Creative Emotional Reasoning Computational Tools Fostering Co-Creativity in Learning Processes

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GAME DESIGN

C²LEARN PROJECT DELIVERABLE NO. D4.1.2

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Abbreviations used

A) Abbreviated names of the project consortium partners

Abbreviation	Explanation
EA	Ellinogermaniki Agogi, Greece (coordinator)
UEDIN	The University Of Edinburgh, UK
OU	The Open University, UK
NCSR-D	National Center For Scientific Research "Demokritos", Greece
UoM	University of Malta, Malta
SGI	Serious Games Interactive, Denmark
BMUKK	Bundesministerium Für Unterricht, Kunst Und Kultur, Austria

B) Other abbreviations in alphabetical order

Abbreviation	Explanation
C²Learn	Acronym of the project (full title: Creative Emotional Reasoning Computational Tools Fostering Co-Creativity in Learning Processes)
DoW	Description of Work (Annex I of the Grant agreement no. 318480)
EC	European Commission
FP7	The Seventh Framework Programme for Research and Technological Development (2007-2013)
ICT	Information and Communications Technologies
M#	#th month of the project (M1=November 2012)
TEL	Technology-Enhanced Learning

Executive summary

This document offers the **final game design deliverable** of the C2Learn project. It builds on the method and game patterns identified in the first game design deliverable (D4.1.1) and fuses input from work on the C2Learn theory (WP2), learning design (WP2), C2Learn computational tools (WP3 and WP4) and the C2Learn pedagogical practice (WP5).

The document introduces the role of game and play activities within the C2Learn environment (identified as C2Space), describes the design process followed and concludes with the descriptions of a number of detailed **digital** game descriptions (4 game activities) and playful activities (2 play activities) and their links to the overarching C2Learn **gameful social environment** (C2Space). Both the C2Learn theory and pedagogical practice is realized through the palette of games and tools described herein. Furthermore, the available C2Learn technology is supported under each game and digital tool designed.

1 INTRODUCTION

This deliverable describes the design process followed for materializing the C2Learn **digital** *games* and C2Learn **digital** *play* activities within the overall C2Learn environment. Towards that endeavour we will base our designs on and use the interim deliverable entitled "Overview of the C2Learn Approach: cohesion and consistency in the project" named henceforth the **C2Learn integration deliverable**.

1.1 GAME DESIGN WITHIN THE DIGITAL C2SPACE

The digital C2Space as described in the *C2Learn Integration deliverable* contains a number of C2Learn aspects of playfulness framing game design within the C2Learn pedagogical practice and the learning design. This deliverable focuses solely on the **digitized** components of C2Learn playfulness (see Fig.1)

Summarizing the design decisions and contributions of this document with respect to the overall C2Learn structure (Fig. 1) we mainly focus on the C2Quest experiences and in particular on the C2Games experience - through a number of 4 dissimilar games designed for fostering human creativity based on different game design patterns (4Scribes, Constellations, Iconoscope and Alive Maps). In addition we put an emphasis on the C2Fun experiences by describing the design and use of two authoring tools (Creative Stories and C2Create) and we also touch upon the C2Assistants describing their role in the overall C2Space as they form a vital component of all C2Games designed.

Please note that the C2Explorations experience is loosely connected to digital spaces and mainly realized through the combination of C2Space, C2Quest and C2Assistant experiences and, thereby, not directly investigated in detail in this deliverable.

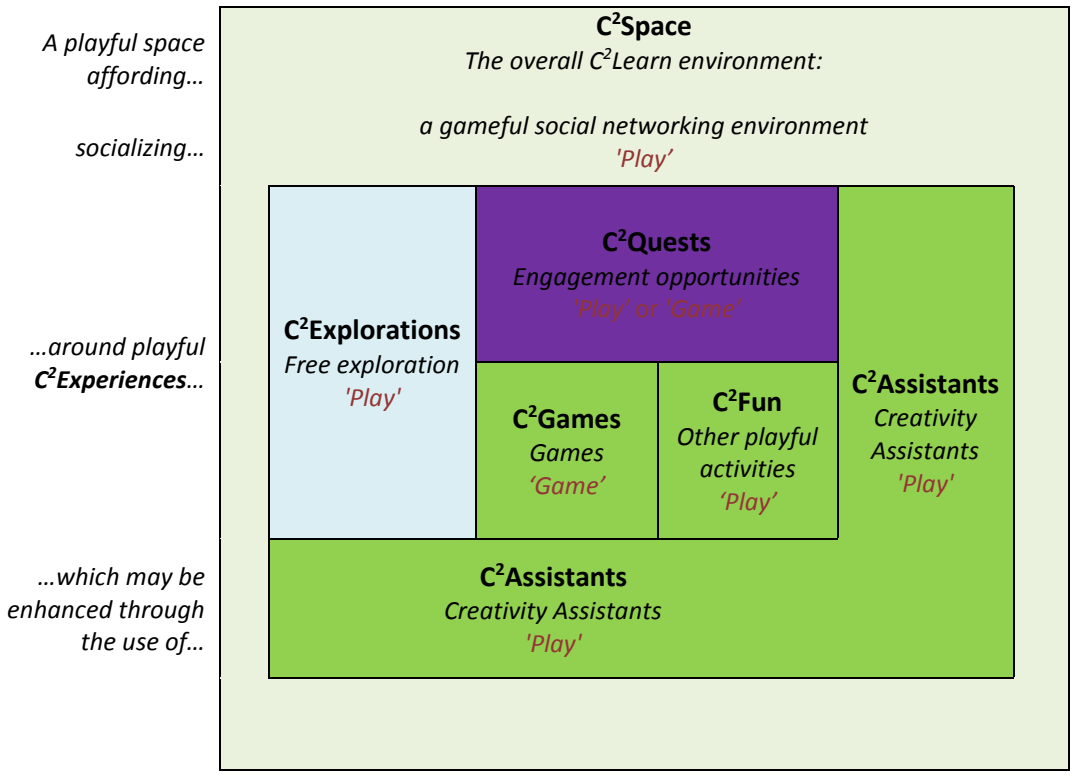

Figure 1 - The C2Learn approach viewed as a C2Space and its subcomponents as derived from the C2Learn Integration deliverable. This deliverable focuses on C2Space, C2Games, C2Fun and C2Assistants (indicated with green colour).

1.2 STRUCTURE OF THE DOCUMENT

Section 2 reviews the literature on games for creativity that inspired and initiated the game C2Learn game design process. Section 3 describes the general game design process principles followed in C2Learn using a game example as a guide for that process. Section 4 describes the general C2Space Environment, while section 5 describes the components that span across all C2Experience activities and how these components are created. Finally, sections 6, 7, 8 and 9 describe the four C2Game activities designed (4Scribes, Constellations, Alive Maps and Iconoscope, respectively). For each of the games presented in this document (Sections 6-9) the following information is provided:

- Game Design description.
- Further detailed descriptions guiding the implementation of the game.
- The game within pedagogical practice (pedagogical orchestrations in C2Learn practice) as described in the C2Learn Integration deliverable, Section 3.2.1.
- The game realized as a C2Experience with respect to the key elements of C2Learn pedagogical practice and learning design (as described in the C2Learn Integration deliverable, Section 4.5.1).
- The use of C2Learn computational tools from the game
- The gameful connection of the game in terms of feedback to players and the C2Space.

After all C2Games are described, Section 10 outlines the two supporting tools, or C2Fun activities, (C2Create and Creative Stories) by describing the applications and procedures of how players can create and modify the common elements of the C2Space. The deliverable's main conclusions are summarized in Section 11.

2 BACKGROUND: GAMES FOR CREATIVITY

In this section we discuss the multiple games that inspired the C2Experiences, described in Sections 5, 6, 7, 8 and 9 of this deliverable. The rationale for the choice of games, detailed descriptions of them, their genre types and their specific mapping to the C2Learn theory is provided in the revised (interim) D4.1.1 deliverable.

In the early stages of the game design process, a multitude of games and game patterns (Björk 2003) were analysed and explored on their effectiveness in fostering co-creativity (see deliverable D2.3.1) between the groups of players. Some particular games stood out, specifically games within the story-making and construction genre (see Table 1).

Game	Genre	Inspired Mechanics	Theory
Once Upon a Time (Atlas Games, 1994)	Story Making	- Players narrate story; - Secret Ending; - Cards as Stimuli; - Semantic Stimuli; - Disruption through player interruption.	- Co-Creative Thinking (A1 and A2); - Social Engagement.
Fiasco (Bully Pulpit Games, 2009)	Role-playing story making	- The Tilt disruption; - Players role-play one character; - Stochastic premise assignment (rolling dice).	- Co-Creative Thinking (A1 and A2); - Social Engagement.
Microscope (Lame Mage Productions, 2011)	Role-playing story making	- Top-down story-telling approach; - Flexible timeline; - Light & Dark tonality; - Story Palettes; - No Competitive Elements.	- Co-Creative Thinking (A1 and A2); - Social Engagement; - Wider Picture of Change.
Rory's Story Cubes (Rory O'Connor, 2005)	Story making	- Diagrammatic Stimuli; - Turn taking story narration.	- Co-Creative Thinking (A1 and A2); - Social Engagement.
Dixit (Libellud, 2009)	Mix between story-making, subterfuge and bluffing.	- Abstract diagrammatic stimuli with multiple interpretations; - The ambiguity scoring system.	- Co-Creative Thinking (A1 and A2); - Social Engagement.
Creatorverse (Linden Lab, 2012)	Construction	- Geometry based diagrammatic creation tool; - Shared Space for creations.	- Co-Creative Thinking (A1 and A2); - Social Engagement; - Wider Picture of Change.

Table 1 - Inspired Patterns of Creativity from Existing Games

3 DESIGN PROCESS

This section outlines the general game design process followed in C2Learn (section 3.1), describes iterative game design principles adopted in the project (section 3.2) and uses the design of the *4Scribes* game as a guide through the process.

3.1 ITERATIVE DESIGN PROCESS

The task of game design in the C2Learn project has been conducted in an iterative manner and in dialog with the multidisciplinary consortium of the project. *Iterative design* is a commonly used and recommended (see, e.g. Wenzler, 2009) development method. Prototypes constitute important thinking-tools for game development and game research alike (M. P. Eladhari & Ollila, 2012). Prototypes are generally first produced in paper format (i.e. paper prototypes) followed by software/digital prototypes in later iterations of the design. According to Salen and Zimmerman (2001) a prototype is "played, evaluated, adjusted and played again, allowing the designer or design team to base decisions on the successive iterations or versions of the game. Iterative design is a cyclic process that alternates between prototyping, play-testing, evaluation, and refinement."

3.2 ITERATIVE GAME DESIGN WORK IN C2LEARN

The iterative game design process in C2Learn was initiated by a two day long participatory game design workshop to which UoM invited representatives from the partners of C2Learn in February 2013 (M4). In the workshop it became clear that it was necessary to map out what constraints for the design would be most beneficial to use in the project with respect to how to realize different theories of co-creativity within the C2Learn pedagogical practice given the various technological innovations offered by the C2Learn computational tools within the available game development resources. The workshop was followed by a period consisting of mainly three activities: *mapping of game design patterns* (Björk, 2003) to theories of co-creativity developed in the project, *design prototyping*, *and devising of the possibility space of the design* (see Fig. 26 in the revised version of D4.1.1), which was presented to the partners. At the C2Learn summer school organized by EA the same year in Crete the designers were able to discuss the ideas of the different game design patterns for creativity with teachers. At the summer school in July 2013, EA further worked on types of game design scenarios for the game design. In September 2013, through a series of iterative design processes via dialogue with C2Learn partners, C2Learn theory concepts were mapped successfully to Game Design Patterns (see Table 1 in the revised version of D4.1.1). The patterns of *Storytelling*, *Combining*, and *Construction* were recognized as especially promising for the C2Learn aims. With these guidelines, along with preliminary specifications of classroom practice a new round of game prototyping commenced.

In addition to achieving the main goals of fostering co-creativity (as summarized in the C2Learn integration deliverable), the following specifications for games' use in classrooms were taken into account:

I. Games should be possible to be mapped to any curriculum content;
II. Games should be possible to be played within 45 minutes;
III. Games should be replayable and extendable;
IV. Games should appeal to players of age groups between 10 to 22 years, and
V. Games should be sufficiently simple for teachers to use as part of their pedagogical practice on co-creativity.

In addition, it was necessary to consider, that in order to foster a *living dialogic space* as described by Chappell and Craft (2011), it would be necessary to incorporate a *play* modality that allowed players to talk, and not be confined to their own screens in a computer lab. The modality of using tablets as target platform had proved useful in previous project SGI had partaken in, and hence, tablets were agreed upon by the partners as the target platform.

3.3 DESIGN PROCESS EXAMPLE: AN EARLY PROTOTYPE OF 4SCRIBES

The first design pattern approached was storytelling, in the form of adopting proven successful methods from analog story making games (as described in section 2.3.1 in the revised version of D4.1.1) in the prototypes constructed.

In the designs of the story making prototypes we used symbolic images such as in *Story Cubes* (Rory O'Connor, 2005), and we used a similar way of generating the initial setting for a game as in *Fiasco* (Bully Pulpit Games, 2009). Inspired by *Once Upon a Time* (Atlas Games, 2004) players have a "hand" of cards that they can use as their tokens in creating a story. We also make use of the notions of "light" and "dark" as used in *Microscope* (Lame Mage Productions, 2011) to add more dramatic tension as well as use the dynamic way a story is built on the playing surface/board.

We then devised a deck of cards as the play tokens. The deck was reiterated several times in order to present a balance of characters, events, objects, and actions that may be used across games. When creating the deck we took into account common game elements from games presented in section 2.1.3 in the revised D.4.1.1 along with inspiration from basic components from narrative theory, mostly from Propp's Morphology of the FolkTale (V. Propp, 1968), Cambell's The Hero with a Thousand Faces (J. Campbell, 1949), and Polti's 36 dramatic situations (G. Polti, 1917).

In the most promising paper prototype, 4Scribes, three to five players created a story collaboratively while **secretly steering** it towards their own personal secret ending. The winner was decided among through voting at the end of the game about which ending made most sense for the full story.

3.3.1 AD-HOC PLAYTEST

4Scribes underwent early "ad-hoc" tests (M. P. Eladhari & Ollila, 2012) in October and November 2013. These tests are typically the first to be conducted, ensuring that as much as possible gets 'right' before the work of piloting with end users and software prototyping is started.

Five play-test sessions were conducted with three to five players in each session. Of these, three sessions were conducted on Malta by UoM, and two in Greece by EA. The same procedure was followed in all tests, though small changes to the game rules as those were introduced between each of the sessions. In those cases where we had fewer than three play-testers, the designers stepped in as players. In total, the game was played by 10 players, 3 of which were female and 6 of which were Greek residents (the other 4 being residents of Malta). Their median age was 37.5. All participants except one had experience playing board games, and all participants had experience of playing digital games.

The objective of the play-tests performed was to assess the creative output of players using the Elements of the C2Space, in the form of a card deck.

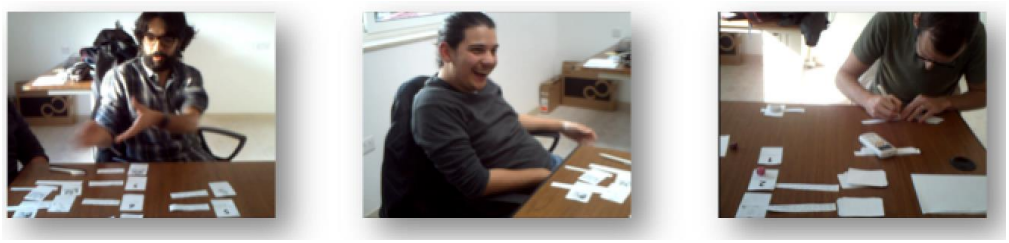

Figure 2 - Ad-hoc play-tests of a paper prototype of 4Scribes.

In the following section, this play test is presented in some detail, in order to illustrate the design process. The designs of the other games presented in this document have undergone similar procedures.

3.3.2 PLAYTEST PROCEDURE

Players were first briefly introduced to the key concepts of 4Scribes, explaining the concept of the premise, the elements of the game (as playing cards) and the objective of the game. Figure 2 shows players in the process of playing the prototype. Although not much time was spent on the explanation phase, as we believed that players would understand the concept more thoroughly while playing. During play we paid close attention to instances where players would have new ideas about improving the game itself, if players felt excited, confused or bored and instances where they would want to add their own creative input to the current game session.

Players were then asked to “think aloud” during the whole play test. Once the play session finished we allowed players to digest the events and discuss the game between themselves, for a few minutes. Following this the players were asked as a group questions about their experience playing the game, when they felt confused, what they disliked / liked most about the game, ideas for making it more interesting and finally to specify how much and what type of creative input they had while playing the game. Following this each player was given a survey with similar questions.

Given the limited number of players and the early stage of the design, the players’ responses can only be seen as illustrations and indications, but were generally of an encouraging nature, as shown in the following two quotes. The responses were given when asked about players giving creative input during the play test:

- "Absolutely. It felt impossible to me not to have considerable creative input, given that each "action" I made was literally crafted by me." – Player P.
- “Yes. Creative input was definitely present. Swaying of the story – feeling of build up with each card.” – Player D.

3.3.3 OBSERVATION REGARDING ABSTRACTION LEVEL OF ELEMENTS

In the play-test of 4Scribes conducted by UoM on Malta, we paid attention to those instances where players' creativity seemed hampered, in that they did not know what to do, or that the affordances given in at a particular time did not help them to come up with ideas on how to

progress the story. With regards to the cards (creative stimuli) given to players, we made observations that led us to change both (1) what mix of cards players got on their hand at the beginning of play, and (2) the deck of cards. (In the C2Space digital environment these game entities are called **Elements** rather than cards – see Section 4).

In the first play tests players were not given cards that were divided between a fixed number of character cards and event cards. In one session players had, collectively, more character cards than they had event cards, and in another, there were fewer figure cards. In the first instance, it became problematic to introduce too many characters to a story. The story seemed incoherent, and players hesitated. In the latter case, several stories were produced (as a result of an event card after an event card) but not focused on certain characters, which added a sense of abstraction in the play. In the later play tests, we gave each player a fixed (and more balanced) set of character and event cards. The result of that was that the storytelling process seemed to flow easier. A potentially interesting observation was that players tended to start the first round of cards by introducing their character card, and then tended to focus the stories on `their' character while driving the story to their pre-formulated, individual goal. This was not uniformly applied, but was still observed as a tendency. The nature of the play did not shift over to role playing in that players acted through the character when narrating, but there was a clear shift of focus. It seemed to help players with structuring to have both a secret ending to strive for and a character in the story advocating toward the formulated secret goal.

On several occasions players hesitated when they were to use numbered cards with only a single word in them, noting that it was too abstract to them. We also noted that the cards with images on them seem to sparkle more ideas, in comparison to those cards that did not have images on them. Players stated that they liked the myth cards better because they had illustrations.

For the character cards, the feedback from players was quite the opposite: they were too concrete. The first naming of the cards used the traditional card deck names for them, such as “King” and “Queen”. This was, in two sessions, interpreted in a literal fashion so that the settings became those of royal courts. Another observation was that all players did not take the colours (in later iterations these became elements – fire, wind, earth and water) into account – they were too busy understanding other, to their mind, more important rules. Only when they were in a creative rut was the colour taken into account. We saw this as an indication that the colours are useful as a creative input, but that their introduction can come later along the process of playing the game.

To us, it seemed as it was crucial for the play experience to have the elements used as external stimuli to be at the 'right' level of abstraction: concrete enough to give stimuli, but abstract enough to allow for the own creative input.

In order to find an appropriate level of abstraction we iteratively changed the elements in between play-test sessions as informed by our participants. The results of these iterations – and additional iterations while further developing the other games that are part of the C2Space – are visible in the section outlining the **Elements** used the C2Space.

3.3.4 OBSERVATION REGARDING ASPECTS OF COLLABORATIVE STORY CREATION

In the play-tests conducted by EA in Greece with teachers, special attention was paid to the narrative co-creative aspects of the prototype. It was observed that players gradually, along with playing, forgot the initial theme and setting of the game session. Instead, players got carried away and created stories that albeit interesting, sometimes were extravagant and with a low degree of coherence.

For the digital prototype we took these suggestions to heart, where the chosen premise is clearly visible at all times during play. Other observations from the EA team sparkled ideas on how to experiment with time-lines in the narration by using the visual space of how the elements are placed. Such observations were used in later prototypes, and are clearly visible in the game *Constellations* (see section 7). Another fruitful observation was in what manners it might be possible to use role-play and other perspectives within the 4Scribes game. This feedback was taken to heart in the design of the 4Scribes Role Playing variety (see section 6.4.4).

3.3.4.1 CURRENT AND FUTURE DESIGN PROCESS

The design presented in this document is expected to be adapted to what is best suited to the project, as informed by pilots with users and by internal paper and software prototyping of a similar nature as the example described above. As such, the design process does not end with the delivery of this document, but will evolve during the development and implementation tasks conducted by SGI. While some of the current designs may change during development, the main design principles will keep consistent with the end result, which is the creation of games that foster co-creativity.

Part of the task of designing a game is to be an advocate for the player (Fullerton, 2004). In the case of C2Learn it means that at any point, designers ask the design and themselves questions such as "*Will players enjoy this? Will they feel in control? Will this help them co-create and be creative?*" In effect, it means to ask the same questions as are asked of the players in the co-creativity assessment wheel presented in D5.3.1. Simultaneously, the future development of the computational tools needs to be taken into account in so that the design can adapt to potential new promising technologies further enhancing the capacity of the C2Learn **gameful social activities** to foster of co-creativity.

4 GAMEFUL SOCIAL ENVIRONMENT: C2SPACE

In the C2Space (See Fig. 1) players get feedback on their progress and game activities in three main ways. First, the C2Assistants give **presents** to the players when they do something that the C2assistant finds remarkable. The presents are in the form of quirky and amusing pictures that reflect the nature of the C2Assistants. Second, for progressing in the games in different ways, such as participating, winning or making something, players get **badges** reflecting their efforts. Finally, players' progress and achievements in terms of co-creativity are reflected by **awards** that teachers and students can give to each other, as a way of mediating the feedback in a systematic manner.

The approach of using the three different main feedback methods to players is grounded on the Learning Design deliverable (D.2.2.2) that addresses the widely theorized critique of gamification within game studies which argues against such game oriented strategies that provide primarily *extrinsic* reward motivators (Nicholson, 2012) which rely on operant conditioning (rewards, points, limited meaning). In addition, studies in the field of human creativity suggest that extrinsic motivators lower the potential for fostering creativity (Amabile, 1998a; 1998b) and co-creativity. Instead, by employing **gameful** design, C2Learn's

Learning Design aims to increase *intrinsic* motivation by paying careful attention to the match between task and learner and the careful construction of learning groups (Amabile, 1988a; 1988b).

4.1 PRESENTS FROM C2ASSISTANTS

The different C2Assistants (see Section 5) are anthropomorphized characters that get excited over the different computation (in-game) metrics that they can trace from the players' performance. They each "give" presents to players when a certain percentage of a max value if applicable is reached (i.e. a threshold value). If this happens, a sound is played (each C2 Assistant has their own sound). In the end screen of the game, or if that is not possible, a screen when coming 'back' to the C2Space displays an image with the present given from the C2Assistant. Each C2Assistant will have a library of images to give as presents and predetermined written dialog lines when they give them away. For example, the *Mad Scientist* C2Assistant (for the full description of the C2Assistants see Section 5) can give away telescopes, test tubes and other paraphernalia associated with science and exploration, and the *Wise Oracle* can give away marble statues, images of paintings, or book-tomes with classic titles. The presents are displayed in a designated space on the players' individual page, and are visible anyone who visits the page.

The presents from the C2Assistants span through all games of the C2Space – i.e. the same "pile" of presents are used in all C2Learn games.

4.2 BADGES FOR PLAYING

Players are awarded badges for participating in game sessions, for creating things while playing, and for winning games. They also get special badges for playing in certain ways, for example by making special combinations. Badges are not visible as "empty" containers to be completed. Instead, they are displayed in a player's individual space when they are earned.

The majority of the badges are specific to each game described in the corresponding game design documents (Sections 6-10). For example, the 4Scribes (Section 6) basic version can, among others, give the badge "Veteran Scribe" for the completion of five games of 4Scribes, and the badge "Narrative commission" for having played with at least five character elements created by other players. The badges appearing in Table 2 are those that will appear in the first iteration of the digital C2Space.

Badge Name	Accomplishment
Creative Force	Play at least one game of C2Experience.
Storyteller	Play at least one game of 4Scribes (Section 6) and Constellations (Section 7).
Engineer	Play at least one game of Alive Maps (Section 8) and Iconoscope (Section 9).
Junior Artisan	At least one creation has been used by another player.
Veteran Artisan	At least one creation has been used 5 times by other players.
Junior Elementalist	Customize at least one element.
Veteran Elementalist	Customize at least 10 elements.
Wizard	Customize at least 25 elements.

Table 2 - C2Space Badges

4.3 AWARDS FROM TEACHERS AND PEERS

Important **aspects of human co-creativity** are **not immediately traceable** by the digital environment and its applications, but are critical to include and represent in the C2Space through by mediating feedback to players from their teachers and peers. In the Learning Design deliverable (D2.2.2) *co-creativity is defined as novelty that has emerged through shaped ideas and actions and which involves players taking account of the impact of that novelty.* In order to encourage the core aspects of the learning design, teachers and learners can give each other awards of the three following types:

- Novelty (thinking or doing differently)
- Co-creative
- Considering impact

The awards will be represented in the players' individual space, along with badges awarded for play and presents from the C2Assistants. The facilitation of awards will be further specified in the scenarios in the context of designing pedagogical activity for the pilots.

4.4 DISPLAY OF PRESENTS, BADGES AND AWARDS

To facilitate a creative playful state we are working on the hypothesis that it is critical that the games in C2Space do not display evaluations in forms of *numbers* or other *signs* during the core episodes of play. The main reason is that these types of extrinsic rewards can be directly detrimental to creativity (Amabile, 1998a; 1998b). At the same time, playful designs showing progress in terms of *skill* and *development* (Hamari, 2014) are useful for encouraging desired behaviours and for guiding players in exploration of a game environment.

In the C2Space different symbols for achievement are, therefore, generally represented in the **social environment**, **rather than within the game** applications. Through this division in iterative design work our aim is to find a balance on how to encourage co-creation and achievement, but at the same time not "kill" the creativity by instrumentalizing it.

In addition to the representation of badges, presents from C2Assitants, and awards from teachers and peers, the individual page of a player will contain information about the players' name, their school, teacher, and the elements they have created for their individual deck of C2Elements, along with texts and images that are products of playing the games in the C2Space.

Figure 3 – A mockup of the C2Space Interface

4.5 ETHICS AND IMPACT AWARENESS IN C2SPACE

The C2Space and all C2Game and C2Fun activities collectively realise all five aspects of co-creativity C2Learn practice: **A. Co-creative Thinking [A1. Possibility Thinking - A2. Creative Emotional Reasoning, B. Social Engagement, C. Ethics and Impact Awareness, D. Wider Picture of Change** – see C2Learn integration deliverable. Details about how each activity realizes co-creativity aspects are provided in the description of each C2Game/C2Fun activity. It is worth noting that the impact of **Ethics and Impact awareness** will occur mostly within the C2Space environment and it is not directly associated to any of the C2Game/C2Fun activities designed. Due to this the sections mapping the games designed to **Ethics and Impact Awareness** were omitted in this game design deliverable **as they do not reflect the games** or the game design **directly.** Ethics and Impact Awareness is a concept that will occur **outside (and beyond) any digital gameful activity**, from a reflection upon the gameful activity itself.

5 GAMES AND PLAY: C2EXPERIENCES

Four games and **two applications** supporting co-creativity are specified in the remainder of this document. The games can be said to be either mostly supporting *diagrammatic reasoning* (Alive Maps and Iconoscope), or mostly *semantic reasoning* (4Scribes and Constellations), each of them using C2Learn computational tools intended for them. While the games for semantic reasoning are intended for medium to long-term play, the ones for diagrammatic reasoning can be played more quickly. All games and applications are **tied together** both by the **C2Assistants** (Section 5.1) who can assess and give feedback regarding the computational metrics used for creativity in C2Learn, and by the **Creative Elements** (Section 5.2) that function as creative seeds or triggers, but also themselves sometimes being products of co-creation (Section 5.3). Figure 4 illustrates how the different components are connected within the C2Space.

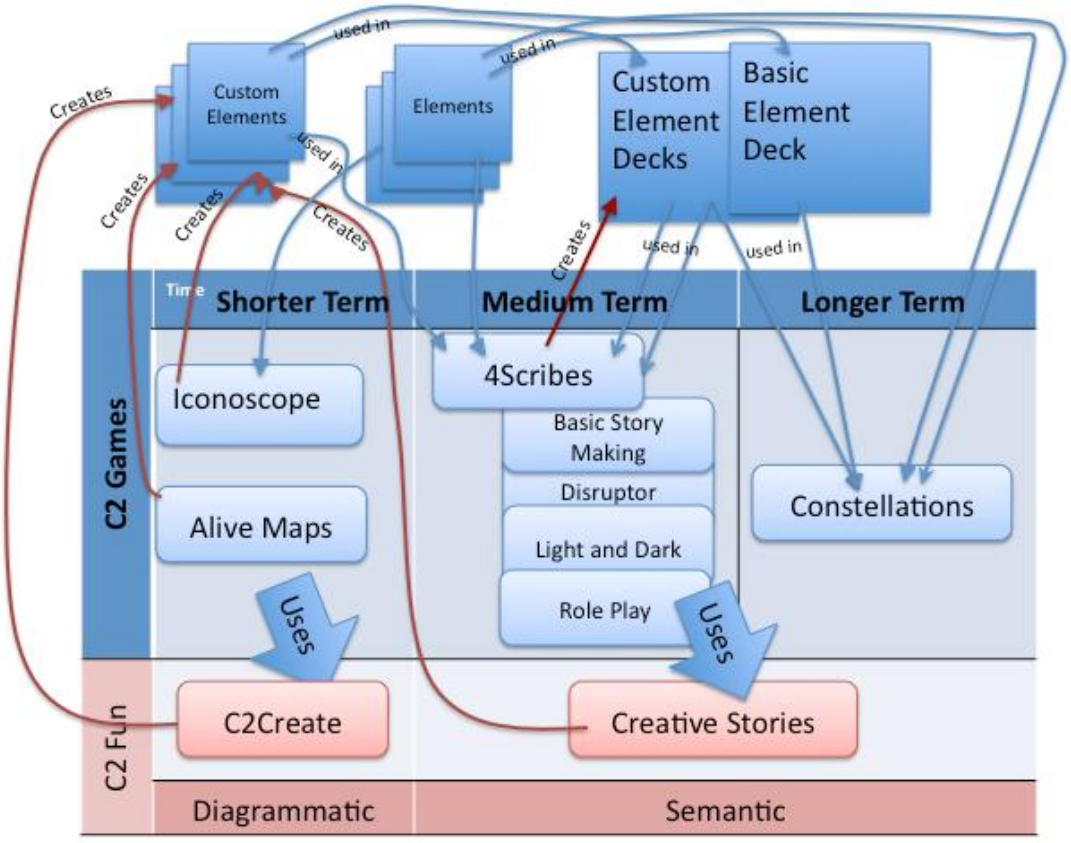

Figure 4 - Mapping of C2Games and C2Fun Experiences to the overall C2Space Environment

The C2Space is **unified by C2Assistants** (Section 5.1) and **Creativity Elements** (Section 5.2), which act as **overarching layers** amongst the games and playful activities. This remaining of this section describes the **common components and features** across all C2Learn activities: the C2Assistants, the Creativity Elements, and how elements and decks of elements are created and customized (Section 5.3).

5.1 C2ASSISTANTS

The foundations of the C2Learn project foresee that learners in their C2Game and C2Fun experiences learners will be interacting (directly or indirectly) with entities/agents/characters that have computational intelligence capacities which offer further opportunities for fostering human creativity via human-machine interaction – e.g. realizing mixed-initiative co-creativity (Yannakakis et al., 2014). These digital entities are termed 'Co-Creativity Assistants' or, C2Assistants throughout this document.

C2Assistants' key aim is to **gamify** the artificial intelligence technology available in C2Experiences and the C2Space by personifying the interaction among the game activities, the social environment and the computational tools. They are embedded both in C2Experiences and C2Space contributing to a unifying C2Learn experience across activities. These agents (1) facilitate learners to use creative thinking computational tools by proposing suggestions to problems, resources or practices to learners and (2) inform or alert learners to further engage in C2Experiences. As an **example** of a C2Assistant persona a *Mad Scientist*

character could be connected to the *novelty* notion and be the one that proposes the most diagrammatically-novel shapes in the Iconoscope game, suggests the most novel abstract artwork in the C2Create activity and forces students to maximize the (underlying) semantic novelty of their stories in Creativity Stories. A small number of C2Assistants with different properties and creativity priorities and scope will be designed to be of use to all activities of the C2Space. In Table 3 we provide the initial set of C2Assistant personas (as these are connected to various aspects of creativity during play) and their potential functionalities across game and play activities.

C2Assistant (Tentative Name and General Persona Properties)	Creativity Aspect(s)/Metrics Considered	C2Games and C2Fun Uses of the C2Assistant Persona
Mad Scientist **The Mad Scientist would be the assistant that always proposes artefacts that maximize the novelty value (or sets of novelty values) of the artefact.**	**Semantic Novelty** (of artefacts such as text and stories) [see definition of semantic novelty in D3.1.2 and alternative definitions such as surprise and impressiveness.] **Diagrammatic Novelty** (of artefacts such as diagrams, maps, or icons produced via MI-CC) [see definition of novelty in D4.3.x]	**4Scribes:** Influence the semantic novelty of elements by choosing to give the most novel elements of different types (depending on which variety of 4Scribes is played) from a C2Space sample. **Constellations:** Influence what elements are shown to learners. **Alive Maps**: Influence the novelty of diagrams, shapes or icons suggested. **Iconoscope**: Influence the novelty of diagrams, shapes or icons suggested. **C2Create:** Influence the diagrammatic novelty of items (diagrams/shapes) suggested based on all created items. **Creative Stories:** Usage of the thinking seed and word cloud tools with a high difficulty
Wise Oracle **The Wise Oracle shows learners earlier highly-valued artefacts (from students and/or the teacher) under a specific context (game and semantic context). Artefacts are evaluated via ranked/rated/like annotations.**	**Quality** (or **Value**) (of artefacts such as diagrams, maps, or icons produced via MI-CC) [see definition of quality in D4.3.x]	**4Scribes:** The Wise Oracle provide players with elements to build stories around that are the highest rated ones from a C2Space sample**.** **Constellations:** Influence what elements are suggested to Learners. Present popular texts from high valued constellations to learners as inspiration.

		Alive Maps: Influence the quality of content suggested by earlier annotations of the content (i.e. maps). **Iconoscope**: Influence the quality of content suggested by earlier annotations of the content (i.e. shapes and icons). **C2Create:** Influence the quality of content suggested by earlier annotations of the content (i.e. designed diagrams). **Creative Stories:** Use of teacher initiated input for obtaining thinking seeds and word clouds
Typical Tom **and** **Progressive Petra** **We see two key C2Assistants in relation to *semantic* typicality as *conservative* (Typical Tom) which proposes elements that maximizes typicality to a set of elements defined (which can vary) and *progressive* (Progressive Petra) which proposes elements that are atypical to the set of elements defined.** **We see two key C2Assistants in relation to *diagrammatic* typicality: a *conservative* (Typical Tom) C2Assistant which proposes maximally-typical suggestions to the learner and a *progressive* (Progressive Petra) C2Assistant which suggests maximally atypical content (maximum divergence from the typical set).**	**Typicality** (of artefacts such as diagrams, maps, or icons produced via MI-CC) [see definition in D4.3.x).	**4Scribes:** Influence the choice of elements provided to players in terms of typicality / atypicality, given provided sets of elements used in the different varieties of 4Scribes. **Constellations:** Influence the elements that are chosen each turn, in the same fashion as described above in 4Scribes. **Alive Maps**: (**In case a typical set is provided**) Influence the typicality / atypicality of content (i.e. map components) suggested compared to the typical set defined by the teacher under a particular theme and context. **Iconoscope**: (**In case a typical set is provided**) Influence the typicality / atypicality of content (i.e. shapes) suggested compared to the typical set defined by the teacher under a particular theme and context. **C2Create:** (**In case a typical set is provided**) Influence the typicality / atypicality of content (i.e. shapes) suggested compared to the typical set defined by the teacher under a particular theme and context.

		Creative Stories: Suggestion of thinking seeds and world clouds using words that are frequent / rare in the story written thus far (Typical Tom and Progressive Petra respectively).
Chaotic Kate ***Semantically* this C2Assistant will generate a random semantic word for the elements used within the session.** ***Diagrammatically* this C2Assistant offers either completely random diagrammatic suggestions or suggestions driven by particular aspects of diagrams, maps and icons such as e.g. balance and symmetry. These will be defined in each diagrammatic C2Fun and C2Game activity.**	**Other aspects / objectives** (randomness, balance, symmetry etc.)	**4Scribes:** Kate creates new elements for players that can be used in 4Scribes sessions, where which type of new element is created depend on which variety of 4Scribes that is played. **Constellations:** Create new elements that are presented on the learner's turn. **Alive Maps**: Random map suggestions or suggestions based on a set of properties of the map designed (e.g. balance, symmetry, shape behaviour, etc.). **Iconoscope**: Random icon suggestions or suggestions based on a set of properties of the icon designed (e.g. balance, symmetry etc.). **C2Create:** Random diagram suggestions or suggestions based on a set of properties of the diagram designed (e.g. balance, symmetry, etc.).

Table 3 – The five C2Assistant personas, their corresponding creativity aspects and metrics considered, and their use in each C2Game and C2Fun activity.

C2Assistants clearly define one of the **overarching** features of the C2Space. These entities exist in different forms in all C2Games and C2Fun activities. While their role will be described in detail in each 'play' and 'fun' activity of this deliverable, this section offers a holistic view of their potential as a **powerful gameful feature** in the C2Space. The following table summarizes the role of the C2Assistants in each C2Experience covered in this deliverable.

C2Experience	C2Assistants' Role
4Scribes (C2Game)	Pick the C2Assistant in the beginning. The C2Assistant will influence what elements and disruptor elements are generated

	or proposed. The *Mad Scientist* will propose elements that are the most novel from a sample of elements (either from a collection from the C2Space, or a user defined collection). The *Wise Oracle* will propose elements that are the highest rated from a sample of elements. The Typicality agents will suggest either typical (*Typical Tom*) or atypical (*Progressive Petra*) elements, which are compared between a set of elements from the C2Space, or the conjunction of the players own elements, and a "Comparison" deck given by the teacher/host. *Chaotic Kate* will suggest randomly created elements created on the fly for that specific session.
Constellations (C2Game)	A number of C2Assistants suggest what elements are shown to the learner during play, in a similar fashion as in the 4Scribes game above. The Wise Oracle C2Assistant may additionally present snippets of text to learners if desired, in order to spark additional inspiration.
Alive Maps (C2Game)	A number of C2Assistants suggests alternative maps and diagrams to each player. Each C2Assistant persona has different "interests" and perspectives with respect to the diagram. While one (*Mad Scientist*) focuses on the visual diagrammatic novelty of the icon with respect to a group of students or an archive that is stored for a particular concept another C2Assistant might suggest diagrams that have been previously ranked high in the C2Space (*Wise Oracle*) or other C2Assistants (*Typical Tom / Progressive Petra*) might suggest diagrams that are typical/atypical to the concept. Completely random or other objective-driven (e.g. map balance) proposals are suggests by another C2Assistant (Chaotic Kate).
Iconoscope (C2Game)	A number of C2Assistants suggests alternative diagrams to each player in a similar fashion as in the Alive Maps game above.
Creative Stories (C2Fun)	C2Assistants are used to regulate the way that the different forms of creative input are propagated to the learners. In accordance to their "personality", the different C2Assistants suggest harder or easier input to be used in the story crafted by the players.
C2Create (C2Fun)	C2Assistants are behind each suggestion that is proposed for the student to consider. Each assistant is mapped to different heuristics such as diagrammatic novelty, typicality, balance etc. described in the table above. The detailed description of the role of C2Assistants in C2Create and their underlying diagrammatic creativity metrics are covered in deliverables 4.3.x.

Table 4 – C2Assistants' Roles across all C2Game and C2Fun activities.

5.2 ELEMENTS

Creative Elements are C2Learn gaming artefacts that can be used in multiple games. The **basic Creative Elements Deck** consists of different elements representing characters, events, and other things. Each player can customize their own **personal deck of elements**, as well as create entirely new elements.

5.2.1 RATIONALE

Tokens in games symbolize different things. For example, Chess pieces represent the power structures of medieval times. Playing cards, with their four colours, have been given symbolic meanings dating back centuries, such as “hearts” for love and relations, and clubs for money.

The Creative Elements Deck can be compared to card decks. Playing cards and different decks of playing cards have through history been used as the common artefacts affording multiple games. For example the standard 52-Element deck (also known as the *French Deck*) is widely used in a variety of games such as the game of Poker, Blackjack, Bridge, and Hearts. Cards are also widely used to represent highly abstract concepts and provoke stimulus to the player, a good example is the game *Dixit*, where an image is open to hundreds of interpretations (as represented by its gameplay). *Once Upon A Time* uses semantic elements, in order to constrain and stimulate the player into advancing the story; the game also allows players to create their own elements, adding further variation to the game.

In the design of the Creative Elements we draw upon the classic nature of cards as a base for combinatorics, creating unity within the games in C2Space, and to it we add the creativity of players, providing means to be a co-creator of a nature of the game, by modifying existing and creating new basic elements to use within the games as described in Section 5.3. As such, players are given the agency to add their own individual meaning for further use and potentially transformation when they are used in new unexpected playful contexts.

5.2.2 ELEMENTS WITHIN THE C2LEARN PEDAGOGICAL PRACTICE

The Creative Elements of the C2Space environment [**B** - Social Engagement: Engaging in playful, game-like experience of the wider activity] are capable of providing:

- Playful experiences beyond the wider activity: Through the act of element creation, which are then used within multiple C²Experiences;
- Community evaluations and the creative trace of learner creations: Through the act of element sharing/displaying;
- Having learners feel that there are long-term consequences and challenges: Through the act of element progression / evolution.

Creative Elements is one of the multiple ways learners will be able to interact with the C²Space environment. Much like the popular card game *Magic: the Gathering* (Wizards of The Coast, 1993), learners will be able to build and customize their very own **Creative Elements Deck**, which can then be used in different games in C2Space. User created elements can be displayed and shared between players within their own “personal creative profile” in the C²Space environment [**C** – Ethics and Impact Awareness: Allowing players expressing and sharing their values].

Elements within a learner’s deck will also keep track of its history (e.g. display games where this element was used, how many times it was used in a game, how many times it was shared)

allowing players to keep track of previous events and reflect on them [**D** – Wider Picture of Change: Keeping track of previous activities for reflection].

Some elements (i.e. Character Elements) will also change depending on the number of times they are used within games, or gain colour alterations depending on the elements played during a particular game or even being affected by a random event, acting as a disruptor [**A2** – Creative Emotive Reasoning]. This may help learners think differently about their characters, as semantic adjectives describing their character might change and subsequently how they are used within the game, widening the gap of possibility thinking with "what if" questions [**A1** – Possibility Thinking].

5.2.3 BASIC ELEMENTS DECK

The Creative Elements deck consists of several *suits* (**Fire**, **Water**, **Wind**, and **Earth**) that are of three different *types*: **Character**, **Myth** and **Scene** elements. The Scene elements are of four types, loosely corresponding to their suits. The Fire Scene elements represent Emotions, The Water elements represent Actions, the Wind elements represent events, and the Earth elements represent Objects. Players can also make their own custom elements.

When using the elements in play, its suit can serve as a creative seed especially in the story-making games in the C2Space. Elements are not meant to be interpreted literally, but are an idea and an archetype that should spark the imagination of players; this is especially true for Myth elements.

5.2.3.1 ELEMENT TYPES

The **three** types of element (Myth, Character, Scene) across all suits are intended to provide a basic set of building blocks for a fictional or a symbolic world. In that world, the Scene elements provide events, actions, objects and emotions, Character elements provide the personage, and the Myth elements provide pivotal elements, which can make a big difference, or tilt something in a new direction.

The **Myth** elements are numbered and are not part of any of the suits.

The **Character** elements are **seven** within each of the five suits: the Baby, the Boy, the Girl, the Man, the Woman, the Elder Man, and the Elder Woman (of fire, water, wind or earth). Character elements have additional properties in comparison to the other elements, allowing for characters to evolve and accumulate history through use in the different activities in C2Space. Characters have a Suit, a name, a description adjective (e.g. Grumpy, Sad, Lonely), representation of the character, a background colour and pattern, as well as its individual statistics such as links to other characters, number of times used in a story, stories participated and other facts that may prove useful. The character can get assigned new adjectives both through character creation by players and through use in play in the 4Scribes *Disruptor* version. A character **can only have two adjectives** at any given time. If a character is assigned a third new adjective, the oldest adjective is removed from the element's representation, but is stored and displayed in the place where the characters' statistics are shown.

The **Scene** elements are **twelve** in each suit, with the numbering starting at 1. The Scene elements of Fire are Emotions, those of Water are Actions, those of Wind are Events, and

those of Earth are Objects. Additionally, players can create their own elements from scratch making up a **fifth element**.

Player-created elements are numbered in the order they are created. These are not part of the Basic deck except as blank elements. Figure 5 illustrates an artistic representation of three example elements.

Figure 5 – Artistic representation of example Elements. From left to right: Fire Scene, Water Character, Myth.

5.2.3.2 ELEMENT SUITS

The elements deck has **Five suits**: Water, Earth, Wind, Fire and the Fifth element. Each suit has a number of characters, and a number of Scenes. Each suit is numbered from 1 to 12.

Fire elements relate to emotions and relationships.

> They consist of emotions, such as love, hate, anger, joy, etc. Roles we assume and give others can lock us, or free us. Like fire, emotions can be sparked to provide warmth or if uncontrolled leave a trail of devastation.

Water elements relate to our inner worlds of thoughts, ideas and imagination.

> They consist of Ideologies, philosophical concepts, and ways of thought. They govern what actions we take. Like water, human minds can flow in different directions, and when working together can break the hardest of rocks.

Earth elements relate to the physical.

> They consist of physical items, objects, graspable materials. Most objects within everyday life come from the earth, allowing us to build tools which augment our power.

Wind elements relate to society, systems and communication:

> They consist of noise, dialog, communication, strategy and systems, such as economics or politics. We are affected by them, events happen to us. Like wind, humans provide sound and communicate to prove their existence.

The **Fifth** elements are user-created elements, and can as such be associated to a multitude of concepts.

5.2.3.3 LIST OF ELEMENTS IN THE "BASIC DECK"

Number	Fire	Water	Wind	Earth	Myth	Fifth Element	Numeral
1	Agony, Pain	Learn	Lies	Weapon	Birth		**I**
2	Anger	Craft, Make, Build	Miracle	Treasure	Magic		**II**
3	Confusion	Flee, Run	Performance	Vehicle	Rules		**III**
4	Shame, Guilt	Deal, Do Business	Sharing	Food, Drink	Lovers		**IV**
5	Sadness, Grief	Defend	Accusation	Book	Falling		**V**
6	Trust	Influence	Celebration	Symbol, Crest	Justice		**VI**
7	Obsession	Scheme, Plan	Disappearance	Companion, Pet	Isolation		**VII**
8	Happiness, Joy	Fight	Challenge	Tool	Luck		**VIII**
9	Pride	Travel	Grow Old, Decay	Talisman	Strength		**IX**
10	Fear, Terror	Help, Rescue	Prophesy	Instrument	Perspective Change		**X**
11	Certainty	Give	Quest, Receive	Map	Death		**XI**
12	Eureka!	Take	Metamorphosis	Plant, Flora	Cooperation		**XII**
13	Baby of Fire	Baby of Water	Baby of Wind	Baby of Earth	Darkness		**XIII**

14	Boy of Fire	Boy of Water	Boy of Wind	Boy of Earth	Rebuilding	**XIV**
15	Girl of Fire	Girl of Water	Girl of Wind	Girl of Earth	Light	**XV**
16	Man of Fire	Man of Water	Man of Wind	Man of Earth	Betrayal	**XVI**
17	Woman of Fire	Woman of Water	Woman of Wind	Woman of Earth	Success	**XVII**
18	Elder Man of Fire	Elder Man of Water	Elder Man of Wind	Elder Man of Earth	Judgement	**XVIII**
19	Elder Woman of Fire	Elder Woman of Water	Elder Woman of Wind	Elder Woman of Earth	Completion	**XIX**

Table 5 - List of Elements of the "Basic" Elements Deck

5.3 ELEMENT CREATION

One of the central features of the C2Space is the capacity of elements to be created by its users individually or as a group. As common elements across the C2Experiences have either a semantic dimension, or a diagrammatic dimension, or both, the creation phase of elements entails the process of utilizing the C2Learn computational tools for free-form of expression and creativity that can be shared in the C2Space. Element creation can be viewed as a **C2Fun** play activity which occurs prior or after the C2Game activity.

The obvious element creation phase we envisage for the C2Space involves the use of the C2Create (diagrammatic reasoning) tool coupled with semantic reasoning tools. Elements produced – having icon, imagistic and semantic tags/words (or word clouds) can be shared in the C2Space of each individual. The creations can be evaluated by students and teachers and rated across different aspects of creativity or given badges. Such elements have a direct use in 4Scribes and the Constellations games as described in the corresponding sections below). On the contrary the Alive Maps and the Iconoscope games incorporate element (diagram and icon, respectively) creation within their mechanics and no separate element creation phase is considered for these games. The table below provides the overview of element creation across all C2Games.

C2Game	Element Creation
4Scribes	Elements are created as a result of coupling the C2Create tool (diagram, icon or image) and the semantic reasoning tools (word, words clouds).

Constellations	Elements are created as a result of coupling the C2Create tool (diagram, icon or image) and the semantic reasoning tools (word, words clouds).
Alive Maps	Map creation is incorporated with the game. The final maps created within the game can used as the inconistic/diagrammatic aspect of an element. Their semantic theme/concept can also be used.
Iconoscope	Icon creation is incorporated within the game. The final icons created within the game with their corresponding semantic context can be used directly as an element within C2Space.

Table 6 - Overview of element creation across all C2Games

5.3.1 PROCEDURE OF ELEMENT CREATION

Students will be able to create their own versions of the elements through the following procedure:

1. **[Pick an Element]** Go to the element page in the C2Space and pick an element.

- If the player picks a character element, the procedure outlined in step 5 is followed. Else, she proceeds to step 2.
- The player can alternatively pick an empty card, to make a new element altogether. If so both steps 3A and 3B are followed.

2. **[Select what to change]** Choose whether to change the element's **image**, and/or its **text**.

3A. **[Change text]** If the student chooses to change the element's **text** a window opens that contains the following components:

- The image of the element (at a central position, that is, central form the point of view of the application, not that it is in the middle of the screen).
- A box for typing in one to three words (at a central position)[1].
- Words are suggested by the Thinking Seed Generator (at a central position). Players can tap these works to choose them for their elements. The words change if the player types a word of their own, or if they choose one of the suggested words. If a C2Assistant is active, it impacts which words are generated.
- Icons for the C2Assistants (at a peripheral position), that players may tap in order to change the active assistant, and thus, the nature of words suggested.
- A box for typing in a text (at a peripheral position). If tapped, the player can choose either a blank window of unassisted text writing, or the Creative Stories

[1] The box would allow a limited number of letters such as 300. This number will likely be changed in accordance with the results of future play tests.

application for writing text. Once the element is saved, this text is only visible if a player taps it and chooses to inspect it. A small text-symbol will indicate that the element has more text left.

- A button for saving the element (in a central position).

3B. **[Change image]** If the student chooses to change the **image** of the element, a window appears displaying the word of the element and the option to add an image via one of the following options:

- Make a new image using the C2Create tool, allowing the player to choose a co-creativity assistant (C2Assistant).
- Choose a map already made while playing the Alive Maps game [**note**: in the case of maps their corresponding theme can be borrowed to complete the text part of element].
- Choose an icon already made while playing the Iconoscope game [**note**: in the case of icons their corresponding semantic context can be borrowed to complete the text part of the element]
- Choose an image from a sample image library provided in C2Space.

4. **[Saving the Element]** in both phases of step 3, players may try different suggestions offered by the C2Assistants until they are content, or, alternatively, can choose to complete the element not using the suggestions given. Once they are done they need to tap the save button.

5. The student has chosen to **modify a Character Element**. A window opens allowing the player to:

- Chose and adverb from a predefined list (Grumpy, robotic, etc.).
- Give the character a name by typing in a text box ("Eric").
- Make a visual representation character by choosing from different combinatory options (similar to games where players create avatars or simulated characters).
- Write a short text about the character by typing in a text box. This is optional. The writing is unassisted. Once the element is saved, this text is only visible if a player taps it and chooses to inspect it. A small text-symbol will indicate that the element has more text left.

6. **[Placing the element in C2Space]** the students can inspect their element at their individual page where they are represented. The new element is added to the student's personal elements deck. In case there was already an existing customized card, this is moved to a page with archives.

DESIGN NOTE

For the image component we are considering to add functionality for students to add images of their own, such as photographs or drawings made in other applications. Future piloting may show if this a desirable feature, however, there is a general consensus that a predefined set of images and characters will be provided in order to be consistent with the overall C2Space aesthetics. That set will satisfy security constraints and guarantee content appropriateness.

5.3.2 CHARACTER AVATAR CREATOR

Character avatar creation will start by **picking the element the player wishes to modify**. The player will then be able to **customize the visual appearance of the character** through the character avatar creation tool.

The character avatar creation tool will allow learners to customize the avatar of their character cards. The tool will resemble a traditional character creation tool allowing learners to customize the look and style of their character representation from a set of clothing, hairstyles, faces, character shapes, skin tones, etc. Optimally the customizability options should allow for a large variety of avatar styles. The avatar styles themselves will have minimalistic approach making sure to avoid realistic representations.

5.3.3 SYSTEM CREATED ELEMENTS

Some C2Games will feature the C2Assistant Chaotic Kate, which will create random elements used by learners during the play session. C2Games taking advantage of this feature will be predominantly the semantic games.

5.3.3.1 GENERATING SCENE ELEMENTS

For these elements the system, with the aid of the semantic reasoning tools, will randomly choose a word and attach it to an already existing diagrammatic representation available in the default library C2Space Library.

5.3.3.2 GENERATING CHARACTER ELEMENTS

For these elements the system will randomly generate a character by randomizing the customization options of the character creation tool, and with the help of the semantic reasoning tools apply a name and the adjectives associated.

5.3.4 DECK CUSTOMIZATION

In order to facilitate card customization and card aggregation, teachers and learners will have the possibility of arranging elements into decks. Decks consist of a group of elements that are aggregated together into a collection, usable by the users in certain C2Games.

Decks can have customizable names referring to that specific collection of elements. We envision decks as an easy way for teachers to aggregate domain specific elements created by the learners (e.g. the teacher asks to create elements related to the Rainforest), or for learners to curate their elements as they wish.

DECK FEATURES

- Name Deck;
- Add Element to Deck;
- Remove Element from Deck;
- A Teacher will have the ability of combining learner created decks into a single one;
- Learners may view and comment on other learner decks.

6 C2GAME: 4SCRIBES

This section describes the 4Scribes story-making C2Game and its several varieties to be included in the C2Space.

6.1 GAME SUMMARY

4Scribes is a story making game for four players using **Elements.** The objective of the game is to collaboratively create a story, while each player tries to steer the narrative towards their individual (secret) ending. The premise of the story can be given by a teacher, decided by the players, or generated by computational tools. The winner is decided through the players, who each anonymously vote which ending was the "best".

6.2 4SCRIBES GAME DESIGN DESCRIPTION

Each player has their own tablet, with the current game board and their hand of elements and other tokens. Each tablet keeps track of the game asynchronously.

There is a basic, starter version of 4Scribes, and three varieties (*4Scribes Light and Dark, 4Scribes Disruptor and 4Scribes Role-Play*). The basic version should be played first in order to familiarize teachers and students with how the game is played. In the following, the basic version is described, followed by descriptions of the varieties and how they differ from the basic version.

6.2.1 BASIC DIGITAL VERSION (4 TABLETS AND 4 PLAYERS)

The basic digital version introduces teachers and students to how 4Scribes is played. As such it has a small number of possibilities in comparison to the varieties of the game.

6.2.1.1 SETUP GAME SESSION

At the start of the game a **premise is chosen**, either by the teacher or the players (see Fig 6). The premise will define the setting and theme of the gaming session. Additionally, players may individually choose one of the C2Assistants by tapping on the icons representing them (see Fig. 7). The choice will determine what type of elements a player gets in their hand.

```
You will together tell a story about [theme] [setting].
You will together tell a story about Equality in Space.
```

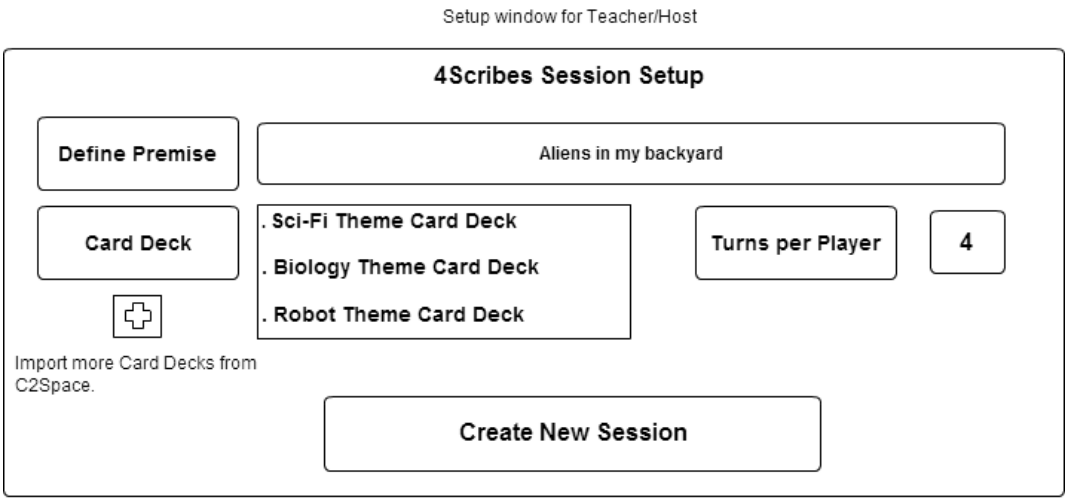

Figure 6 - 4Scribes Basic Teacher/Host Setup

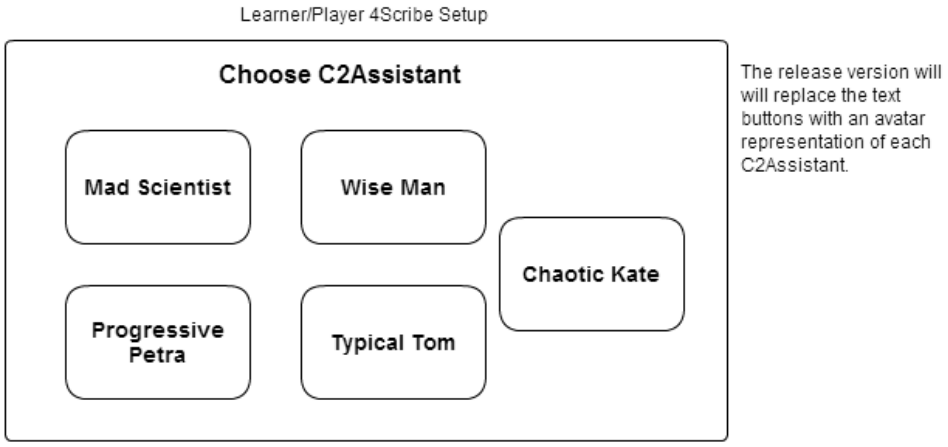

Figure 7 - 4Scribes Basic Player/Learner Setup

When the premise and C2Assistant are chosen, **each player receives a pre-defined number of elements**, which they can play in the game. One element is a Myth. The player is prompted to write a secret ending in accordance with the Myth (see lower part of Fig. 8).

> `Write your secret version of how the story about` **`[theme] [setting]`** `ends: with` **`[NameofMythCard]`**`!`
> `Write your secret version of how the story about` **`Equality`** `in` **`Space`** `ends: with` **`Justice`**`!`

The gameplay is turn-based. **Players progress the story** on their turn **using an element** from their hand, **voicing the progression of the story** to the other players. Once done, they

summarize it in a short text limited to 120 characters) as illustrated in the upper part of Fig. 8. Between each turn, the starting order of players is reshuffled.[2]

> **[PlayerName],** it is your turn! Pick an element from your hand, and tell what happens next! Remember that your story ends with **[NameOfMythCard].** When you are done, type a sentence or two summarizing it here: **[Textbox]**

During play players drag an element from their hand and drag it into the game board, which locks the card and place and prompts the tablet keyboard, allowing players to type in the story progression.

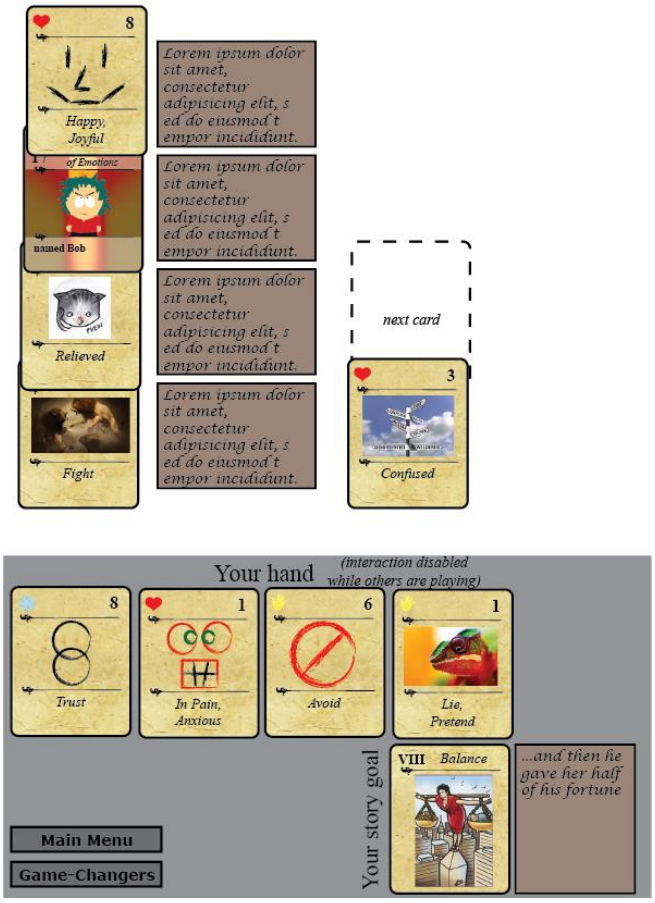

Figure 8 - Prototype mock-up of user interface for the base version of 4Scribes.

Once each player has no more elements in their hand (with the exception of the hidden Myth) the storytelling phase is over. One by one **each player will reveal their secret ending and myth**. Once all endings are revealed, **players anonymously vote for the best ending** (players may not vote on their own ending) by tapping on the card representing it. **The player with the most votes wins the game**.

[2] Playtests showed that if the same turn order between players is maintained, the player who starts and respectively ends the turns gets unfair advantages.

[PlayerName], your team members have granted you victory! The story about **[theme] [setting]** ended with **[NameofMythCard]**!

6.2.2 4SCRIBES LIGHT AND DARK VARIETY (4 PLAYERS AND 4 TABLETS)

The *Light and Dark* variety is a variation on the 4Scribes game, where learner created endings are randomly attributed a dark or light modifier. This gives the players goals in different directions, and often results in more dynamic play, because of the conflicting goals.[3]

Dark and Light endings refer to the tone the learner should take into consideration when writing their secret ending. **Dark** refers to dark themed endings, **working against the ideals of the premise**. **Light** refers to lighter themed endings, **working towards the ideals of the premise**.

6.2.2.1 HOW IT IS PLAYED

Light and Dark modifiers are picked at the beginning of the game. In each game there must always be at least **one person who has a Dark modifier** and **one person who has a Light modifier**, **the rest of the players are dealt the Light/Dark modifiers**.

Write your secret version of how the story about **[theme] [setting]** ends: with **[NameofMythCard]**!

You have a **DARK** card. Work against any ideals of **[theme]**!
OR
You have *LIGHT* card. Work towards any ideals of **[theme]**!

Dark players will try and steer the story against the premises ideals, while Light players will try and accomplish them. Light/Dark card players at the beginning of the game choose to either play as a Dark player or a Light player (e.g. *"[Dark] …and the entire village burned!"; "[Light] …and civilization flourished and years of peace and prosperity were achieved!"*).

Players never show which side they are on when playing the game. The Light and Dark modifier is only revealed at the end of the game.

6.2.3 4SCRIBES DISRUPTOR VARIETY (4 PLAYERS AND 4 TABLETS)

The *Disruptor* Variety is a variation of how adjectives are attributed to other characters during gameplay. In this version of the game, players will have the ability of playing **adjective tokens** on recently played characters from other players.

Adjective tokens are word modifiers that affect a character and must be integrated in the story by the player. Example of adjective tokens include: Grumpy, Evil, Robotic, Joyful, Sad, etc.

[3] Play tests showed that if all players in a group strived to Equality, and noone towards Non-Equality the experience, the play was perceived as to easy and less exciting. This was especially true for players that had already played the game once or twice.

A small number (3) of adjective tokens are given to each player in the beginning of the game. The active C2Assistant will determine the range of adjectives that are given.

6.2.3.1 HOW IT IS PLAYED

Adjective tokens can be played as soon as the turn-taker plays a character. Only the player who is next in turn can put down an adjective token on the turn-taker's character.

Example:

> *It's John's turn. He decides to play a character called "Knight" and lays it on the table.*
>
> *Robert wants to use his adjective token "Grumpy" on John's Knight. However, Robert was the last to play, so he is unable to play his adjective token.*
>
> *Julia's turn is up next, so she can play an adjective token. She could abstain, but decides to play the "Frightened" token on John's Knight, transforming the character into a "Frightened Knight".*
>
> *(Everyone on the table laughs, but John grimaces) "Okay so, Lancelot is actually a well renowned knight! But he has a dark secret, he is actually a really big coward, who lets others do the fighting for him…." – John telling the continuation of the story.*

6.2.3.2 REPRESENTATION IN GAME (UI)

Adjective Tokens are displayed graphically in a similar manner as Fridge Magnets. The players' adverbs are displayed prominently in proximity to the elements a player has in their 'hand'. **In order to play an adjective token, the player marks it, and drags it to the character card** it is to be associated with, placing it on top of it. The **name of the Element character changes when this procedure is completed** according to the following:

> "**[CharacterName]**, the **[Adverb]** *[CharacterElementName]*".
> Ex: **Eric**, the **Robotic** *Young Man of Fire*.

6.2.3.3 LIST OF ADVERBS

In this section we present a small sample of adverbs usable in this variety. Adverbs related to characters' age are omitted since they are represented in the element (for example, the *boy* of Fire).

> Frightened, sentimental, grumpy, brave, cowardly, beautiful, tragic, misanthropic, foul, evil, naked, kind, compassionate, robotic, tiny, huge, confused, sick, happy, ignorant, expert, handy, clumsy, bullied, cruel, orderly, sloppy, dog-like, cat-like, frozen, passionate, caring, violent.

List of adverbs is subject to change informed by piloting.

6.2.4 4SCRIBES ROLE-PLAY VARIETY

In the Role-play Variety of 4Scribes (4Scribes-RP), **players take on roles of character elements** that they either have designed themselves or are given to them. When playing 4Scribes-RP, **each player starts the round by introducing their character to the story**, characters are

revealed on each players turn. Then, **throughout the play, they tell the stories in the role of their character**, adopting the perspective of their character. Players can, in addition to **writing what their characters narrate**, **specify how it is narrated by choosing from sets of textual expressive options**.

Players can, of their own volition, or advised by the teacher, create a new personal character element prior to play, by accessing the Character Element creator. Then, at the beginning of play, players choose the character they want to play with by choosing it from their inventory.

6.2.4.1 SETUP GAME SESSION

Once the premise is set, the decks specified and the C2assistants chosen, players are presented with a window showing their own personalized character elements. A tab on the window for viewing character elements is presented to the learners. Characters are displayed in relation to the decks they belong to. The decks displayed are the ones specified by the host/teacher. Players choose what character to play by tapping on the element.

"[PlayerName], choose who you are when you tell the story about **[theme] [setting]**!"

6.2.4.2 TEXT INPUT IN 4SCRIBES-RP

The text fragments written by the different players are formatted in the interface so that is clear both during the playing and once the story is finished that when the players write they do it as characters rather than as all knowing narrators. The general convention of signalling dialog is used, so that each player's text fragment is preceded by ["Name of Character Card"].

During play, each player's textbox has the additional text displayed in a prominent position ["Name of Character Card" says [expressive]:].

The work "says" is clickable, and if clicked a dropdown list of different synonyms for 'saying' are displayed. The [adverb] is a small button displayed in a discreet manner. If clicked a drop down list of ways something can be said is displayed.

By default, if the player does not click either option, their text will be displayed as:

Name says: Text
Example: Eric says: I wanted the ring of happiness for myself, but when I saw my sister took it, I didn't have the heart to deny her. I held my tongue.

The first time a player makes an input the card type is also displayed:

Name (type of card) says: Text
Example: Eric, (a young man of emotion) says: I am the younger brother of five sisters, who all loved me dearly. I grew up believing the world was made just for me. What an awakening I was to have!

If a player activates the [says] and the [expression] options the text is truncated with the chosen options. Players can choose none, or one, or two of them. Choosing two options would be displayed as follows.

```
Name [way of saying] [manner of saying]: Text
Example: Eric mumbles dejectedly: I had misunderstood so much.
I saw the ring, and it seemed the only way for me to redeem
myself. I had to have it.
```

A number of words adapted to the tablet interface, is displayed in the user interface, selected from the words listed in the table below (Table 9). The words may be subject to change in accordance with results of piloting.

Way of Saying	Manner of Saying
Narrates; Tells; Declares; Shouts; Screams; States; Remarks; Pipes up; Mumbles; Whispers; Murmurs; Stammers; Utters; Grumbles; Rumbles; Whimpers; Whines; Mutters; Babbles; Blurts; Cackles; Blubbers; Chatters; Gushes; Prattles; Rants; Raves; Spills the beans; Squeals; Exclaims; Proclaims; Bellows; Cries; Hollers; Roars; Announces; Shrieks;	Exuberantly; Dejectedly; Quietly; Defensively; Menacingly; Nervously; Knowingly; Nicely; Obnoxiously; Recklessly; Bitterly; Wickedly; Aggressively; Questioningly; Boastfully; Emotionally; Eagerly; Hastily; Hysterically; Impatiently; Jealously; Optimistically; Cheerfully; Anxiously; Calmly; Defiantly; Frantically; Persuasively; Reluctantly; Sentimentally; Shyly; Rashly; Viciously; Zealously; Victoriously; Reassuringly; Resentfully;

Table 7 – Way and manner of saying options in 4Scribes-RP

6.2.5 4SCRIBES PRINTABLES

4Scribes Printables is a boardgame version of 4Scribes, **implementing the majority of the gameplay mechanics of the tablet version to a physical card game**. In order to play this version, **learners may select a deck of elements (which will be used for play) which can then be printed** and used beyond the digital environment. **A .pdf version of a deck of elements are provided through the C2Space** in order for learners to specifically select which elements they which to play with (or with what decks).

Printables is designed to be played beyond the confinements of the classroom and for learners who wish to play 4Scribes with friends who do not own a tablet surface outside of the classroom.

In order to play the Printables version learners will require the following:

- At least one complete element deck (more cards can then be added);
- A pen for each player;
- Strips of paper to write on;
- Two six-sided dice.
- Rule-book (part of the PDF with the elements deck).

Optional

- Custom made dice for premise selection.

6.2.5.1 SETUP GAME SESSION

Printables is played in the same fashion as the digital version with some minor differences.

1. Select a premise using 2 dice (e.g. Fig. 9) or mutual decision.
2. Divide the deck in the following fashion: Scene Elements, Character Elements and Myth Elements.

3. Give 1 Myth to each player (*This is the secret Myth*):
    a. Each player writes a secret ending, which is their secret goal.

Distribute 2 scene, 1 myth and 1 character elements to each player (don't forget to shuffle each of the 3 individual decks!).

Start Game!

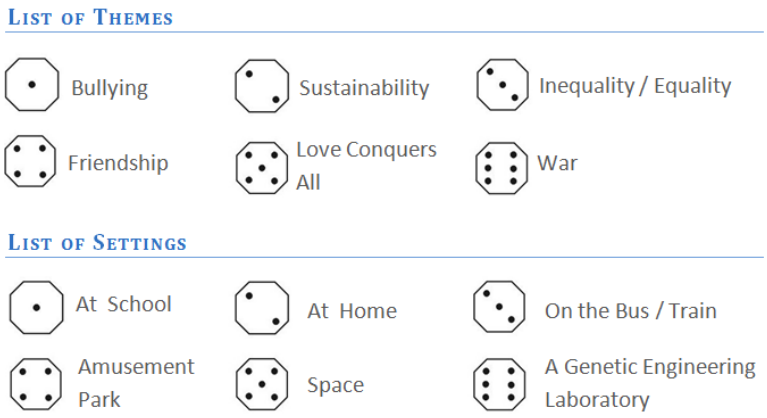

Figure 9 - Random Premise Selection for 4Scribes Printables

6.2.5.2 HOW IS IT PLAYED

Players take turns, clockwise, to continue **telling the story based on the elements** they have in their hand. **Each time a player plays an element** he/she must **write no more than a sentence on the strip of paper** and play it beside the card. This sentence must be the continuation of the narrative based on the player's card.

The last turn is the secret Myth revelations, where **each player reveals their intended endings**. The **most popular ending between the players is declared the winner**. If no ending can be decided "diplomatically" then players are required to vote. Each player must vote on one ending. They cannot however, vote blank or on their own ending. If a stalemate occurs, then the players who tied must both pick a new card from the deck and continue playing, until the other players decide who the winner is.

6.3 4SCRIBES WITHIN THE C2LEARN PRACTICE

The following table provides descriptions of learner and teacher practice falling under each of the five elements of creativity for the 4Scribes game. The 4Scribes game facilitates multiple aspects of: possibility thinking, CER, social engagement, and wider picture of change. The 4Scribes game can be viewed as a **medium-term** and **more structured** C2Game activity within the possible time frames of pedagogical orchestrations in C2Learn practice (C2Learn Integration deliverable, section 3.2.1).

The Learners	**The Teachers**
A1 Possibility Thinking • Think about possibilities rather than approach learning as solely acquisition of factual knowledge.	• Provides challenges provoking learners to get involved in possibility thinking.

○ Elements in hand stimulate learners to *think differently*. ○ Players themselves may act as both of consumer and instigator of problem-solving. • Story premises are flexible allowing for "What If" scenarios; ○ Experimentation with different pluralities of places, activities and characters ○ Learners take control of multiple personalities and characters within the story creation process ("As If"); • Exploring and co-creating stories. • Players collaborate and co-operate in the creation of a story;	• Encourages and facilitates learners to pose problems to others; • Replayability of premises allows for the creation of "What If" scenarios, by customizing the premise as a "What If" question and the elements used during play. • May create and devise learner activities through the creation of a premise and elements that can explore multiple pluralities, such as places, activities, people and encouraging story exploration.
A2 CER • Reframing of problems, dilemmas, issues and come up with new responses to given situations. • Learner induced disruption through previous turns and plays (the competitive element). • Random disruptors that forces learners to reframe their play. • Actively experiment with re-combining elements of creative challenge. • Facilitates the shift of perspective, allowing learners to go beyond the material provided by description of the elements and the premise.	[as in A1 above] • May intervene in order to trigger learners' new responses. • Facilitates brainstorming tasks.
B Social Engagement • Co-Creation within a group. • Learners engage in dialog through the act of storytelling: ○ Pose Questions ○ Debate Ideas ○ Promotes dialogue and encourages peers to voice their ideas ○ Actively generates conflict and forces learners to seek different paths • Learners negotiate and promote their ending in the end-game. • Turn-based gameplay allows each learner to take control of a story, leading the creative effort during that point: ○ Take charge and leads on their turn ○ Each learner has a turn, sharing the control and	• Assigns/Facilitates: ○ The creation/management of the learner groups for play ○ collaborative learner work ○ whole class work • Acts as a facilitator and arbiter of the game, and agrees the rules with learners. • Enables and facilitates learner dialogue: ○ Through the customization of interesting premises; ○ Through the customization of session specific elements; ○ Allowing learners express different viewpoints. • Encourages all learners to express their opinion and critique during game. • Intermediary between conflict when occurred: ○ Allows turn taker to express his action to others. • Manage and verify if all learners are taking individual initiative during their turn. • Withdraws from the stage as much as possible, becoming an observer and facilitator of play.

leadership equally (flattened hierarchies) ○ Decisions have consequences to the story and characters ○ Instigates Action • Created stories are presented to the wider C2Space, motivating learners to be creative and have their work appreciated and valued by others. • Engage in playful actions with others: ○ Allowing learners to immerse themselves in the premise and story ○ Are willing to take risks and leave their "comfort zone" ○ Learning about co-creation with other learners both during the play session and the wider reflective phase.	• Allows space for learners to take risks outside their "comfort zone"
D Wider Picture of Change • Created stories are stored within the C2Space, allowing learners to reflect on created stories. • Characters keep track of other character relations and their story history.	• Facilitates the learners to set goals aspiring and enacting creative change.

Table 8 - Framing of 4Scribes with C2Learn Practice

6.4 4SCRIBES WITHIN THE PLAYFUL C2LEARN PEDAGOGICAL PRACTICE

The following table provides insight into how 4Scribes links to the C2Space properties and is realized as a C2Experience with respect to the key elements of C2Learn pedagogical practice and learning design.

4Scribes within C2Space	4Scribes as a C2Experience
A1 Possibility Thinking • Provides learners with a digital space motivating them to think differently through gameful elements: ○ Navigating through previous challenges; ○ View how own created characters and elements affect other learner stories. • Keeping track of the Possibility Thinking activities: ○ Motivating learners to think differently through the reflection of previously created stories. ○ View and critique of own and other learner created content.	• Facilitates learners to get involved in the playful exploration activity and facilitates the co-creation process of session: ○ Teacher may provide "What If" premises and "As If" environments; ○ Requires learners to explore and engage in the co-creation process (designing, editing and extending); ○ Enhances the application of CER non-linear thinking techniques (see below).

A2 CER [as in A1 above] • Designing more interesting and original elements and characters, for disruption in-game sessions.	[as in A1 above] • Includes elements disrupting learners' established routines and patterns: ○ Disruption elements and player induced disruptions (without teacher intervention). • Playfully realize brainstorming tasks.
B Social Engagement • Teacher's management of individual, group, whole class learner activity. • Teacher decision on learner grouping. • Provides access, organization and overview of the learner content for both learners and teachers. • Open critique, debate and evaluation between learners on created in-class stories and content. • Learners taking lead in the dialogue process and the reflection of content created. • Attach and host dialogue and evaluation to specific stories and content. • Keeping track of learner turns and decisions during the story creation session, for later reflection and discussion. • Motivates learners to engage and create novel content in the story making sessions, through gameful experience. • Provides learners with feedback and discussion about their creative activity.	• Afford collaborative and communal activity, which is realized within the group and placed within the wider community. • Premises and custom endings motivate learners to debate and solve their personal challenges within the game session. • Each turn a learner is encouraged to express their story and change perspective due to previous player disruptions. • Enables the expression and management of conflict in a "contained" safe manner. • Leadership consistently changes, allowing learners to take control. • Involves the exploration of new ideas, with story consequences. • Moments of decision making. • Allows learners to agree/disagree/challenge with each other in order to gain feedback during play. • Allows experimentation with pluralities.
D Wider Picture of Change • Allows learners to obtain badges and rewards, through their activity.	

Table 9 - Framing 4Scribes within the Playful C2Learn Pedagogical Practice

6.5 C2ASSISTANTS IN 4SCRIBES

At the start of the session the teacher (or learner) will define which **C2Assistant will act as the "Elementalist"**, which basically **consists of distributing the elements which will go in players hand for that session**. C2Assistants will **select the elements from a substantial sample of elements within the C2Space**. Each player element hand will still consist of 2 Scene Elements, 1 Character Element, 1 Myth and 1 Secret Myth, although they will be picked by the chosen C2Assistant.

For the Disruptor version C2Assistants will also distribute the adjective tokens learners will be able to use on other player characters during the game. C2Assistants will select the

adjectives from a substantial sample of character elements within the C2Space. The system may **collate adjectives that exist as part of characters elements in the whole C2Space, or relevant subspaces depending on local network and database topography**.

In the **Role-Play version the C2Assistants will assign which characters each learner will play**. Teachers may turn off the usage of assistants for the setup phase. C2Assistants will select character elements from a sample obtained from the C2Space. Typicality of characters can be measured based on their diagrammatic representation and the adjectives associated to the characters.

The table below summarizes how the C2Assistants will function within the 4Scribes game versions.

	Mad Scientist	Wise Oracle	Typical Tom	Progressive Petra	Chaotic Kate
Standard and Light and Dark	Most Novel Elements from C2Space sample.	Highest Rated Elements from C2Space sample.	The Typicality of Elements between a set of C2Space Elements and Teacher defined set of Elements.	The Atypicality of Elements between a set of C2Space Elements and Teacher defined set of Elements.	Generate new random Elements.
Disruptor	Most Novel Adjectives from C2Space sample.	Highest rated adjectives from C2Space sample.	The Typicality of adjectives between a set of C2Space adjectives and Teacher defined set of adjectives.	The Atypicality of adjectives between a set of C2Space adjectives and Teacher defined set of adjectives.	Generate new random adjectives.
Role-Play	Most Novel Character (avatar + adjectives) from C2Space sample.	Highest Rated Character (avatar + adjectives) from C2Space sample.	Typicality of characters (avatar + adjectives) between a set of C2Space characters and Teacher defined set of characters.	Atypicality of characters (avatar + adjectives) between a set of C2Space characters and Teacher defined set of characters.	Generate new random characters.

Table 10 - Description of C2Assistant Actions within 4Scribes

6.6 USE OF COMPUTATIONAL TOOLS

4Scribes relies on the use of semantic tools as indicated in Table 11, when teachers set up game sessions of the system (see D3.1.2).

C2Game: 4Scribes			
C2Learn Tool/Service Type		**Computational Tool**	**Use (*) / Potential Use (o)**
		Thinking Seeds Generator	*

Semantic Reasoning Computational Tools	Tools fostering Idea Conception	Web Miner	O
		Cloud of Thoughts	O
		Competitive Thinking Spaces	
	Tools assessing Dimensions / Aspects of Creativity	Novelty Computation	*
		Surprise Computation	*
		Impressiveness Computation	*
		Creativity Points Computation (Text-on-Text)	*
	Supporting Tools	Search Engine Wrapper	
		Text Clustering	
Diagrammatic Reasoning Tools	Tools fostering Idea Conception	New Graph Retrieval	
	Tools assessing Dimensions / Aspects of Creativity	Novelty Computation	
		Typicality Computation	
	Supporting Tools	Mind Mapping Server	
Mixed Initiative Co-Creation		Mixed-initiative Procedural Content Generation (C2Create variants)	
Profiling		User Profiler	*

Table 11 - Applicable tools for 4Scribes4

The hand of elements presented to the learner in the beginning of the game are picked from an element pool of the conjunction of all of the elements that were created by learners within the C2Space or a pool of elements specifically set up by the teacher (usually domain specific). Elements are chosen either based on their semantic **Novelty** (Mad Scientist), **Value** (Wise Oracle), **Typicality** (Typical Tom/Progressive Petra) or **Randomness** (Chaotic Kate).

Novelty will be measured as the semantic novelty (D3.2.1) of an element in contrast to the elements a significant C2Space element sample. Value will be measured with the help of the C2Space through a crowd-sourcing methodology, where element assets with higher social ranking have higher value. Typicality assistants will require further information, such as a

predefined set of elements set by the teacher for the game or the default element set (without any learner customization – see Fig. 10). Typicality will be measured by comparing elements from a set of playing elements (i.e. the learner's own decks or a large sample of C2Space elements) and a teacher defined element set. A typical or an atypical element will be the semantic distance of an element from the playing set compared to the teacher defined set. Play towards typicality would increase the potential coherence of a narrative as a result of the play. Randomness will consist of creating a brand new element (non-existent in the pool of elements) in the hopes of creating learner disruption.

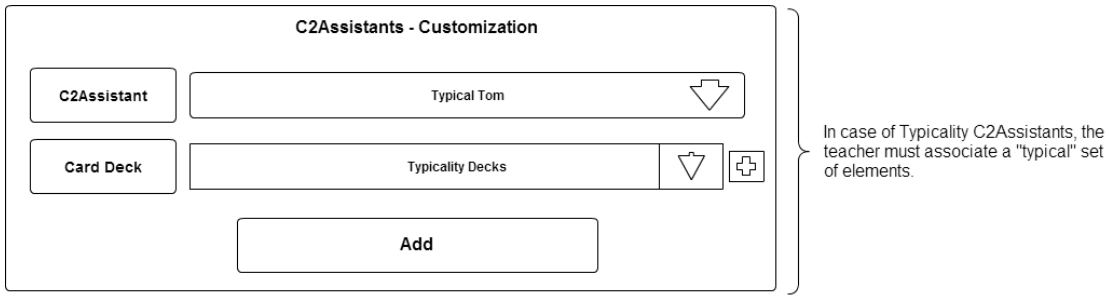

Figure 10 - Example of C2Assistant Customization (Typicality)

The game **will inform the user profiling** service by storing the following information: user id, group id, the turn by turn use of elements during play (representation in an XML format), C2Assistant used, C2Assistant suggestions at each step of the interaction (representation in XML format), suggestions picked, characters used, elements used, final game state, resulting text fragments and the results of the voting to determine the 'winner'.

The user profiler, in turn, **may influence** the behaviour of one or more C2Assistants, such as **which cards are picked** for learners to play.

6.7 CONNECTING 4SCRIBES TO THE C2SPACE

Stories produced by playing are posted on the players' individual spaces in the C2Space. The stories are posted on all participants' pages no matter who 'won' a certain session. The player who won gets a special indication on the story, marking it as winner. On the individual page, players can choose whether they want the story to be readable by others in the C2Space. Badge values are awarded to players for play of 4Scribes as indicated in Table 12.

Badge Name	Accomplishment
Junior Scribe	Complete at least one game of 4Scribes
Veteran Scribe	Complete at least five games of 4Scribes
Honorary Scribe	Win at least one game of 4Scribes
Renown Scribe	Win at least five games of 4Scribes
Narrative Commission	Play with at least five character elements created by other players

Table 12 - 4Scribe Badge Descriptions

7 C2GAME: CONSTELLATIONS

Herein we provide the detailed game design description of the *Constellations* story making C2Game.

7.1 GAME SUMMARY

Constellations is a story making game, using **Elements** that span across multiple sessions. The game applies a top-down approach, where an overarching theme is chosen and players fill the "blanks" and shape the story universe across multiple sessions. Each session may be played by different learner groups, allowing groups to focus on certain parts within the story universe or contribute to other parts previously played by other groups. The game has no competitive elements, players work together in order to provide compelling and interesting stories.

Constellations fits into the C2Games space of the overall C2Space environment, as it consists of a structured playful experience, which can span over multiple gameplay sessions.

7.2 CONSTELLATIONS DESIGN DOCUMENT

Constellations is a story making game where players work cooperatively to create a compelling fictional universe. Stories may intertwine and may be created in different points in time and space. Constellations focuses on a long-term storytelling experience, where the addition and combination of various micro story sessions contribute to a bigger story universe. Sessions may be played concurrently (if in different points in time or space) or progressively (continuing a story of a previous session).

7.2.1 THE OVERARCHING UNIVERSE, THE PERIOD AND THE CONSTELLATION

Constellations is a top-down story building game, which begins by defining an epic theme (the Overarching Universe). For **the Overarching Universe a list of events (Periods) is specified, which consist of timeline milestones where world changing events have happened** (e.g. The Stone Age, The Bronze Age, etc.).

Periods are named accordingly to the universe and consist of a set of Constellations created by the learners who through these help shape the period they are playing within, which consequently shapes the overarching universe. Periods may also be associated to a Light or Dark tonality, which only adds flavour to the period (e.g. The Stone Age was a Dark Period in Humanity, while the Bronze Age was Light Period).

A Constellation is a gameful play session, where learners cooperatively play a story-making game in order to specify and further detail the Period they are playing within. **Constellations may be extended** (i.e. progress the same story in a future session) **or may overlap with other Constellations** (i.e. stories that intersect with one another).

7.2.2 STORY CONCEPTS

Story Concepts are facts about the universe that transcends periods and are known by all. It specifies concepts, objects, facts that are common between all periods, which tie the periods together. **During sessions learners may have the ability or even be prompted to create a concept, however they will always be specific to a constellation** they are currently playing, unlike story concepts that transcends all constellations and periods.

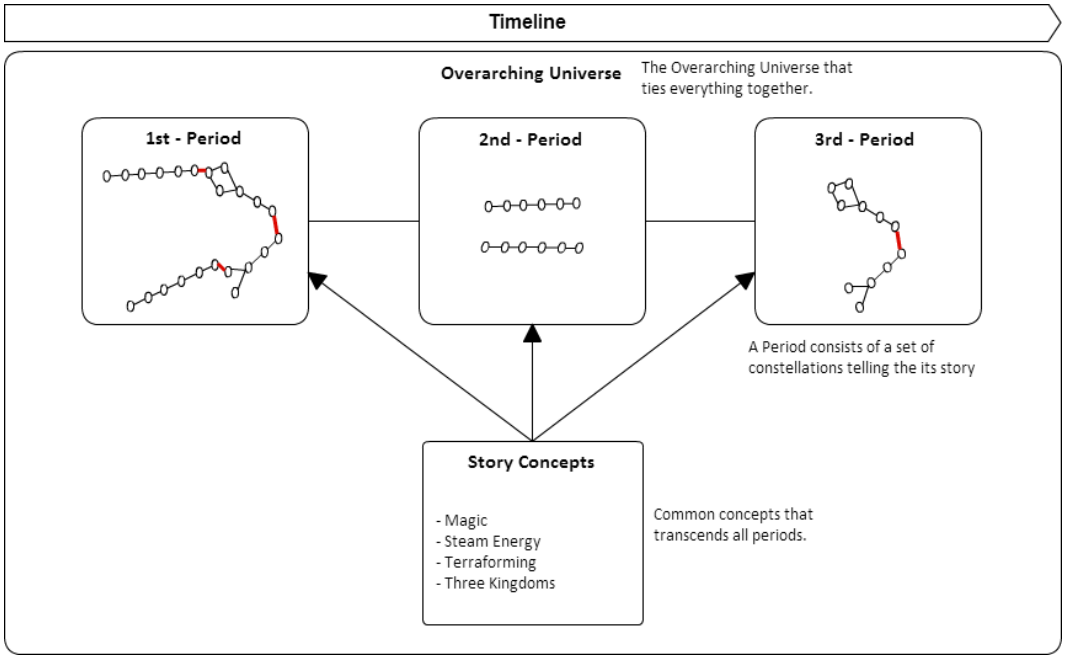

Figure 11 - Overarching Universe encompasses Periods and Story Concepts. Periods encompasses Constellations; Red Lines denote Constellation Extensions.

7.2.3 DISRUPTORS

A Disruptor is a random modifier that affects the learner's turn. The learner must take into account the disruptor during his turn, as some disruptors might be associated to specific characters within the story. Disruptors will have a random chance of appearing during play. Disruptor types include:

- **Character Specific Disruptors** – These disruptors will attach themselves to a character that is being played in the Constellation.

  Examples include:
  "Wounded"; "Scarred"; "Handicapped"; "Healed"; "Motivated"; "Inspirational"; "Honoured"; "Dishonoured"…

- **Constellation Concept Disruptor** – These disruptors will attach to the constellation from that specific point in time forward and will be a common concept throughout the **constellation only**. The turn-taker must specify a constellation concept that would make sense in that point in time; learners are encouraged to discuss a new concept with the rest of his story group.

- **Relationship Disruptors** – These disruptors will create a character connection between two characters within the constellation that is being played. If there is only one character within the current played Constellation, then this disruptor is replaced by a Character Specific one.

  Examples include:
  "Falling in Love"; "Hate"; "Jealousy"; "Friendship"; "Rivals"; "Partners"; "Brother/Sister"; "Father/Mother";

- **Timeline Disruptor** – This disruptor affects the diagrammatic timeline randomly. Examples include:
    - Modifying the node connections so that un-played nodes are parallel;
    - Creating a constellation that intersects with a particular node in the current constellation (which can then be played at a later date) simulating crossing storylines;
    - Creating a random constellation configuration that starts after the ending of the current constellation.

7.2.4 LONG TERM PLAY

Constellations is a **long-term** C2Game experience, where the aggregation of micro playful sessions (i.e. The Constellation) will contribute to the construction and creation of a co-creative fictional story universe. Constellations was designed so that multiple groups of players (from the classroom or not) would be able to co-create within the same universe simultaneously (i.e. each group is assigned a Period within the overarching storyline). Constellations was also designed not as a competitive game, but rather as a cooperative game, where players band together to discuss and build interesting stories and settings.

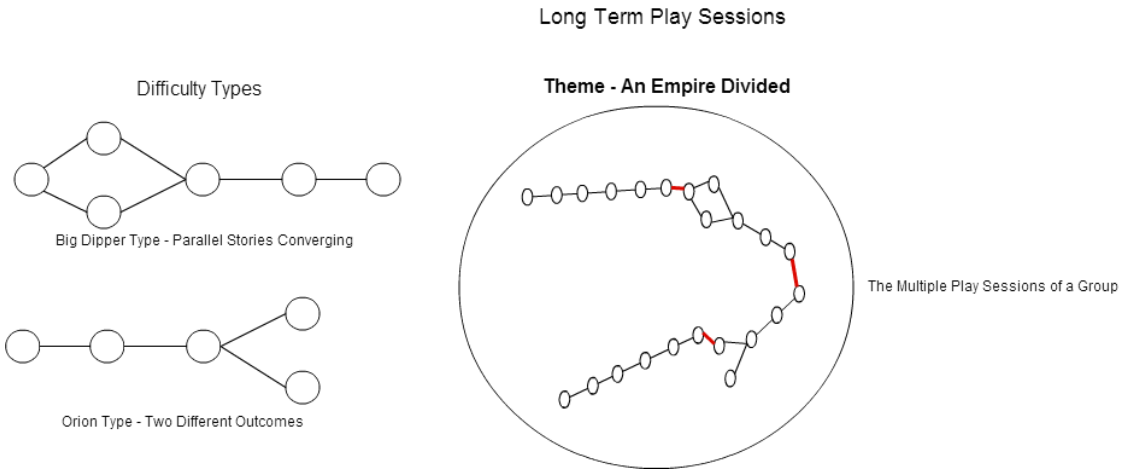

Figure 12 - (Left) Types of Constellations; (Right) Representation of a Constellation within a Period; The red connections represents a Constellation with multiple play-sessions.

7.2.5 SETUP GAME

The setup phase is divided into two types. The **initial setup phase** is completed only once, in which the **overarching universe theme, the Periods and Story Concepts are decided**. **The Constellation setup, is where the gameful play sessions are defined** (e.g. Number of turns per player, C2Assistant used, specific deck setup). All of the above setups can be accomplished by the *teacher* or even *discussed* in the classroom, allowing students to select and vote on particular themes that are interesting to them.

7.2.5.1 INITIAL SETUP PHASE – DEFINING THE OVERARCHING UNIVERSE, THE PERIODS AND STORY CONCEPTS

Each Overarching Universe is a onetime only setup process which is as follows:

1. **Pick an overarching theme**. The theme should relate to the bigger picture of the story universe. In addition, **the theme should be epic, abstract, one sentence long** and most importantly set some initial concepts into the mind of the players. **The theme should also be timeless** and spark the imagination of learners and a world they want to explore.

   Examples:
   "Mankind has harnessed the power of magic";
   "Planet Earth has become inhabitable";
   "Two empires at war";
   "Mankind takes to the seas, and discovers the New World".

2. **Divide the game in *Periods*** *(Min. 3)*. These represent long spaces in time within the game universe (centuries or millennia) and can have a *Light* or *Dark* tone. A couple of sentences should be used to describe this period. (**Note –** More Periods can be added later on, as the game progresses). Constellations will fit within these time periods, detailing that period within the story universe. As sessions are played the more detailed the story universe will become (i.e. populated with characters and events).

   Examples for overarching theme - *Mankind has harnessed the power of magic***:**
   "The first Magic enabled humans are born. Empires turn to war, harnessing this limitless power - ***Dark****";*
   "Magic is controlled. The first council of Magi is born from the ruins of ancient empires - ***Light****";*
   "Fear of the sorcerers; the rise, rebellion and exile of the non-magic users - ***Dark****".*

3. **Decide on *Story Concepts*** *(Min. 5)*. **Story Concepts are facts about the story universe**, things that are **common between all periods and known to everyone between all sessions**; it might be a forbidden power, an object of desire, the names of kingdoms, etc. Story Concepts can be chosen by the teacher, but it is recommended that learners take part in this process suggesting concepts for the universe.

   Examples for overarching theme - *Mankind has harnessed the power of magic***:**
   "Magic"
   "Born in Magic"
   "3 Kingdoms - Principality of the Sun, The Water Kingdom, The Empire of the Bear"
   "Terraforming"
   "Steam Technology"

7.2.5.2 CONSTELLATION SETUP

A Constellation is a small story within the larger overarching story universe. A Constellation sits within the story arc periods allowing learners to mould the events which shape the period they are playing within. Players may extend previously played Constellations, either backwards (play the past) or forward (play the future). Players may even create a parallel Constellation detailing other events within the same timeframe but at a different location. A Constellation setup is **a per session** setup and is as follows:

1. Select the period the scenario will take place.

2. Define at what point in the period this scenario takes place, according to other scenarios (if any) – it may be past, parallel (at the same point in time) or future. If it is the continuation of another constellation, then select the constellation to extend. ***Note*** *– Constellations have the potential of crossing with others, creating overlapping storylines.*

3. Define a theme (or if a continuation of a previous constellation, keep the previous theme) and an ending.

4. Define the number of turn per players. A Constellation size should be a multiple of the number of players, i.e. if there are 4 players then a Constellation size should be 4, 8, 12, etc.

Players can continue playing previous constellations, meaning that the ending of the previous session, will serve as the start of the next one, extending the constellation.

7.2.6 GAMEPLAY (4 PLAYERS AND 1 OR 4 TABLETS)

Players will take turns advancing the story through the constellation reaching the ending. At the start of the session a group of characters is defined, these characters will be the main actors of this session and will be used throughout the constellation.

START OF THE SCENARIO – CHOOSING CHARACTERS VERSION 1

Players will discuss the scenario and which characters are going to be used in this scenario. If it is the continuation of a previous scenario, those characters will be suggested characters, although players are allowed to use any character.

START OF THE SCENARIO – CHOOSING CHARACTERS VERSION 2

Players will discuss the scenario and the system will choose which characters will be used in this scenario. If this session is a continuation of a previous scenario, the previously used characters will have a higher probability of being chosen for the current game.

START OF THE SCENARIO – CHOOSING CHARACTERS VERSION 3

Players will discuss the scenario. During play characters are revealed with an associated action. From that point onwards that character is usable by everyone in the session. Characters have a higher probability of appearing at the beginning of the session.

7.2.6.1 Turn Taking

Constellations is a **turn-based story making** game, each turn will consist of the following:

1. At the start of a player's turn the system rolls a virtual dice with a small probability of a player being affected by a Disruptor;

2. 3 story elements, guided by one of the C2Assistants, are revealed to the player; the player must choose one of these and base the story progression on the element chosen (see Fig. 13).

3. The turn taker reveals his event to the rest of the group. The turn takers word is **final**, although players may vote to veto his play, and retell the event, based on **2** conditions:

   - If the player didn't take into account his disruptor (if rolled) and element card;
   - If the player's event contradict previous statements in the storyline;

   In order for the veto rule to take affect **all learners (besides the turn-taker) must agree to veto**.

4. To finalize the play, the turn taker writes down the continuation of the story summarized in 3 to 4 sentences (see Fig. 14).

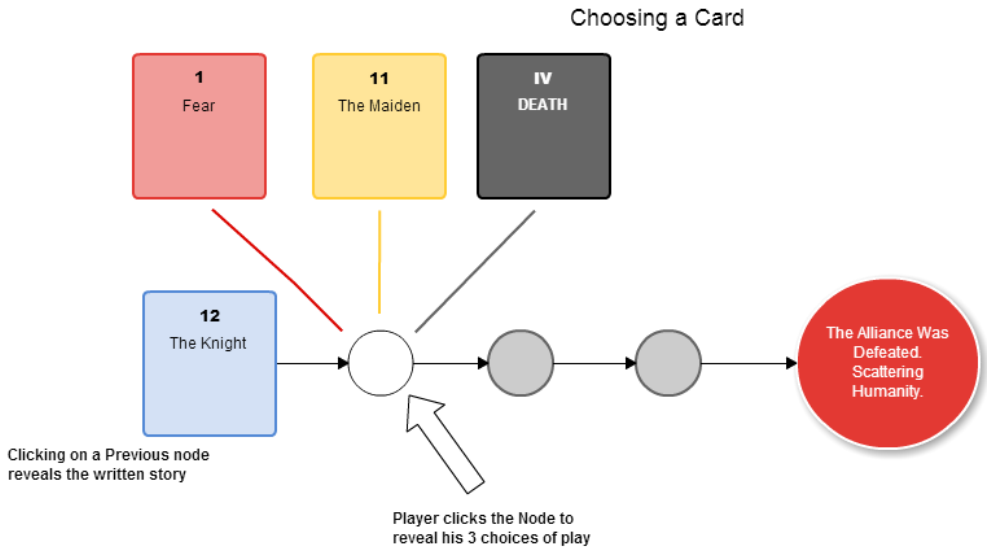

Figure 13 - Player Turn Example

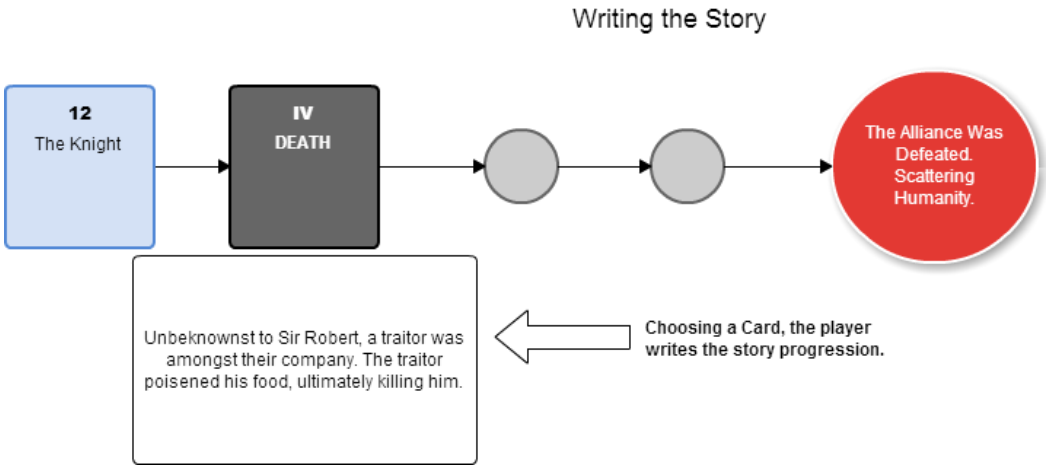

Figure 14 - Example of Player Finalizing Turn

7.3 CONSTELLATIONS WITHIN C2LEARN PRACTICE

The following table provides descriptions of learner and teacher practice falling under each of the five elements of creativity for the Constellations game. The Constellations game facilitates **possibility thinking**, **creative emotive reasoning** and **social engagement**. The Constellations game can be viewed as a **long-term structured** C2Game activity within the possible time frames of pedagogical orchestrations in C2Learn practice (C2Learn Integration deliverable, section 3.2.1).

The Learners:	**The Teachers**
A1 Possibility Thinking	

• Learners are tasked to produce story segments cooperatively with other players; • Scenarios may provide problems and conflicts that allow learners to interact and play with; • Abstraction of concepts allows users to explore the possibility space, without tying down creativity; • Can provide alternative side by side stories, giving the ability of "What If" scenario sessions; • Learners during play can control characters from other learners, allowing for a change of perspective.	• Teachers may set an overarching theme and milestones that present a constant problem within that story universe; • Per session basis, teachers may present new problems or concepts that are born within that story session; • Teachers may also define an ending or/and a beginning for a session, in order to provoke "What If" or "As If" questions; • Teachers may also define which elements can be used during a session or the entire story universe.
A2 CER • During play learners have full control of the story, acting as an agent of disruption themselves; • Learners also interact with element disruptors that randomly appear during play, forcing them to apply certain conditions on their next turn; • Story timelines may vary, causing a time disruptor, where stories may interconnect, diverge or converge;	• Acts as intermediary between learners and story;

B Social Engagement
• Learners in engage in playful action cooperatively;
• On their turn, learners must voice (if in person) and write down their story progression. Allowing other players to view, and discuss their contributions to the story;
• Per session, the group cooperatively builds a story within the larger story universe;
• The story universe is cooperatively constructed along multiple sessions through various story groups;
• Story concepts allow learners to explore common myths that are overarching between stories of different groups;
• During a session each player has control over the current story:
  ○ During play learners may discuss current and past events opening dialog space with other players;
• Controversial plays may require players to negotiate their contribution with other players.
	• Assign/Facilitate
	  ○ Creation of an overarching theme with the learners, set the stage and allow learners to contribute;
	  ○ Define story concepts, myths, items or powers that are true over the entire story universe
	• Encourages learners to explore problems within the story universe
	  ○ Present problems that arise for that session;
	  ○ Present new story concepts that are born from that timeline onward;
	  ○ Assign new or different characters to a story session, allowing learners to explore different perspectives

D Wider Picture of Change • Learners may set/have a common ending objective during a session they might strive towards;	• Teachers may question certain story session, forcing the group to express their decisions during play;

• Learners may also set aims and goals of where they envision the story arc will end up; • Story Universes are a key feature in allowing learners to reflect on their and other player contributions through the overall story universe; • Learners will influence a bigger picture (the story universe) through the play of short micro sessions;	

Table 13 - Framing of Constellation with C2Learn Practice

7.4 CONSTELLATIONS WITHIN PLAYFUL C2LEARN PEDAGOGICAL PRACTICE

The following table provides insight into how Constellations links to the C2Space properties and is realised as a C2Experience with respect to the key elements of C2Learn pedagogical practice and learning design.

Constellations within C2Space	**Constellations as a C2Experience**
A1 Possibility Thinking • Motivates learners by keeping track of previously created stories in order to contribute something new and different to the story; • Challenges learners to think differently and work within the constraints; • Session decisions can be reflected at a later date and influence present decisions from the learner.	• Facilitate learners to get involved in playful exploration of a given possibility space and co-construct a new possibility space: ○ Presenting them with 'what if' scenarios and 'as if' environments; ○ Requiring them to explore and co-construct (designing, editing, extending) stories; ○ Enabling/enhancing the application of CER non-linear thinking techniques, through visual timelines and story disruptors;
A2 CER [as in A1 above] and: • Previously created stories can be used by learners to create disruptions in the story universe; • Timelines can be varied and generated by the system, motivating learners to think about the concept of space/time differently;	[as in A1 above] and: • Elements that disrupt a learners' established routines and patterns: ○ without teacher intervention/trigger ('automatically') ○ facilitating teacher intervention • Playfully realize brainstorming tasks.
B Social Engagement • Teacher can set an overarching story where the whole classroom may contribute; • Offering opportunities for individual, collaborative and communal activity; • Providing access to, organization and overview of the creative activities to the learner, the group and the community; • Keeping track of the learner contributions, mostly story and game	• Afford collaborative and communal activity realized within the group and placed within the wider community; • Use the motivational power of posing debatable challenges and dilemmas; • Encourage the expression and consideration of different viewpoints; • Enable the expression and management of conflict in a 'contained' safe manner;

actions, allowing learners to reflect and discuss the story progression and evaluation; • Learners may take the lead in the creation of the story and its characters; • Learners and teachers all have the ability to contribute to the overall story equally; • Learner contributions and decisions will be tracked and can be used for later reflection; • Enacts a playful, game-like (gameful) experience of the wider activity; • Helping learners feel as players engaged in a longer-term challenge; • Allowing creations that groups and the community can evaluate as interesting or surprising; • Keeping trace of the activities so that learners can reflect on them in their evaluation of the experience afterwards	• Involve (changing) leadership roles; • Emphasize equality of opportunities within the group, everyone has equal influence on the story; • Include moments of decision making and of translating decisions into action.
D Wider Picture of Change • Keeping track of activities so that learners can reflect on them in their evaluation of wider change.	

Table 14 - Framing Constellations within the Playful C2Learn Pedagogical Practice

7.5 USE OF C2LEARN COMPUTATIONAL TOOLS

The use of C2Learn computational tools in this game is presented in the Table below. Constellations will predominantly utilize the Semantic Tools (see D3.1.2) as C2Assistants, for use during the gameplay component of the game and the C2Space component of Constellations.

C2Game: Constellations			
C2Learn Tool/Service Type		**Computational Tool**	**Use (*) / Potential Use (o)**
Semantic Reasoning Computational Tools	Tools fostering Idea Conception	Thinking Seeds Generator	*
		Web Miner	o
		Cloud of Thoughts	o
		Competitive Thinking Spaces	
		Novelty Computation	*

	Tools assessing Dimensions / Aspects of Creativity	Surprise Computation	*
		Impressiveness Computation	*
		Creativity Points Computation (Text-on-Text)	*
	Supporting Tools	Search Engine Wrapper	
		Text Clustering	
Diagrammatic Reasoning Tools	Tools fostering Idea Conception	New Graph Retrieval	
	Tools assessing Dimensions / Aspects of Creativity	Novelty Computation	
		Typicality Computation	
	Supporting Tools	Mind Mapping Server	
Mixed Initiative Co-Creation		Mixed-initiative Procedural Content Generation (C2Create variants)	
Profiling		User Profiler	*

Table 15 - Applicable tools for Constellations

C2Assistants are used in a similar fashion (i.e. Element Selection) as in 4Scribes (See Section 6.6). Furthermore, the Wise Oracle C2Assistant **may** present learners – if requested by the learners themselves – high valued excerpts of previous written texts, from different constellations or even story arcs. This may serve as a way of inspiring learners as they wait for another player to finish their turn.

The game **will inform the user profiling** service by storing the following information: user id, group id, overarching universe, period, the turn by turn constellation as it is being played (representation in an XML format), C2Assistant used, C2Assistant suggestions at each step of the interaction (representation in XML format), suggestions picked, the final constellation, characters used, elements used and the texts written.

The user profiler, in turn, **may influence** the behaviour of one or more C2Assistants, such as **which cards are picked** for learners to play.

7.6 CONNECTING CONSTELLATIONS TO THE C2SPACE

Constellations will use elements and characters previously created by players. The story universes in which the Learner participates in will be represented in his C2Space. The Learner

may also view his stories (which he participated) and other group stories within the specific story universe. Learners will also be capable of visualizing the path of their own created characters and the associated constellations that their characters are attached to.

The specific game badges earned through the Constellations game are represented in the table below.

Badge Name	Accomplishment
Astronomer	Play at least five games of Constellations
Where no Man has gone before	Your created characters have been played five times by other players
Telescope	Create a new Constellation
Stargazer	Play/Create at least five Constellations from the same
Galaxy Trucker	Play/Create at least five Constellations, each one in a different story arc

Table 16 - Constellations Badge Descriptions

8 C2GAME: ALIVE MAPS

This section describes the Alive Maps diagrammatic reasoning C2Game and, as in the previous game descriptions, it provides a game summary, it places the game within the C2Learn theory and pedagogical practice and ends with a full game description, use of computational tools, and the Alive Maps badge system

8.1 GAME SUMMARY

In the single-player game Alive Maps players make diagrams representing structures, concepts from society, science and other areas. The game or a teacher provides an initial concept that the players create aided by C2Assistants. During play, a teacher or the system can introduce a dramatic tilting, a change in the setting, that requires the player to change perspective and modify their diagram. Concepts are represented as colourful shapes, associated via connections, which can be used to apply specific rules to the connected shapes. There is no winning criterion per se – in Alive Maps the activity is geared towards simulation and construction for its own sake, similar to play in games such as *SimCity* (Maxis, 1989) or *MineCraft* (Mojang, 2011). In several ways, Alive Maps has a similar motivation of freeform, human-evaluated storytelling as 4Scribes, but works on the diagrammatic rather than on the semantic level. However, at the end of a session where many learners create simultaneously, peers and teacher may vote on the 'best' creation. Semantic reasoning is existent as an underlying/analogical process triggered through the abstract diagram (Yannakakis et al., 2014).

Alive Maps offers a highly interactive experience to the learners, with abstract notions (represented visually) moving on the screen, interacting with other notions and forming a gestalt entity, which likely can only be interpreted by the creator herself. While the game has several simple rules, their combination – along with the highly malleable canvas on which the game is being played – can offer vastly different experiences, guaranteeing emergent complexity and that no two playthroughs will be the same. In addition to these, the C2Assistants can disrupt the experience further, allowing learners to present a final result that is very different to that of their colleagues.

8.2 ALIVE MAPS DESIGN DOCUMENT

In Alive Maps, the teacher provides a theme and a starting map (representing a **what-if** situation). Players interact with the map with the 'help' of the C2Assistants, and have a specific time to finish their map (specified by the teacher, assumed 5-10 minutes). Once the time has elapsed, the map is frozen in time and students take turns presenting their maps in front of the class. As in other C2Games, maps are peer evaluated and/or assessed by the teacher.

Objects can be associated via connections, which can be used to apply specific rules to the connected shapes. Initial rules are hardcoded into the predefined theme, but can be modified by the C2Assistants. The final list of themes will be finalised after the first rounds of experimentation/piloting with the game, along with each theme's rules and shapes.

8.2.1 THE TEACHER'S ROLE

The teacher can choose a theme and load one of the pre-existing scenarios *(e.g. a model of an aquatic environment)* and specify which shapes are available to all students in the beginning of the game.

In addition to the above, the teacher can disrupt a pre-existing scenario in order to provide a what-if situation *(e.g. what if an oil spill causes a large black cloud to appear in the middle of the ecosystem?).*

Instead of loading pre-existing scenarios, the teacher can let players start from scratch by only specifying shapes available to the users to add to an empty map *(e.g. describe the story of Free Willy with 5 shapes and 7 connections)*.

8.2.2 THE LEARNER'S ROLE

Learners can **add objects** to the *AliveMap*, provided that they are available on their sidebar. Adding a shape to the *AliveMap* is done by clicking the object on the sidebar and dragging it to a location in the Alive Map. Once released, all the game rules which apply to the *AliveMap* start taking effect on the new object. Learners have a specific number of **shapes of specific colour** and once the sidebar is empty of objects, the only way to get more is from C2Assistants.

Learners can also connect shapes to each other by using the '**connect**' icon on the sidebar. Once the Connection button is pressed, the game enters *connect mode*, and dragging from one object to another connects the two objects with a line (representing a semantic connection).

Learners can **break connections** by swiping their finger on top of an existing connection.

Learners can also delete a few shapes using an **eraser** with a finite number of uses (specified by the teacher). Once the eraser button is pressed, the game enters *erase mode*, and clicking an object on the *AliveMap* will remove it completely and irrevocably from the game. Students can **move** existing objects of the *AliveMap* around, by clicking them and dragging to their desired location.

8.2.3 THE LEARNER'S INTERFACE

The UI is comprised of two parts: the *canvas*, where the *AliveMap* is drawn and updated based on the game rules, and the *sidebar* which contains shapes that can be added to the *AliveMap*, buttons for adding connections or erasing objects, and the C2Assistants which can be interacted with (clicked on).

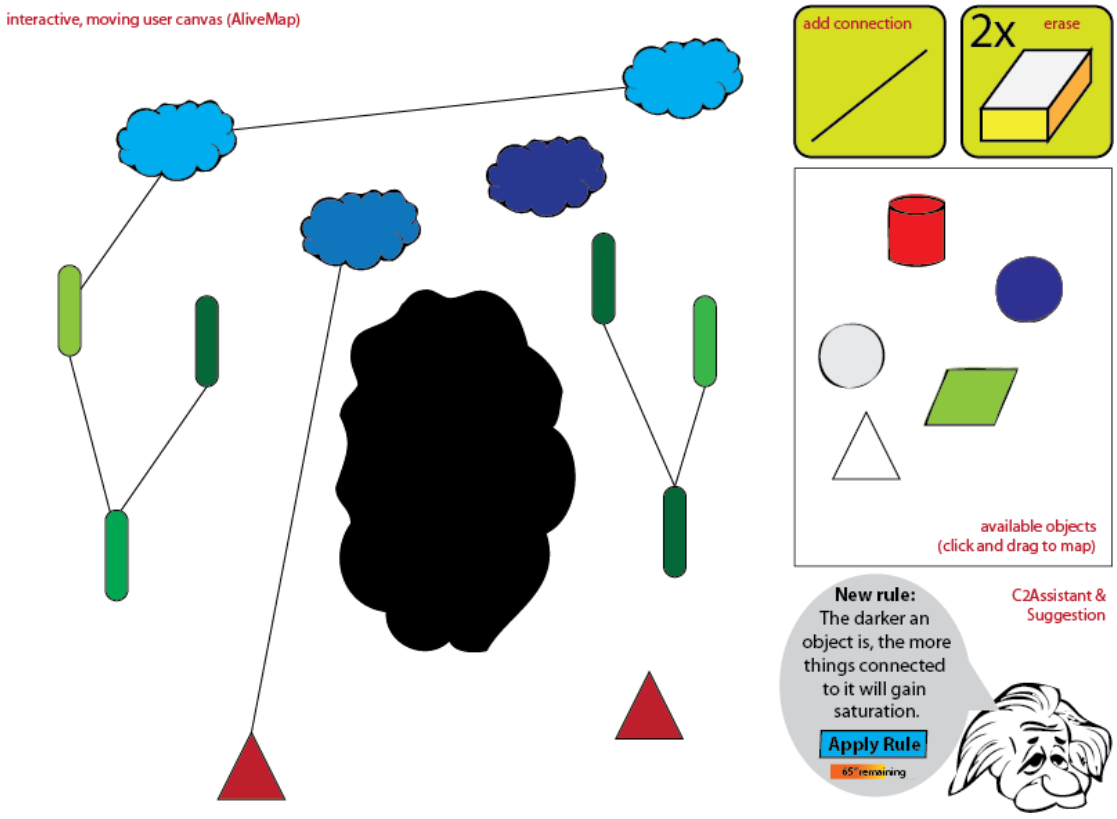

Figure 15 - The Learner's Interface in Alive Maps

8.2.4 THE C2ASSISTANT'S ROLE

Change (or invert) **a global rule**: for instance, the *Mad Scientist* can make all cloud shapes move towards the bottom of the screen, rather than towards the top which is the rule up to that point (see example below).

Add a new object to the sidebar, thus making more objects (which were not expected by the teacher) available to the learners.

Modify a specific object (e.g. change its shape or colour). This can be done by dragging a new shape or paint bucket (respectively) from the assistant's balloon to the shape they want to change. The new shape or new colour is designated by the C2Assistant, but which existing object will be modified is decided by the learner.

Re-connect: a particularly disruptive assistant can break all connections on the learner's Alive Map and replace them with an equal amount of connections between random (or not so random) objects.

8.2.5 ENVIRONMENT AND GAMEPLAY

Alive Maps offers a wide array of options for learners to experiment, in this section we describe the gameful environment of Alive Maps and how it is played.

8.2.5.1 SHAPES AND COLORS

The drawing environment will allow learners to use a variety of shapes and colours.

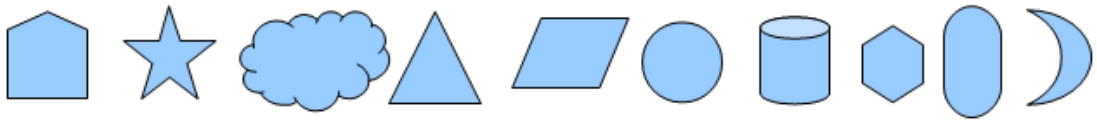

Figure 16 – Example shapes available in Alive Maps

NOTE ON COLORS

Colours will use the HSB format, which is comprised of:

- **Hue:** The "attribute of a visual sensation according to which an area appears to be similar to one of the perceived colours: red, yellow, green, and blue, or to a combination of two of them".
- **Saturation:** The "colourfulness of a stimulus relative to its own brightness". Saturation of 0 is grayscale; saturation of 1 is the most vibrant colour possible.
- **Brightness:** The "attribute of a visual sensation according to which an area appears to emit more or less light". Brightness of 0 is black, regardless of hue/saturation, while brightness and saturation of 1 is white regardless of hue.

Figure 17 – Example colours available in Alive Maps

8.2.5.2 GLOBAL RULES

Shapes may perform actions/animation depending on the shape type or colour.

RULES BASED ON AN OBJECT'S COLOR

- The darker the colour's brightness, the more things connected to it will lose saturation (simulates pollution).
- The more saturated the colour, the faster the object grows in size (simulates life).
- The darker the colour's brightness, the more it drags nearby objects closer to it (its drag force is proportionate to its size). Dragged objects do not necessarily need to be connected to the dark object (everything goes).
- When colours become fully de-saturated, they start getting black (simulates pollution).
- Anything colliding with a completely black object dies, and the black shape grows in size (simulates death/pollution).

- Objects with high saturation and similar hues repel each other (simulates hunters fighting for territory in an ecosystem).

RULES BASED ON THE OBJECT'S SHAPE

- Jagged shapes (with acute angles) which are connected with each other keep reducing each other's size until only one shape remains (simulates carnivores fighting for dominance).
- Circular shapes (no acute or right angles) grow in size if there are connected only with other circular shapes.
- Cloud shapes always move towards the top of the screen with a speed proportional to their size.
- Shapes with any right angles move towards the bottom of the screen with a speed proportional to their size.

8.2.5.3 SCENARIOS

Scenarios consist of a **set of pre-made** *Alive Maps* that may be directly used or customized by the teacher for classroom use. Scenarios usually map to a specific theme such as *Environment* or *Society*.

JUNGLE ECOSYSTEM SCENARIO

Jungle ecosystem with many brown cylinders representing logs. These logs are connected with most other entities, forming an ecosystem which is built upon the woodland and keeps hunters disconnected from each other. The teacher can provide a **what-if** scenario by breaking all connections from the *Alive Map* or by converting all brown cylinders to black (burned down forest).

AQUATIC ECOSYSTEM SCENARIO

Aquatic ecosystem with relatively stable number of hunters/sharks (spiky white objects representing teeth) and cyan clouds (representing fish swarms). Teacher can provide a **what-if** scenario by inserting a big black cloud shape (an oil spill) or by removing most cyan clouds (due to over-fishing).

8.2.5.4 GAMEPLAY

THE TEACHER

The teacher loads the environment theme, and is presented with 5 possible scenarios under the Environment theme: 'jungle ecosystem', 'aquatic ecosystem', 'clean coal', 'wind energy', and 'isolation of Australian fauna'. She selects aquatic ecosystem and loads her *AliveMap* on 'admin' mode. She adds a big black cloud at the centre of the *AliveMap* provided: she wants to discuss oil spills today. She chooses to add 5 concepts to the sidebar so that all her students have access to them: a white triangle (shark), a red cylinder (toxic waste), a blue circle (water), a white circle (air) and a green parallelogram (Greenpeace ship).

THE LEARNER (ALINA)

Once the teacher tells her to start the Alive Map app, Alina connects to the server and downloads the teacher's Alive Map. The simulation starts immediately, and she sees that the

nice ocean ecosystem is being threatened by a big black cloud, which the teacher told her is an oil spill. She immediately glances at her sidebar, trying to figure out how the 5 shapes shown there can help her fight the oil spill. She drags a red cylinder next to the black cloud, and connects it via the Connect button. She has played the environment theme before, and knows that the black cloud will eventually take all the colour from the other objects and eat them, so this vibrant red thing should buy her some time to save the pretty cyan clouds. She looks at the *Mad Scientist* at the bottom of her sidebar, and hoping that he can break the rules, like he often does, she clicks on him to get an option for a mechanics' change.

THE C2ASSISTANT (MAD SCIENTIST)

The *Mad Scientist* observes what all the students are currently doing: it seems that a lot of them are having desaturated objects (due to the desaturation rule of the black cloud). Since desaturated objects and cloud shapes are very common at this state of the game, the *Mad Scientist* tries to break this pattern by suggesting a new rule for Alina: "New Rule: The darker an object is, the more things connected to it will gain saturation." Under this text, the C2Assistant places a button saying "Apply Rule" and waits for Alina to click on this button.

BACK TO THE LEARNER (ALINA)

Alina doesn't really understand how the C2Assistant's rule can make any sense if black is oil pollution, but that is why they call him the *Mad Scientist*! She is currently too panicked that her entire ecosystem is turning to grey, so she quickly presses *Apply Rule*, and makes connections from the black oil spill to all other objects. Soon, all connected objects start gaining happy colours! This will be hard to explain to the teacher in the end, she knows, so she starts making up a story how the blindingly cyan fish are actually radioactive because of the radioactive red barrel which is connected with a line to the black cloud --- the radioactive ingredients merged with the oil and covered everything! She hopes her story wins her the first place with her fellow students: she knows a lot of them have seen the latest Spiderman movie and will like this radioactive stuff.

THE EVALUATION PHASE

After 10 minutes, the teacher says that the game is over and everyone's *AliveMap* freezes at its current state. All maps are transferred to the teacher's tablet, and now she calls each student up to the board to explain what their map represent. Alina is next to last, so she is happy that no-one mentioned radioactivity yet: thank you, *Mad Scientist*! Unfortunately, the teacher is evaluating the best story, so it goes to Mark who ended up with a massive black cloud which ate all the other objects: his story was a depressing tale about how all species eventually got polluted and grayed/black from the oil spill. Such a boring story, Alina thinks... "this is so unfair!" She hopes that her *AliveMap* will at least receive some likes from her classmates….

8.3 ALIVEMAPS WITHIN C2LEARN PRACTICE

The following table provides descriptions of learner and teacher practice falling under each of the five elements of creativity for the Alive Maps game. Alive Maps facilitates possibility thinking and CER; social engagement is not supported during the interaction with the Alive Maps game but is of paramount importance when presenting the final map to class. Alive Maps can be viewed as a **shorter-term**, **focused** and **structured** C2Game activity within the possible time frames of pedagogical orchestrations in C2Learn practice (C2Learn Integration deliverable, section 3.2.1).

The Learners	**The Teacher**

A1 Possibility Thinking • The availability of concepts as objects, their visual placement and most importantly interaction with other objects allows for possibility thinking via **visual diagrams**. • Learners are requested to solve diagrammatic what-if scenarios via visual diagrammatic reasoning and creative re-interpretation of associated concepts. • Learners experience the moving, interactive world and change it to their will.	• The teacher can provide challenges provoking learners to get involved in possibility thinking. • The teacher can be inspired by existing themes and scenarios or allow freeform concept drawing. • The use of the game encourages and facilitates learners to ask their own 'what if' questions and to engage in 'as if' activity • Devises learner activities that can only be satisfactorily completed if learners actively experiment with arranging and interacting with content. • Integrates the use of CER non-linear thinking techniques in the game.
A2 CER • Address a given challenge (problem). • Learners reframe the AliveMap problem posed and come up with entirely new responses to a given situation: ○ They engage in activities that disrupts their pattern of thought and action via the use of the C2Assistants acting as disruptors. ○ They create new diagrammatic analogies ○ They actively recombine elements of the creative challenge ○ Actively facilitate a shift of perspective, by uncovering unthought of associations between (connected) concepts.	[as in A1 above] and • Intervenes (indirectly) to trigger learners' new responses by disrupting students' established routines and patterns.
B Social Engagement • Learners make associations by consciously placing themselves, and their creative outcome in the wider frame of the community (whole class, school) • Learners have an interest in getting their creative activity (AliveMaps output) appreciated and valued by others. • Learners engage in playful action: ○ Immerse themselves in the experience of the creative process ○ Facilitate immersion in the experience of the creative process and interactive, changing form of AliveMaps ○ Are willing to take risks and/or leave their 'comfort zone' (thus possibly generating surprising ideas)	• Assigns/facilitates: ○ individual learner work ○ whole class work • Encourages all learners to express their opinion. • Facilitates the learners to become aware of being in charge of their own AliveMap to others. • Designs peer/group evaluation into the activities, so that learners can 'promote' their creative solutions to others and peers can co-evaluate their creativity. • Emphasises the playful nature of the activity (as opposed to the formality of a 'lesson'). • Withdraws from the stage as much as possible, becoming an observer and facilitator of the play (possibly also a co-player or 'meddler' at times at the same time as retaining the teaching agenda) • Allows space for learners to take risks outside 'comfort zones', by encouraging the generation of surprising ideas and avoiding criticism of unconventional thought

Table 17- Framing of Alive Maps with C2Learn Practice

8.4 ALIVE MAPS WITHIN THE PLAYFUL C2LEARN PEDAGOGICAL PRACTICE

The following table provides insight into how Alive Maps links to the C2Space properties and is realised as a C2Experience with respect to the key elements of C2Learn pedagogical practice and learning design.

Alive Maps within C2Space	Alive Maps as a C2Experience
A1 Possibility Thinking • Addresses and poses challenges • Encourages/motivates learners to keep thinking differently and address challenges creatively • Keeps track of the possibility thinking activities so that learners can reflect on them both in their efforts to address the challenges, as well as in their evaluation of the experience afterwards.	• Facilitates learners to get involved in playful exploration of a given possibility space, or co-construct a new possibility space, e.g. by: ○ Requiring them to pose their own 'what if' questions and to engage in 'as if' environments ○ Requiring them to explore and co- construct (designing, editing, extending) content • Enables/enhances the application of CER **(diagrammatic)** non-linear thinking techniques (see below).
A2 CER [as in A1 above] and • The design of innovative/interesting visual diagrammatic 'disruptors' (elements that disrupt learner's established routines and patterns), as well as experimenting with their introduction and use within the activities, by taking advantage of digital adaptive technologies: **mixed-initiative procedural content generation and user profiling**.	[as in A1 above] and • Includes diagrammatic visual elements disrupting learners' established routines and patterns ○ without teacher's intervention/trigger ('automatically') ○ or even, facilitating teacher's intervention
B Social Engagement • Offers opportunities for individual, collaborative and communal activity. • Provides access to, organization, and overview of the creative activities. • Provides game-like triggers and information, such as gauges, scores and badges. • Foregrounding solutions/ creations that the groups and community evaluate as interestingly surprising (rewarding those taking the risk to leave 'comfort zones') • Keeping trace of the activities so that learners can reflect on them in their evaluation of the experience afterwards.	• Provides opportunities for individual creativity. • Encourages the expression and consideration of different viewpoints • Involves exploration of what is lying behind a given challenge or situation, including hidden consequences. • Includes moments of decision making and of translating decisions into action. • Enables students to engage/disagree/challenge with one another/each other to gain feedback during the presentation.

Table 18 - Framing Alive Maps within the Playful C2Learn Pedagogical Practice

8.5 USE OF C2LEARN COMPUTATIONAL TOOLS

The use of C2Learn computational tools in this game is presented in the Table below. Alive Maps primarily utilises the **mixed-initiative procedural content generation** (see D4.3.2) tool as C2Assistants available in the game suggest entirely new diagrams of suggest new shapes to be used during the creation. Unlike Iconoscope (see Section 9), the mixed-initiative aspect of Alive Maps is supported by C2Assistants but primarily from the interaction between game rules (either global or customized from the C2Assistants) and the user's input.

C2Game: Alive Maps			
C2Learn Tool/Service Type		**Computational Tool**	**Use (*) / Potential Use (o)**
Semantic Reasoning Computational Tools	Tools fostering Idea Conception	Thinking Seeds Generator	
		Web Miner	
		Cloud of Thoughts	
		Competitive Thinking Spaces	
	Tools assessing Dimensions / Aspects of Creativity	Novelty Computation	
		Surprise Computation	
		Impressiveness Computation	
		Creativity Points Computation (Text-on-Text)	
	Supporting Tools	Search Engine Wrapper	
		Text Clustering	
Diagrammatic Reasoning Tools	Tools fostering Idea Conception	New Graph Retrieval	
	Tools assessing Dimensions / Aspects of Creativity	Novelty Computation	o
		Typicality Computation	o
	Supporting Tools	Mind Mapping Server	
Mixed Initiative Co-Creation		Mixed-initiative Procedural Content Generation (C2Create variants)	*

Profiling	User Profiler	*

Table 19 - Applicable tools for Alive Maps

The choice among the possible disruptions available to C2Assistants will be guided by particular heuristics:

- Diagrammatic **novelty** from Alive Maps currently being designed by other players, Alive Maps already submitted for this specific Theme or previous states of the user's current Alive Map.
- **Typicality** towards the original, pre-existing example which the teacher changed for a what-if scenario (in the example provided, typicality assumes that students should revert the damage of the oil spill to have an aquatic ecosystem similar to that in the original example).
- **Value** based on which Alive Maps (using the same theme) were rewarded with badges in the database.

Each C2Assistant persona will be guided by each one of the selected heuristics (or a combination of heuristics) and each suggestion will be dynamically adjusted based on the diagram currently created.

The game **will inform the user profiling** service by storing the following information: user id, final map (location, shape, colour and size of each shape and its connections), rules applying at the end of the interaction, C2Assistant suggestions at each step of the interaction (representation in XML format), suggestion picked, and votes/tags from all players (or teacher score).

The user profiler, in turn, **may influence** the behaviour of one or more C2Assistants, such as **value** being affected by the most rewarded Alive Maps in the profile and **novelty** affected by all Alive Maps in the profile.

8.6 CONNECTING ALIVE MAPS TO THE C2SPACE

Game specific badges obtained by the learners are represented in the table below.

Badge Name	Accomplishment
Junior Architect	Play at least one game of Alive Maps.
Veteran Architect	Play at least five games of Alive Maps.
Second Opinion	Apply at least one suggestion by a C2Assistant.
Group Effort	Apply at least a total of five suggestions by C2Assistants.
Leonardo DaVinci	Play at least five different themes.

Table 20 - Alive Maps Badge Descriptions

9 C2GAME: ICONOSCOPE

This section describes the final C2Game designed named *Iconoscope*. The structure of the section follows the template used for all C2Games thus far.

9.1 GAME SUMMARY

In the multi-player (i.e. min 4 players) game *Iconoscope* players make icons representing concept given by the system or their teacher. The goal of the game is to both make their own icon representative to the concept but not too obvious, and to guess what the co-players icons represent. Players score points for guessing right, and for having co-players guess what their own icon is representing. However, if all co-players map the icon, the player loses points, hence the need to make an icon that is representative, but not too obvious.

9.2 ICONOSCOPE DESIGN DOCUMENT

Iconoscope is a multiplayer game ideally played in a tablet by 4 players or more. The game builds on the relationship between **concepts** and **icons (that can form a diagram).**

The design of the Iconoscope game is inspired by mechanics of the *Dixit* game and the diagrammatic activity example (named Creativity Icons) provided in deliverable D2.1.2.

This game is different than the other C2Games as it essentially requires the participants to internalize the logic of a disruptor, and then produce one. A concept, a rule, a phrase etc. can under certain circumstances receive a pictorial representation. The game requests its players to produce a diagram (icon, simple abstract image) out of a given input (usually linguistic, but not exclusively). The creativity (disruptive) part comes in through the way this icon is then evaluated. Usually signs or icons are meant to convey unambiguously whatever message, notion, idea etc. they represent. Thus, a common measure of success is their having conveyed their message (notion etc.) as accurately or fully, to as many people as possible, with "all of them" being the ultimate goal.

In **Iconoscope** the diagram produced has achieved its purpose if it has conveyed the idea to as many people as possible, but **not all**. So an icon **fails** if:

- It communicates its intended message (notion etc.) to everyone.
- It communicates its intended message (notion etc.) to no one.
- It communicates its intended message (notion etc.) to fewer people than another competing icon.

9.2.1 SESSION SETUP

The teacher starts the game by picking a small number (e.g. minimum 3) of concepts from a pre-defined set of concepts/ideas/words existent in the game as the input to the students' tablets. Pre-defined terms may include anything from abstract concepts such as *love* and *freedom* to more specific properties such as *house* and *storm*. The final list of concepts will be finalized after the first rounds of experimentation/piloting with the game. In the first iterations, **words (i.e. concepts) from the basic elements deck are used**. In addition to the concepts the teacher also provides the group of players an initial diagram and the **time** required for completing the task/puzzle (i.e. the maximum playing time).

9.2.2 GAMEPLAY

Each member of the group chooses **in secret** which part of the concept input to use in order to produce a new diagram out of the initial one (or its subcomponents), which expresses (communicates) the concept input, albeit with the above evaluation constraints in mind.

Note that if the teacher chooses so, the group can also function as a unit, competing with other groups.

Each player (or group of collaborating players) can choose from a predefined palette of shapes and icons existent in the game. They can drag and drop, rotate, resize, colour existing shapes as well as add new shapes to the shapes suggested by the teacher. The final set of predefined shapes is expected to be of manageable size in order to be easily represented in a tablet; the final icons is to be included to the game will be the outcome of digital playtesting sessions and will be, in part, depended on the set of concepts that come with the game. It is optional that the teacher may specify which icons will be available to the students, thereby affecting the challenge of the game task.

After creating the new diagrams, the players **upload** their creations to the C2Space and the other competing players (or groups of players) try **to guess** which concept - of the available options provided in the concept input - each diagram represents. The diagram that manages to correctly communicate its intended concept message to the most balanced set of players (neither none nor all; see loosing conditions above) wins. Alternatively one can keep playing more rounds and whoever has the higher accumulative score at the end wins.

There are of course several possibilities with respect to the exact final scoring system adopted which need to be playtested in pilot studies in the classroom but the most obvious scoring system is the one that is based on the notion of **Shannon entropy** from information theory. According to such a scoring system the diagram that manages to **maximize the entropy of student answers** wins the game – e.g. get half correct votes (out of two concept options) or get a third of correct votes when three options are available. Variants of Shannon's entropy favouring correct over wrong answers will be tested and piloted. The example below describes a full gameplay of Iconoscope based on a scoring system that follows the principles of Shannon's entropy.

9.2.2.1 EXAMPLE

THE TEACHER

The teacher presents a group of 4 students with the following 3 concepts (input) from the available concepts in the game: **[Love]**, **[Success]** and **[Balance]**. She then provides the following diagram (or a set of two shapes: a circle and an arrow) and sets the game time of 1 minute (default value):

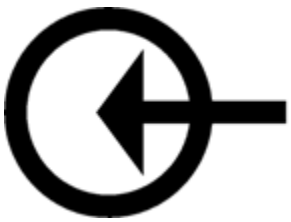

Figure 18 - Teacher Example Icon

THE LEARNERS/PLAYERS

Each player picks one of the concepts and is presented the shapes in his tablet (see mock-up below). Within one minute they are capable of moving, resizing, colouring, rotating the existing shapes or adding new shapes from the predetermined shapes/icons palette. Each player uploads their creations to C2Space when the game is over.

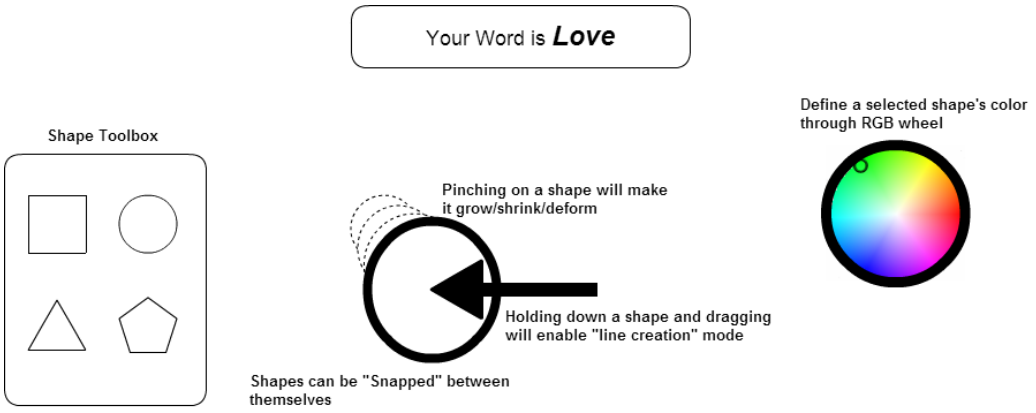

Figure 19 - Example of Iconoscope Drawing Interface

THE C2ASSISTANTS OF ICONOSCOPE

While interacting with the icons a number of C2Assistants – representing different qualities of the diagram such as novelty or balance – suggest alternative diagrams the player might want to consider during the creation. The C2Assistants provide the diagrammatic disruptors of CER and follow the principles of mixed-initiative co-creation (further details are provided in the section about the use of C2Learn computational tools in Iconoscope below).

EVALUATION PHASE AT THE C2SPACE

At the evaluation phase each participant presents his/her diagram to the rest via the C2Space. The other 3 players try to guess which one of the 3 concepts the diagram stands for. The following table shows an example of potential selections of concepts and their corresponding diagrams and scores. The winner of this example is player 2 as she manages to confuse 2 players and get 1 player to correctly guess the concept of her diagram.

Player	**Player 1**	**Player 2**	**Player 3**	**Player 4**
Concept Picked	**[Love]**	**[Success]**	**[Balance]**	**[Balance]**
Diagram/Icon Created				
Other player guesses	[Love]: 3 players	[Love]: 2 players [Success]: 1 player	[Success]: 3 players	[Love]: 1 player [Balance]: 2 players
Score	0	5	0	3

Table 21- Iconoscope Evaluation Example

THE WINNING CONDITION

A potential game scoring/reward function provided in the example above is as follows:

- If all 3 players guess correctly, the player presenting the diagram receives 0 points.

- If none do, the participant presenting the diagram receives 0 points.
- If some do but some do not, the player presenting the diagram receives 2 points for each unsuccessful guess.
- Any participant who guesses correctly what the diagram stands for receives 1 point.

In this scoring system opponent player confusion is valued more (e.g. in the case of player 2) correct guesses (e.g. in the case of player 4).

9.3 ICONOSCOPE WITHIN C2LEARN PRACTICE

The following table provides descriptions of learner and teacher practice falling under each of the five elements of creativity for the Iconoscope game. Iconoscope facilitates possibility thinking and CER and social engagement. Iconoscope can be viewed as a **shorter-term**, **focused** and **more structured** C2Game activity within the possible time frames of pedagogical orchestrations in C2Learn practice (C2Learn Integration deliverable, section 3.2.1).

The Learners	**The Teacher**
A1 Possibility Thinking • The availability of icons and their visual placement allows for possibility thinking via **visual diagrams**. • Learners are requested to solve diagrammatic/puzzle problems as instigators • Learners engage in "as if" situations via visual diagrammatic reasoning • Learners explore and co- construct (designing, editing, extending) content	• The teacher can provide challenges provoking learners to get involved in possibility thinking • The use of the game encourages and facilitates learners to ask their own 'what if' questions and to engage in 'as if' activity • Devises learner activities that can only be satisfactorily completed if learners actively experiment co-constructing (designing, editing, extending) content. • Integrates the use of CER non-linear thinking techniques in the game.
A2 CER • Address a given challenge (problem) • Learners reframe the creativity icon problem posed and come up with entirely new responses to a given situation: ○ They engage in activities that disrupts their pattern of thought and action via mixed-initiative co-creation mechanisms ○ They create new diagrammatic analogies ○ They actively recombine elements of the creative challenge ○ Actively facilitate a shift of perspective, by uncovering hidden aspects of the Iconoscope	[as in A1 above] and • Intervenes (indirectly) to trigger learners' new responses by disrupting students' established routines and patterns.
B Social Engagement • Learners co-create (individually and within a group). They do that by consciously placing themselves, and their creative outcome in the wider frame of the community (whole class, school) • Learners have an interest in getting their creative activity (Iconoscope output) appreciated and valued by others.	• Assigns/facilitates: ○ individual learner work ○ collaborative learner work ○ whole class work • Encourages all learners to express their opinion. • Facilitates the learners to become aware of being in charge of their own image to others.

• Learners engage in playful action, alone and together with the others: ○ Immerse themselves in the experience of the creative process ○ Facilitate immersion in the experience of the creative process for the rest of the group ○ Are willing to take risks and/or leave their 'comfort zone' (thus possibly generating surprising individual or collaborative ideas)	• Designs peer/group evaluation into the activities, so that learners can 'promote' their creative solutions to others and peers can co-evaluate their creativity. • Emphasises the playful nature of the activity (as opposed to the formality of a 'lesson'). • Withdraws from the stage as much as possible, becoming an observer and facilitator of the play (possibly also a co-player or 'meddler' at times at the same time as retaining the teaching agenda) • Allows space for learners to take risks outside 'comfort zones', by encouraging the generation of surprising ideas and avoiding criticism of unconventional thought

Table 22 - Framing of Iconoscope with C2Learn Practice

9.4 ICONOSCOPE WITHIN PLAYFUL C2LEARN PEDAGOGICAL PRACTICE

The following table provides insight into how Iconoscope links to the C2Space properties and is realised as a C2Experience with respect to the key elements of C2Learn pedagogical practice and learning design.

Iconoscope within C2Space	**Iconoscope as a C2Experience**
A1 Possibility Thinking • Addresses and poses challenges • Encourages/motivates learners to keep thinking differently and address challenges creatively • Keeps track of the possibility thinking activities so that learners can reflect on them both in their efforts to address the challenges, as well as in their evaluation of the experience afterwards.	• Facilitates learners to get involved in playful exploration of a given possibility space, or co-construct a new possibility space, e.g. by: ○ Requiring them to pose their own 'what if' questions and to engage in 'as if' environments ○ Requiring them to explore and co- construct (designing, editing, extending) content • Enables/enhances the application of CER **(diagrammatic)** non-linear thinking techniques (see below).
A2 CER [as in A1 above] and • The design of innovative/interesting visual diagrammatic 'disruptors' (elements that disrupt learner's established routines and patterns), as well as experimenting with their introduction and use within the activities, by taking advantage of digital adaptive technologies: **mixed-initiative procedural content generation and user profiling**.	[as in A1 above] and • Includes diagrammatic visual elements disrupting learners' established routines and patterns ○ without teacher's intervention/trigger ('automatically') ○ or even, facilitating teacher's intervention
B Social Engagement • Offers opportunities for individual, collaborative and communal activity. • Provides access to, organization, and overview of the creative activities.	• Provides opportunities for individual creativity. • Affords collaborative and communal activity realized within the group.

• Provides game-like triggers and information, such as gauges, scores and badges. • Foregrounding solutions/ creations that the groups and community evaluate as interestingly surprising (rewarding those taking the risk to leave 'comfort zones') • Keeping trace of the activities so that learners can reflect on them in their evaluation of the experience afterwards.	• Encourages the expression and consideration of different viewpoints • Involves exploration of what is lying behind a given challenge or situation, including hidden consequences. • Includes moments of decision making and of translating decisions into action. • Enables students to engage/disagree/challenge with one another/each other to gain feedback during digital gameplay.

Table 23 - Framing Iconoscope within the Playful C2Learn Pedagogical Practice

9.5 USE OF C2LEARN COMPUTATIONAL TOOLS

The use of C2Learn computational tools in this game is presented in the Table below. Iconoscope primarily utilizes the **mixed-initiative procedural content generation** tool (see D4.3.2) as C2Assistants available in the game suggest entirely new diagrams of suggest new shapes to be used during the creation. The C2Create tool (see description in section below) is the foundation for the use of mixed-initiative design in this game. Suggestions provided during player creation will be guided by particular heuristics such as diagrammatic **novelty** (Mad Scientist) from an archive of diagrams that have been stored for each concept, **typicality** (Typical Tom and Progressive Petra) towards (or against) the typical set of icons defined by the teacher, **value** towards the winning diagrams under each concept (Wise Oracle), winning diagram balance or randomness (Chaotic Kate). Each C2Assistant persona will be guided by each one of the selected heuristics (or a combination of heuristics) and each suggestion will be dynamically adjusted based on the diagram currently created. The detailed descriptions of diagrammatic heuristics are provided in the D4.3.x deliverable series.

The game **will inform the user profiling** service by storing the following information: user id, group id, concept picked, diagram created at each step of the interaction (representation in XML format), C2Assistant used, C2Assistant suggestions at each step of the interaction (representation in XML format), suggestions picked, final diagram submitted, votes/tags from all players for each diagram, game score for each player.

The user profiler, in turn, **may influence** the behaviour of one or more C2Assistants with respect to the diagrams they suggest and/or the initial shape/icon set each player has available realizing a form of dynamic difficulty adjustment based on earlier performance in the game.

C2Game: Iconoscope			
C2Learn Tool/Service Type		**Computational Tool**	**Use (*) / Potential Use (o)**
Semantic Reasoning Computational Tools	Tools fostering Idea Conception	Thinking Seeds Generator	
		Web Miner	

		Cloud of Thoughts	
		Competitive Thinking Spaces	
	Tools assessing Dimensions / Aspects of Creativity	Novelty Computation	
		Surprise Computation	
		Impressiveness Computation	
		Creativity Points Computation (Text-on-Text)	
	Supporting Tools	Search Engine Wrapper	
		Text Clustering	
Diagrammatic Reasoning Tools	Tools fostering Idea Conception	New Graph Retrieval	
	Tools assessing Dimensions / Aspects of Creativity	Novelty Computation	o
		Typicality Computation	o
	Supporting Tools	Mind Mapping Server	
Mixed Initiative Co-Creation		Mixed-initiative Procedural Content Generation (C2Create variants)	*
Profiling		User Profiler	*

Table 24 - Applicable tools for Iconoscope

9.6 CONNECTING ICONOSCOPE TO THE C2SPACE

Game specific badges obtained by the learners are represented in the table below.

Badge Name	Accomplishment
The Apprentice	Play at least one game of Iconoscope.
The Mentor	Play at least five games of Iconoscope.
The Innovator	Win at least one game of Iconoscope.
The Artiste	Win at least five games of Iconoscope.
The Gustave Moreau	Exactly half of the players guess your concept correctly

Table 25 - Badge Descriptions for Iconoscope

10 C2FUN ACTIVITIES

As mentioned earlier, the two activities described in this section can be used both as standalone C2Fun activities and as supporting technological components for the C2Games and C2Asssitants activities in the C2Space (see section 4).

10.1 CREATIVE STORIES

Creative Stories is a collaborative storytelling C2Fun activity where the participating groups are called to write a story in fragments, under a theme defined by the teacher. The application demonstrates potential use of tools for semantic reasoning for use in gameful designs and activities in C2Space. The players can use input from the teacher or from various computational tools in order to progress with their story and gain creativity points. Furthermore, they can observe and use the creations of the other teams and use some elements in their story. The teacher can observe the player's progress during play and monitor each group's activity, providing hints to a group when he thinks it is necessary. The goal of the game is defined by the teacher, and it could be the accumulation of a certain score, the creation of a story of specific length or playing the game for a certain time.

During play, the users can use automated input from computational tools for obtaining stimuli for continuing with their story, or compete with the other teams for using certain terms in their story (see Fig. 20 and Fig. 21 below).

The functionality of Creative Stories and the usage of computational tools within it are described in detail in deliverable D3.1.2, Semantic Reasoning Computational Tools.

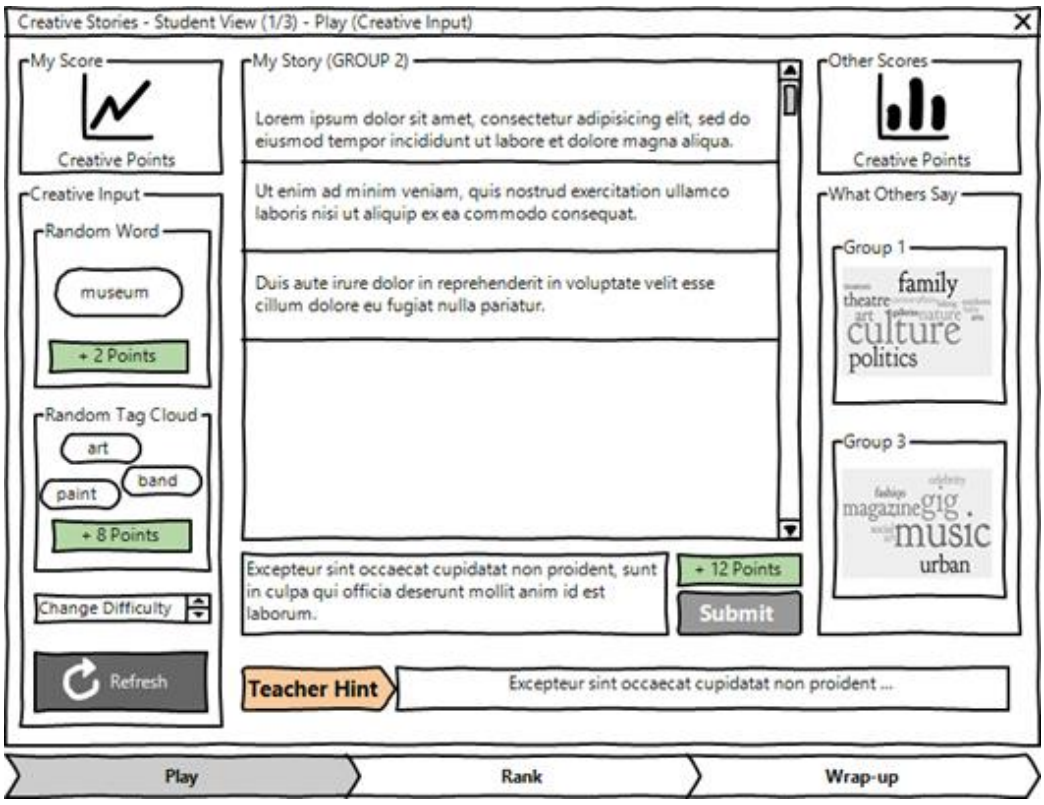

Figure 20- Using Creative Input in Creative Stories

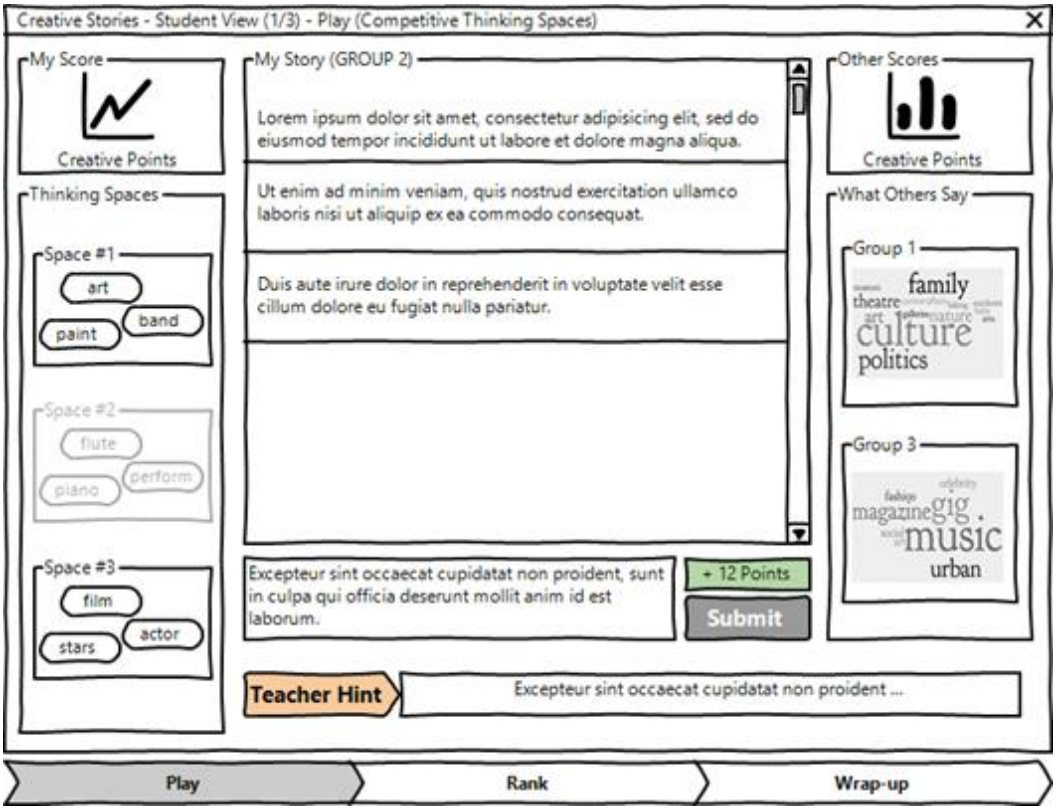

Figure 21 - Using Competitive Thinking Spaces in Creative Stories

10.2 C2CREATE

The Crayon Co-Create (C2Create) tool allows users to create abstract drawings by adding and manipulating geometrical shapes. The tool realizes mixed-initiative co-creation – see deliverable 4.3.1 for the first version of the tool and (Yannakakis et al., 2014) – whose principles are used in several of the C2Game activities described already. C2Create is designed with the objective of fostering creativity in young students, by influencing their lateral path and broadening their possibility space with surprising ideas generated by the software. This is achieved via a suggestion system, which constantly generates new drawings for users to consider while they interact with the tool.

The tool interface (see Fig. 22) is divided into three main windows. The *toolbox* window on the far left allows control over the shape being drawn, its colour, as well as allowing existing shapes to be erased. Any drawing consists of a combination of shapes: in its current version, the C2Create includes *square*, *circle* and *line* shapes. Shapes also have an associated colour chosen via the RGB wheel present in the toolbox. While the current implementation of those three basic shapes may yield substantial drawing complexity (as demonstrated by the designs obtained through pilot studies of the tool) additional shapes (e.g. triangles) are considered for future implementations of C2Create providing further drawing possibilities to the user.

The *canvas* is the main drawing window, placed at the centre of the user interface. On the canvas window users can draw their selected shapes through dragging and dropping. Finally, the *suggestions* window (a C2Assistant functionality) on the far right displays up to eight suggestions generated by the software that can be associated to up to a set of C2Assistants. At any time, users can replace their current drawing with any of the generated suggestions by clicking on them.

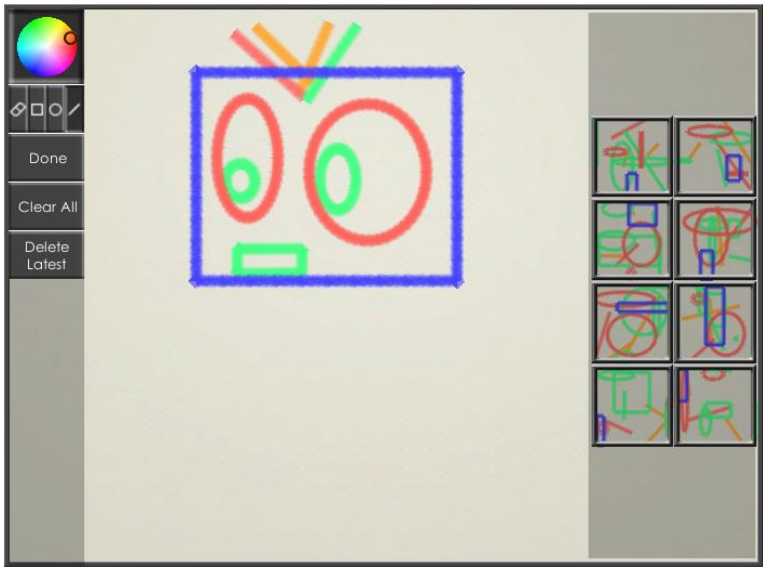

Figure 22 - The C2Create Prototype Interface

The objective of C2Create is to establish itself as a **colleague** or a **co-creator** (or within the C2Learn terminology as a set of diagrammatic C2Assistants) capable of providing innovative and helpful solutions to the learner's current creative process. Suggestions are meant to inspire and alter a learner's diagrammatic lateral thinking process by providing unexpected and novel designs. Each interaction with the tool (i.e. adding, erasing a shape or choosing a suggestion) updates the suggestion windows with newly generated designs. Suggestions are not meant to completely transform user created designs, but provide innovative and unexpected alterations of the user's design.

The complete description of the C2Create tool and its underlying artificial intelligence technology (mixed-initiative procedural content generation) is provided in the 4.3.x series of deliverables where the mixed-initiative procedural content generation prototype development is reported.

10.3 CONNECTING C2CREATE AND CREATIVE STORIES TO THE C2SPACE

C2Create is has a dual role in C2Space. It can be used as a standalone application for the **element creation** activity as described above (see Section 5.4.1. Procedure of Element Creation) whereas its underlying mixed-initiative co-creation (diagrammatic) component and principles are directly utilized from all C2Games that incorporate maps, images and icons: i.e. Alive Maps and Iconoscope. Similarly, the Creative Stories can be used as a standalone playful activity, and as an application used when creating texts in element creation and modification.

Feedback to players in form of tracking and awarding progress is given in C2Create and Creative Stories the same manner as for the other games. When C2Assitants are active, they give players presents in the form of images when threshold values are reached. Players are given specific badges for using C2Create and Creative Stories respectively as described in Table 26.

Badge Name	Accomplishment
Initiate Story Builder	Create at least 10 story fragments
Sketcher	Create at least 5 sketches

Veteran Story Builder	Create at least 25 story fragments
Painter	Create at least 15 sketches
Virtuoso	Obtain the Veteran Story Builder and Painter Badges

Table 26 - Description of Badges within C2Create and Creative Stories

11 SUMMARY

This deliverable served as the C2Learn game design document for all **digital** play and game activities within the C2Learn environment. We started by connecting the game design process to the first game design deliverable (D4.1.1) and then we placed the work of this deliverable in the overall C2Space as identified by the interim C2Learn Integration Deliverable.

We have identified the key properties of the C2Space and designed common features across all game and play activities in that environment, which act as overarching layers amongst them (i.e. creativity elements, C2Assistants, presents, awards and badges) offering the experience of a **gameful social co-creativity space**. After the description of C2Space we proceed in presenting four C2Game activities (4Scribes, Constellations, Alive Maps and Iconoscope) and the variants as well as two C2Fun activities (C2Create and Creative Stories).

The palette of these activities within the C2Space and their dissimilarity with respect to game genre, pedagogical goal, and theoretical scope offer a holistic C2Learn playful experience that both realizes all aspects of C2Learn theory and is directly usable for C2Learn pedagogical practice.

This deliverable offers the main input for the *C2Learn Game Prototyping deliverable* series (D4.4.x).

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