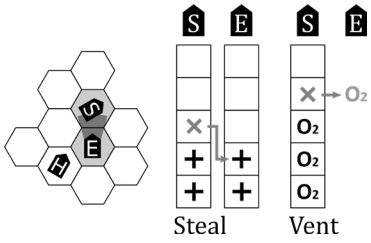

Fig. 14
Enemy attack is successful. Enemy steals one energy slot, unless players don't carry energy, in which case the enemy vents one oxygen slot from the player.

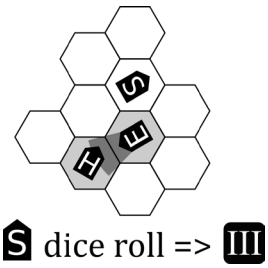

Fig. 15
Player gets to dodge thanks to a dice roll value. The enemy can try to attack other players.

Successful enemy attacks disable players and may steal the player one energy slot – at close range this is always successful. If players possess no energy, enemies puncture their suit, venting oxygen slots (Fig. 14). Stolen energy can only be reclaimed by attacking in the same round. Players that are under attack can try to call for help, to alert others or to dodge (Fig. 15). However, this disables said players for the rest of the turn. A call for help does not prevent damage. Dodging allows enemies to attack other players. Successful player attacks make enemies drop one energy slot and disappear.

2.2 DIGITAL TRANSCODING: GAINS, LOSSES AND EMERGING NEEDS

Developing a digital version granted us the opportunity to learn the implications that stem from transcoding an analogue universe onto a digital one. And to check if it promoted a better chance for emergent gameplay to occur. By distancing ourselves and accepting critique from those willingly involved in the development (players, programmers, observers, among other stakeholders), we were able to discover weaknesses that had not yet been found in the analogue prototype.

The digital game format gave rise to some challenges due to a phenomenon of acceleration of the pace of play, since the game system took over key-procedures originally handled by players themselves. This new pace allowed players to reach the world boundaries in a single move. Therefore and since we wanted to promote the exploration, we have limited the view of the play area and enlarged the initial space of play. Widening the playfield called for additional events to meet higher oxygen and energy demands, but also increased player disorientation as the world extended with no landmarks beyond the visible play area. We have tried to solve this by using a mini-map, which also proved insufficient to resolve this issue.

This transcoding process also obliged to design new digital means to convey information for the players through a Heads-Up-Display (HUD) and a User Interface (UI). We wanted to prevent cluttering the game view, so we opted for a HUD like *Dead Space* (2008). Energy status was shown by light appendages and oxygen through a window in a tank, both in the back of the suit. But, considering that the avatar had such a small screen size, statuses became hard to read (Fig. 16) so we have opted for hovering over that information near the playable characters themselves. For the UI, available actions are presented similarly through text and can be triggered by a box-shaped pointer placed and clicked within the player's movement range (Fig. 17).

Fig. 16
Original HUD comprised of oxygen tank with window to check level, and lighting appendages for knowing energy status. The original models scaled to game screen dimensions became too small and therefore made inspecting statuses hard.

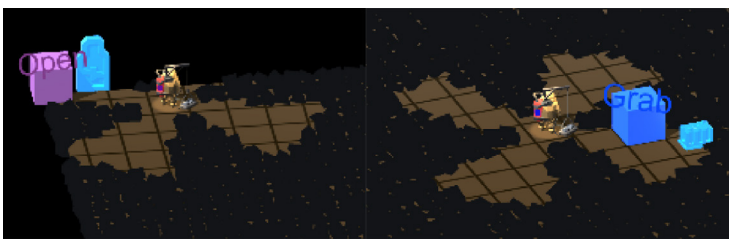

Fig. 17
In-game screenshots of the digital version with current UI.

2.3 TESTING

We understood that the game's complex gameplay was a major upgrade from the analogue prototype due to the constant need to compute manually where, how and if actions were possible, something that slowed down the game's pace and discouraged play itself. Conversely, the digital version accelerated the game's actions, since a machine was able to compute those actions much faster, and this acceleration created other problems:

1. The accelerated pace greatly affected perception of the travelled distance. Players easily reached the game world limits, hindering their willingness to explore the game world.
2. Swapping between player's turns was represented by fast camera movement with pan, tilting and awning, which, although engaging, revealed to be confusing. Therefore we believe that players require a small pause between turns to allow them to "digest" a little better their actions and surroundings.
3. Disorientation was initially thought to be useful. To enforce this, we have only allowed each player a limited perception. We now think differently. The better players grasp their surroundings and share this with others, the better they can build strategies or choose their postures (e.g. competing vs collaborating).
4. The game world doesn't have any visible landmarks, this increases disorienting regarding positioning and distances. This could be solved by placing large recognizable landmarks.

We were also open to critique from those willing to play,[14] and we were able to gather the following relevant suggestions:

1. Adding an inventory for picking additional useful items, e.g. stimpacks, items that enhance player reflexes and range at the expense of health status, like the ones used by the Terran Marines in *StarCraft* (1998) or even a shovel to divert debris.
2. Allowing players to sabotage each other may offer alternative means of sustainment, as they could steal health/ energy resources from each other.
3. Calling for help was deemed as interesting but hardly justifiable, since anyone confined into a makeshift suit would have trouble being heard by others. This further ensued the suggestion of tethering players to enable communication, but then it would also limit movement.

[14] We took some opportunities to demonstrate both the analogue and digital prototypes in various informal gatherings of game developers.

3. DISCUSSION & FUTURE WORK

With this work, we strived to develop a game for individuals to collaborate and avoid competition, a balance that turned out to be hard to achieve. For such, it was necessary to distribute sensing and movement capabilities amongst different player types, but still prevent any competitive edges over one another. Such approach was envisioned as capable to enforce thinking before committing to any action and to reflect on the potential individual role in the ensuing collective effort.

One of the features to be explored was the potential for empathy. Empathy can be established between reader and digital artworks, when the reader (the player in this case) develops mental simulations for understanding how such artworks operate (Carvalhais and Cardoso 2018, 223). So, we aimed at building a game prototype for players to *empathise*[15] with one another in order for them to gain a better understanding of each other's abilities and different field of possibilities, their different horizons of possible actions. Players' traits could then be used in particular combinations in order to devise specific strategies. With that into consideration, these emergent behaviours can then be seen as an exercise in creativity for solving particular problems.

Playtesting allowed us to draw further questions beyond those mentioned in the introduction section, which we list next, taking the opportunity to reflect a bit upon them:

1. *Can scarce information and challenging game settings trigger emergent gameplay?* We are not sure if the gameplay itself was challenging enough. In the analogue prototype, acting is difficult because movement is calculated manually, being hard to keep all rules in mind. In the digital version, however, there is insufficient time to decide how to act and players get easily lost.
2. *Is it possible to support cooperation and competition and still have collaborative emergent gameplay?* As mentioned, when players compete they either have opposing goals or they are trying to accomplish their goal first. Competition differs from collaboration as it gives no certainty of wining for all parties, so

[15] Empathy (definition): Is the ability to place oneself in other's shoes, i.e. a willingness to understand the other's perspective.

players are free to alternate between joint effort, *free riding*[16] and *backstabbing*,[17] all of which can become major strategy advantages in due conditions. The analogue prototype supports to some extent all of these strategies, yet and as stated, playing was so difficult that players could not go beyond a single play session.

During the development of these prototypes, we were able to project other hypotheses beyond the original's intended goals, something we expect to explore in future studies:

1. *Does empathy play a significant role in stimulating collaborative emergent gameplay?* How can games induce empathy? The analogue prototype demonstrated that distributing different abilities amongst players does not necessarily lead to empathy (in the case at hand, those traits are just too hard for players to mentally compute or to simulate). Conversely, in the digital version, speed does not allow for time to reflect on how traits can be turned into an advantage if used together.
2. *What does it mean and what is the influence of collective success over individual success in this game? And are players able to recognize the need for collective success?* Collective or individual success can only be meaningful or influential if it is perfectly clear for players that individual actions have particular consequences (which is not the case in this prototype).
3. *What is the role of the players' educational and socio-cultural background in this game? Can we design for collaboration by turning to players lived experiences?* Insufficient testing did not allow us to infer on how and if player background influences gameplay. Again, this is a valuable question for when designing future prototypes. If they are aimed at different audiences, then they will need to take life experience into account.

[16] Free Riding (definition): happens when players are being evaluated and rewarded as a group and individual group members do not contribute as they should or as much as others do, which can harm the team or group's performance. Free Riding can be very effective in a cooperative game when the rewarding process is blind to individual contribution, possibly favouring those who do not work.

[17] Backstabbing (definition): is the act of betraying someone. It can be an advantageous competitive manoeuvre, e.g. the key to *Diplomacy* (1959) is establishing the right alliances and knowing when to backstab your allies.

In conclusion, the initial analogue prototype was led by an ambition to include too many features, and that resulted in an overly complex experience. This made us realize that future prototypes should be designed with:

1. Less features in mind, keeping context, narrative and graphics as simple as possible to facilitate development and analysis. Distributing different features across different prototypes may allow for easier testing.
2. Means or features that should ease the exchange of information and communication amongst players, as this may be key to attaining successful, in-game collaboration.
3. Rewards for smaller achievements attained collectively, something that seems to share similarities with Gee's principles (2003). Building mastery of the game in smaller steps will ease taking on larger objectives, i.e. the *Incremental Principle* (*ibid*., 201). By doing this with groups bonded by shared interests, i.e. the *Affinity Group Principle*, it will be easier to tackle goals collectively (*ibid*., 201).
4. Balanced rules capable of stimulating cooperation. For this we suggest that future research should focus on players' preferences and on what is important for them, in order to better understand the foundations of collaborative gameplay, thus being able to apply them accordingly.

Regarding the digital prototype, we already listed in section 2.3 some problems we have encountered, and added some possible solutions as well. We should point out that this digital version was a proof-of concept to inspect potential for digital transcoding, and by doing so, if that was able to further stimulate emergent gameplay. Despite the available time and our resource constraints, we believe that procedure to have been successful as we achieved a functional solution. However, in order to achieve our other goals, the game's features and rules will need to be thoroughly fine-tuned.

As-is the digital version is sustained by a single computational device, enforcing the original turn-based game, but we would also like to try to develop a real-time version where all players can act simultaneously. Given all these reasons, we believe that the digital prototype has the potential we seek and we expect to refine it in the future.

ACKNOWLEDGMENTS

The research leading to these results has received funding from the FCT, scholarship reference SFRH/BD/137169/2018.

REFERENCES

Agogué, Marine, Kevin Levillain, and Sophie Hooge. "Gamification of Creativity: Exploring the Usefulness of Serious Games for Ideation". *Creativity and Innovation Management* 24, no. 3 (2015): 415–29. https://doi.org/10.1111/caim.12138.

Anthropy, Anna. *Rise of the Videogame Zinesters: How Freaks, Normals, Amateurs, Artists, Dreamers, Dropouts, Queers, Housewives, and People like You Are Taking Back an Art Form.* New York: Seven Stories Press, 2012.

Bartle, Richard A. "Hearts, Clubs, Diamonds, Spades: Players Who Suit MUDs". *Journal of MUD Research* 1, no. 1 (1996): 19. Last modified, August 1996 at: https://mud.co.uk/richard/hcds.htm

Bartle, Richard A. *Designing Virtual Worlds*. Indianapolis, Indiana: New Riders, 2004.

Boden, Margaret A. *The Creative Mind: Myths and Mechanisms.* New York: Routledge, 2004.

Bogost, Ian. *Persuasive Games: The Expressive Power of Videogames.* Cambridge, MA: MIT Press, 2007.

Bogost, Ian, Michael Mateas, Janet Murray, Michael Nitsche, and The Georgia Institute of Technology. "Asking What Is Possible: The Georgia Tech Approach to Game Research and Education". *The International Digital Media Arts Association Journal* 2, no. 1 (2005): 59–67.

Bycer, Josh. "Examining Emergent Gameplay". 2015. Accessed December 17, 2018 at https://www.gamasutra.com/blogs/JoshBycer/20150916/253682/Examining_Emergent_Gameplay.php.

Cambridge Assessment. "What Is Literacy? An Investigation into Definitions of English as a Subject and the Relationship between English, Literacy and "Being Literate"". *Cambridge Assessment*, 2013. Accessed March 21, 2018 at http://www.cambridgeassessment.org.uk/images/130433-what-is-literacy-an-investigation-into-definitions-of-english-as-a-subject-and-the-relationship-between-english-literacy-and-being-literate-.pdf

Cardoso, Pedro. "Playing in 7D: An Action-Oriented Framework for Video Games" PhD diss., Universidade do Porto, 2016. Accessed September 27, 2018, from: http://hdl.handle.net/10216/82685.

Carvalhais, Miguel, and Pedro Cardoso. "Empathy in the Ergodic Experience of Computational Aesthetics". *ISEA 2018: International Symposium on Electronic Art*, 220–26, 2010. https://doi.org/10.5281/zenodo.1303347

Cariani, Peter. "Emergence and Creativity". *Emergência! - Simpósio Emoção Artificial 4.0*. São Paulo, Brazil, 2009.

Frasca, Gonzalo. "Play the Message: Play, Game and Videogame Rhetoric" PhD diss., IT University of Copenhagen, 2007. Accessed March 26, 2017, from: http://www.powerfulrobot.com/Frasca_Play_the_Message_PhD.pdf

Galloway, Alexander. *Gaming: Essays on Algorithmic Culture.* Chicago, USA: University of Minnesota Press, 2006.

Gee, James. *Learning by design: Games as learning machines.* New York: Palgrave Macmillan, 2004.

Juul, Jesper. *The Art of Failure: An Essay on the Pain of Playing Video Games.* London, UK: MIT Press, 2013.

Koster, Ralph. *A Theory of fun for Game Design.* Arizona, USA: Paraglyph Press, Inc., 2005.

Manker, Jon, and Mattias Arvola. "Prototyping in Game Design: Externalization and Internalization of Game Ideas". In *BCS-HCI* (2011).

Magro, Karen, and Kathleen M. Pierce. "Creative Approaches to Literacy Learning: Grappling with Enormous Problems and Huge Opportunities". *Creative Intelligence in the 21st Century*. Rotterdam: SensePublishers, 2016.

McGonigal, Jane. *Reality Is Broken: Why Games Make Us Better and How They Can Change the World.* New York: Penguin Publishing Group, 2011.

Melo, Ricardo. "On Serendipity in the Digital Medium: Towards a Framework for Valuable Unpredictability in Interaction Design" PhD diss., Universidade do Porto, 2018. Accessed September 27, 2018, at http://hdl.handle.net/10216/113140

Mohamed, Naz O. "An investigation of the relationship between early childhood education teachers' attitude on creativity and the instructional behaviour in the classroom" PhD. diss., University of Massachusetts Amherst, 1986. Accessed February 5, 2018, at https://scholarworks.umass.edu/dissertations_1/4175

Nachmanovitch, Stephen. *Free Play: Improvisation in Life and Art.* New York: Penguin Publishing, 1991.

Norman, Donald. *Emotional Design: Why We Love (or Hate) Everyday Things*. New York, USA: Basic Books, 2004.

Ribeiro, António. *O mistério da criatividade: teorias e práticas criativas nas ciências, na vida quotidiana e na educação.* Porto: Edições Afrontamento, 2018.

Ryan, Richard M., C. Scott Rigby, and Przybylski Andrew. "The Motivational Pull of Video Games: A Self-Determination Theory Approach". Motivation and Emotion 30, no. 4 (December 2006): 344–60. https://doi.org/10.1007/s11031-006-9051-8.

Scott, Michael 'Adrir', and George Ghinea. "Integrating fantasy role-play into the programming lab: exploring the "projective identity" hypothesis." *SIGCSE* (2013).

Sicart, Miguel. *Play Matters*. UK: MIT Press, 2014.

Söderberg, Johan. "Copyleft vs. Copyright: A Marxist Critique". In *First Monday* 7, no. 3 (March 2002). Accessed December 26, 2017, at http://firstmonday.org/ojs/index.php/fm/article/view/938/860

Sweetser, Penny. *Emergence in Games: Course Technology*. Boston, MA: Cengage Learning, 2008.

Toop, David. "The Generation Game: Experimental Music and Digital Culture". In *Audio Culture: Readings in Modern Music*, edited by Christoph Cox and Daniel Warner, 454. Redmond, Washington: A&C Black, 2004.

Waggoner, Zach. *Terms of Play: Essays on Words That Matter in Videogame*

Theory. Jefferson, North Carolina, USA: McFarland, Inc. Publishers, 2013.

Wang, Feng, and Michael J. Hannafin. "Design-Based Research and Technology-Enhanced Learning Environments". *Educational Technology Research and Development* 53, no. 4 (2005): 5-23. https://doi.org/10.1007/BF02504682

Vygotsky, Lev., Semyonovich. "Imagination and Creativity in Childhood". Moscow: Prosveshchenie, 1967. In *Journal of Russian and East European Psychology* 42, no. 1 (Translation, 2004): 7-97.

Zagal, José P., Jochen Rick, and Idris Hsi. "Collaborative games: Lessons learned from board games". *Simulation & Gaming* 37, no. 1 (2006): 24-40. https://doi.org/10.1177/1046878105282279

LUDOGRAPHY

Lord of the Rings. Reiner Knizia. 2000, Fantasy Flight Games.

Dead Space. EA Redwood Shores. 2008, Electronic Arts.

StarCraft. Chris Metzen & James Phinney. 1998, Blizzard Entertainment.

Diplomacy. Allan B. Calhamer. 1959.