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

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Overview of the C²Learn approach: cohesion and consistency in the project

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1 Introduction

This document describes the links between, and cohesion of, the different elements of the C²Learn project. It provides a concise description of how underlying theories, methodologies, designs, technologies and their piloting fit together into a consistent whole which serves the purpose of producing the final C²Learn outcomes.

It is a report to the Project Officer which takes into account the feedback received from the Project Reviewers after the first Project Review, and has been composed as a response to one of their recommendations.

1.1 Time frame

C²Learn is a three-year project. The first year of the project was largely devoted to refining the theoretical and methodological background, as well as to delivering the first early designs and prototypes and their trial, always in close collaboration with user communities in a continuous, iterative process of co-design and evaluation. Thus, the first project year foregrounded a broad examination of possible approaches and options relevant to the project objectives. On this basis, in the second and third years the project is focusing sharply on selected appropriate options and their implementation leading to the final project products.

In this context, the current report reflects important decisions made in the project in the first five months of the second project year (M13-M17), in a process that had started already before the First Review meeting and was intensified immediately after that.

In this context, the present document constitutes an important milestone, denoting the transition of the project into its main phase of intensive piloting with a clear vision and practical understanding of how its rich array of theories, methodologies and technologies integrate into a single approach leading the delivery of a valuable unified ICT-based solution at the end of the project.

1.2 Disambiguation of the term 'environment' in C²Learn

The term '*environment*' has been used to describe various elements of the C²Learn project. For clarity and easy of reference, in the present document and from now on the following terminology is established:

- The C²Learn pedagogical environment
- The C²Learn digital environment.

The C²Learn pedagogical environment is an educational space in the widest sense in which co-creativity as theorized in C²Learn occurs. The C²Learn pedagogical environment can be a classroom, or another educational space outside the classroom, or even a wider space of learning in school and beyond.

The C²Learn digital environment is one of the technological assets of the C²Learn pedagogical environment. The C²Learn digital environment is the '*digital gaming and social networking environment incorporating diverse tools*' envisioned by the project. As described in section 4 of this document, The C²Learn digital environment is a gamified social

networking environment integrating the various digital games, other playful digital tools, and other project technologies into a unified user experience.

Thus, the C²Learn pedagogical environment encompasses the C²Learn digital environment.

The C²Learn pedagogical environment overall is *gamified*, and so is the C²Learn digital environment within it. Gamification permeates all activity in the C²Learn pedagogical environment, including the gamified digital experiences.

1.3 Structure of the document

This introduction (section 1) is followed by the four main parts of the document. Section 2 provides an overview of the parts of the C²Learn project and of their important interrelations. On this background and to further illustrate the approach, section 3 focuses more closely on the elements of pedagogical practice, and section 4 on the elements of playfulness including digital gaming in C²Learn. Finally, section 5 provides a closer look into how the various parts of the C²Learn experience are orchestrated into educational scenarios.

2 Overview: the flow of elements in the project

This part provides an overview of the parts of the C²Learn project and of their important interrelations. The focus is on the progression from the theoretical foundations of the project to the various designs, their development, and eventually their pilot implementation and evaluation in real life educational settings. This is summarized visually in Figure 1, and explained in some detail in the subsequent sections.

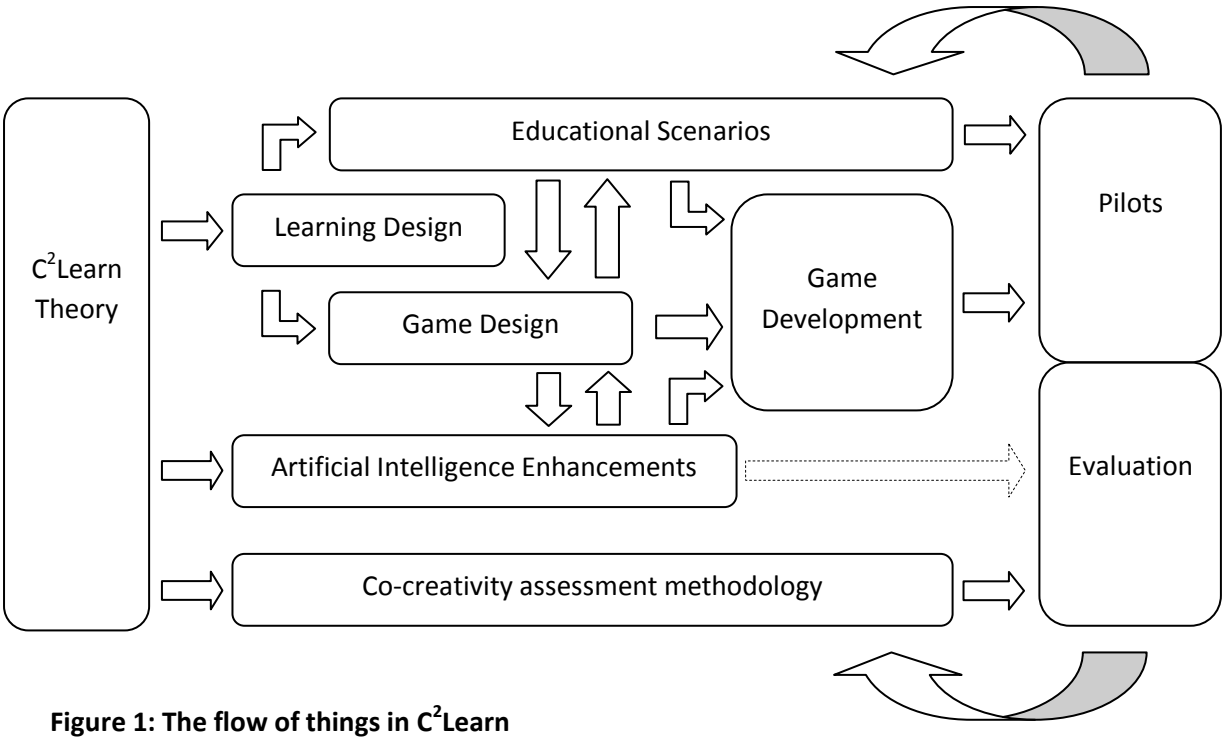

Figure 1: The flow of things in C²Learn

More specifically, section 2.1 describes how C²Learn theory constitutes the starting point and overall frame of the project, as well as the ways in which this theory is operationally offered to the various project strands (in the form of Creative Emotional Reasoning techniques, learning design, and co-creativity assessment methodology). Then, section 2.2 focuses on game design, and section 2.3 on the Artificial Intelligence background technologies which constitute part of the C²Learn technological solution. Section 2.4 presents the user-centred approach of the project as manifested in cycles of iterative co-design with school communities (including the development of educational scenarios). The design phase is followed by technology development and integration into the C²Learn game technologies, which is presented in section 2.5. Section 2.6 concludes the overview of the C²Learn project in this chapter with a discussion of pilots and evaluation.

Overall, it should be noted that the aim of this document is not to provide detailed definitions of the various parts of the project. Such information is available in the project deliverables and not repeated here. The focus of this document is rather on providing an overview of how these parts of the project fit together eventually leading to the final C²Learn products.

2.1 C²Learn theory

The foundations of the project lie in a consolidated theoretical framework encompassing the theories of Wise Humanising Creativity (WHC) and Creative Emotional Reasoning (CER). This framework is referred to in this document as 'C²Learn theory'.

C²Learn theory provides insights into how co-creativity of children and young people can be fostered in formal and informal learning settings through the use of the envisioned C²Learn digital environment and the gaming and other technologies integrated in it.

The design and development of this innovative solution with the potential to foster co-creativity as theorized in C²Learn is the main goal of project. C²Learn theory therefore defines the vision of the project, framing the envisioned C²Learn technologies. In addition, C²Learn theory defines the wider conceptual and pedagogical framework in which the use of C²Learn technologies and C²Learn-inspired learning and teaching practices are placed. Thus, starting from C²Learn theory, the project produces theoretically framed technological innovation combined with designs for its deployment, use, and evaluation in real educational practice.

C²Learn theory encompasses a rich conceptual framework. Probably, not all of its aspects may be equally strongly reflected in each one of the various parts of the C²Learn solution. However, the solution on the whole is framed by C²Learn theory as a coherent whole. One of the main and most interesting challenges of the project is to design the appropriate configurations of the various parts of the C²Learn solution so that each one of them is optimally anchored on the theory, and so that their orchestration represents an application of the whole of the theoretical framework.

While C²Learn theory is the driver of the project, its definition is not a central project aim since the theoretical foundations of C²Learn were already available at the outset. However, part of the project effort in the first year was devoted to the integration of its two theoretical pillars, WHC and CER, into a unified theoretical framework which would provide unified conceptual and methodological input into the rest of the project processes. Nevertheless, theoretical work continues throughout the project, being part of the iterative process of the project. The piloting and refinement of the produced innovation will lead to refinement of the theory by the end of the project, just as it will lead to adjustments in the technology and practices around it.

2.1.1 Theory operationalised

C²Learn theory is provided to the project in an operational form so that it can be used for the design and evaluation of the C²Learn solution. Thus, the theoretical framework is manifested as:

- CER techniques, which offer ways for the application of CER in practice. These are defined in deliverables D2.1.x 'Creative Emotional Reasoning'. CER techniques inform in particular aspects of the Artificial Intelligence enhancements discussed in section 2.3 of the present document, as well as parts of the learning design (see next bullet point below).

- Learning design, which describes how WHC and CER, related components of co-creativity, can be enacted in pedagogical practice. This is defined in deliverables D2.2.x 'C2Learn Learning Design for CER'. Some further insights into how this important aspect of the project shapes the final C²Learn solution are provided in section 3 of the present document. In summary, learning design predominantly frames game design (section 2.2 of the present document) and educational scenarios (section 2.4.1 of the present document).
- Co-creativity assessment methodology, which is used in the pilots to establish to what extent and in what ways the solution produced by the project has the desired effect. This is defined in deliverables D2.3.x 'Co-creativity Assessment Methodology', and presented in overview in section 2.6 of the present document.

2.2 Game design

Playfulness and in particular digital gaming constitute C²Learn's chosen means for the involvement of learners and educators in WHC/CER practices. Therefore the design of the playful elements is central to the definition of user experience in C²Learn. Section 4 of the present document provides further focus on the aspects of playfulness in the project.

Game design is the project process which defines the elements of learners' playful digital experiences, and produces the specifications for the development of the corresponding digital games and other digitally-enabled playful activities. While the design of digital products is the main focus, the process of game design may also propose playful elements of the C²Learn experience which will be implemented in the gamified C²Learn pedagogical environment through non-digital means.

C²Learn theory frames game design, so that the designed playful digital experiences can foster co-creativity as theorized in C²Learn. This is done through learning design, which constitutes the main initial input of game design. Important relevant aspects of learning design are focused upon in section 3 of the present document.

Game design thus translates the theoretical and pedagogical propositions of the project into designs for corresponding digital games and other playful digital activities fostering co-creativity. These designs may be based on the adaptation of existing game designs which are repurposed so that they can afford C²Learn co-creativity, or may be completely novel designs inspired from C²Learn theory.

An additional task for game design in C²Learn is to devise ways for the integration of the background Artificial Intelligence (AI) technologies of the project (described in section 2.3 of the present document) into the C²Learn games and other playful activities, exploiting the potential offered by these technologies both for enhanced playfulness and for added learning value – the latter of course originating in learning design.

Game design is focused on elaborating designs appropriate for technological development. The details of the pedagogical use of the designed games and playful activities in learning settings is defined by educational scenarios, which frame the implementation of creative learning activities in the pilots. There is an interactive relationship between game design and pilots: initially the educational scenarios provide ideas for C²Learn activity in given

educational settings; then game design proposes games and playful activities for use in those educational settings; and subsequently educational scenarios are updated to incorporate the use of the elements proposed by game design, providing the concrete framework for the implementation of the pilot activities. Educational scenarios are further discussed in sections 2.4.1 and 5 of the present document.

Overall, game design in C²Learn is a complex task requiring iterative, collaborative multidisciplinary work. It is led by the game expert group of the project, but required close collaboration with the theory, pedagogy, and technology teams. The process starts with a translation of the theoretical background and corresponding pedagogical priorities into an initial design negotiated and agreed between game designers and theory and pedagogy teams. This may be developed through play-testing, using paper-based prototypes. Emerging out of this initial phase, or immediately following it, is the identification of ways in which the background AI technologies can be meaningfully and purposefully used to enhance the playfulness and learning value of the experience that is being designed. The outcome is the final design including integration of the artificial intelligence enhancements, which is delivered for digital realization through the development of the C²Learn game technologies (discussed in section 2.5 of the present document).

Game design in the C²Learn project is defined in deliverables D4.1.x 'Game Design'.

2.3 Integration of Artificial Intelligence enhancements

An important innovative element of the playful digital experiences designed is the exploitation of background Artificial Intelligence (AI) technologies from the fields of knowledge acquisition and representation, and mixed-initiative procedural content generation. These assistive technologies are offered as web services available for integration into to the C²Learn game technologies.

The use of the background AI technologies offers opportunities for learners' further empowerment as creators and creative thinkers within the defined frame of co-creativity as theorized in C²Learn. Thus, input from the background AI technologies is integrated into the playful digital experiences to help make thinking processes even more playful and more challenging, e.g. by presenting the player with an unexpected reframing of the problem at hand or with an extended possibility space. In addition, integrated background AI technologies help the system (and the teacher) 'understand' and adapt to learners during their playful digital experiences. These are aspects that game design takes into account and purposefully integrates into the digital games and other digital playful activities, as discussed above (section 2.2). Finally, elements of the background AI technologies can prove useful as secondary contributions to evaluation, as discussed in section 2.6.2.1 of the present document.

In the first project year, some of the background AI technologies were also made available for use outside any wider playful digital experiences, through stand-alone tools such as the computational tools palette and the mixed-initiative procedural content generation prototype. These early prototypes mainly served purposes of demonstration of possibilities to the consortium and of limited trials of elements of the project approach in the first

project year. Stand-alone tools offering the background C²Learn technologies for independent use remain within the solutions offered by the project, but the integration of these technologies into the design of the playful digital experiences is the priority in the second and third project years.

The background AI technologies are defined in deliverables D3.1.x 'Semantic Reasoning Computational Tools', D3.2.x 'Diagrammatic Reasoning Computational Tools', D3.3.x 'Emotive Reasoning and Emotion Detection Computational Tools', D3.4.1 'User Profiling and Behaviour Detection', D3.5 'Computational Tools Interoperability Specification', and D4.3.x 'Mixed-initiative Procedural Content Generation'. The following sections provide and overview.

2.3.1 Creative Emotional Reasoning (CER) tools

The C²Learn background technologies from the field of knowledge acquisition and representation include information extraction, text and graph analysis, domain modelling, and adaptive dialogue systems. These are used to equip the learner with tools supporting Creative Emotional Reasoning (CER) as theorized in C²Learn.

The project extends existing computational tools and develops new computational tools supporting CER, including semantic, diagrammatic and emotive lateral thinking. Through the adaptation and customization of existing state-of-the-art information extraction, and text and graph analysis technologies, the project produces semantic reasoning tools and diagrammatic reasoning tools. In addition, the project develops innovative computational tools supporting emotive reasoning, by detecting and representing emotive state and its change, thus enhancing players' awareness of the emotive impact of their actions.

2.3.2 Mixed-initiative procedural content generation

The background AI technologies also include mixed-initiative procedural content generation (MI-PCG). Learners' playful digital experiences are enriched through the application of mixed-initiative human-machine co-creation processes, in which the learner and the computer co-create content for the playful digital experience. This content may be generated either due to a relevant requirement of a specific playful activity within the context of that activity, or generated merely through user initiative and shared with others. The overall aim is to empower learners as creators: they create their own assets, maybe also inspired by others' creations, and they use those assets in their playful activities.

2.3.3 User profiling & adaptive experience

The playful digital experience is dynamically modified by the system and adapted to each user's characteristics, so that the user is presented with a personalized experience of enhanced playfulness and increased opportunities for co-creativity as theorized in C²Learn. This customization is realized through the use of adaptive dialogue techniques and a user profiling service based on modeling of personal, behavioural, and contextual data, including the input from the emotion detection technologies of the project. This modelling is initially based on manually designed user stereotypes but, as user data become available, machine learning techniques will also be used for updating/refining these stereotypes or discovering new clusters of user groups.

2.4 Co-design with school communities

All processes of design described above are carried out by engaging end-user school communities in iterative dialogic cycles leading to the various design decisions and their implementation. These cycles typically include pre-pilot co-design workshops, pilots of C²Learn experience in real life educational settings, and post-pilot co-design workshops operating as the entry points to a new cycle leading to piloting (Figure 2).

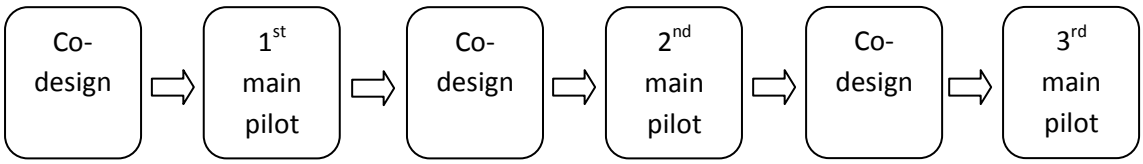

Figure 2: Co-designing and piloting together with school communities

The consortium has invested effort in building communities of educators and students around the C²Learn project, in Austria, Greece and England. In close collaboration with these communities, research teams in the three countries gather user requirements, co-design locally appropriate solutions for the introduction of the proposed C²Learn innovation in real-life learning settings, and negotiate and plan various instances of such an introduction for the purposes of piloting and evaluation.

Details of this process, including timing and other organizational aspects, are defined in deliverables D5.2.x 'C2Learn User Evaluation Plan'. Important outcomes of this process are the educational scenarios, which are discussed below in section 2.4.1, and defined in deliverables D5.1.x 'C²Learn Scenarios, Use Cases and User Requirements'. Finally, since piloting is closely interwoven with evaluation, it is discussed in more detail in section 2.6 further below.

2.4.1 Educational scenarios

Educational scenarios constitute that aspect of the design of the C²Learn solution which is most strongly shaped by the collaborating school communities and framed by their educational realities. They are a design tool aiming to provide input directly from educational practice, so that the innovative technologies deployed and practices introduced will correspond to the needs, circumstances, expectations and aspirations of the end users. At the same time, they illustrate to the world of education the range of possibilities offered and examples of effective use of the C²Learn solution.

Educational scenarios 'translate' learning design and game design into plans for the implementation of concrete activities in real life educational settings, predominantly in the pilots run within the project, but eventually also in other educational settings. They are developed collaboratively with educators, and their development is interwoven with processes aiming at establishing user expectations and requirements.

Educational scenarios are developed in three main iterations, while they remain open to elaboration and refinement throughout the project. In the very early stages, scenarios

started as short narratives illustrating possibilities meaningful to users, aiming to present a range of potential directions without being prescriptive. Later on in the first project year, the original scenario ideas were critically examined and selected scenarios were further elaborated. From the second project year onwards, educational scenarios are being transformed from open and generic ideas into concrete use cases, i.e. detailed designs of C²Learn experience in given educational settings. In this sense, scenarios are now becoming an important input into technology development and integration, shedding light on pragmatic restrictions and priorities.

The above described procedure applies to the use of educational scenarios as tools used to frame and shape the pilot activities in the project. In the long term, educational scenarios are provided to teachers and learners as open-ended tools encouraging them to develop their own designs of C²Learn activity, outside the pilots and beyond the end of the project.

Educational scenarios are defined in detail in deliverables D5.1.x 'C²Learn Scenarios, Use Cases and User Requirements'. In the present document, section 5 offers a closer look into how educational scenarios provide the integration of the various parts of the project into a coherent C²Learn user experience in a given educational setting.

2.5 Development of the C²Learn technologies

The final designs delivered by game design are subsequently developed through the deployment of game technologies. AI enhancements are integrated into these as specified by game design. Game technologies, with AI enhancements integrated into them, constitute the digital product of the project. This includes various smaller digital games or other playful digital tools, and the C²Learn digital environment, a gamified social networking environment integrating the various technologies and overall the C²Learn digital solution into a unified user experience – appropriately positioned within the wider framework of the gamified C²Learn pedagogical environment.

Technology development uses educational scenarios as a source of specific information of the pragmatic context of use of the technologies in the pilots, so as to adjust and prioritize accordingly. The outcomes of the process are fully working, user-engaging technological prototypes delivered for trial during the project and for further exploitation beyond its end.

The development of the game technologies and its documentation constitute deliverables D4.4.x 'C²Learn Game Prototyping'. In the present document, section 4 provides details of the various parts of the digital product and of their interrelation, in the context of a discussion of the aspects of playfulness in C²Learn.

2.5.1 Interoperability with learning technologies

C²Learn technologies are implemented according to interoperability specifications based on Learning Technology standards (such as ADL SCORM, IMS LD, ADL xAPI and ADL Learning Registry) as well as standards from other domains (e.g. Workflow Management: BPEL), so that they can be interoperable with other standard-conformant e-learning technologies. The relevant provisions made by the project are documented in deliverable D4.2 'C²Learn Content Representation'.

2.6 Pilots and evaluation

The aim of piloting in the project is to test and evaluate with users the C²Learn experience, including both the technologies developed and the pedagogical practices enabled by these technologies. In the pilots, educational activities specifically shaped around the use of the C²Learn technologies and methodologies are implemented in real-life educational settings, as foreseen by the educational scenarios (cf. section 2.4.1 above). The aim is to create conditions for evaluation, which provides the project with feedback used for further refining design and development and for introducing adjustments and improvements.

2.6.1 Pilots in schools

Piloting in C²Learn is a complex process, the conceptual and organisational details of which are provided in deliverables D5.2.x 'C²Learn User Evaluation Plan' and D5.3.x 'C²Learn User Pilots'.

In summary, the pilots are realized in Austria, Greece, and England, in selected school communities collaborating with the project. Overall the pilots cover all learner age groups targeted by the project and other educational setting details, by distributing them to the various pilot sites based on availability and other local conditions.

User piloting of the innovation is realized in four ('1+3') pilot cycles. The first introductory pilot cycle was limited in scope and completed towards the end of the first project year. In the remaining of the project, there are three main pilot cycles:

- The 1st main pilot cycle will have been completed by M21 (July 2014). This includes very limited use of paper-based prototypes and focuses mainly on the use of the first early digital prototypes of the integrated products. Due to restrictions imposed by school life (Easter holiday periods, exams, end of school year), this cycle only includes as much pilot activity as pragmatically possible.
- The 2nd main pilot cycle was originally planned for M25-M30 (November 2015 – April 2015). However, current planning foresees that it will start earlier, in September 2015, so that it can span over eight months, i.e. most of a whole school year. This is the central piloting activity of the project.
- The 3rd main pilot cycle is much shorter and carried out close to the end of the project (M34-M36; August – October 2015), aiming at finely adjusting and finally shaping the project products.

All pilot implementation activities are underpinned by a clear set of ethical principles, and the project follows rigid procedures relating to the handling of personal data (including personal data of minors), complying with all relevant policies followed locally in each participating school.

2.6.2 Evaluation

Evaluation is realized during the pilot activities in real-life educational settings through the application of a co-creativity assessment methodology specifically developed on the basis of C²Learn theory. The core aim is to evaluate C²Learn's impact on learner's co-creativity as theorized in the project, by documenting change as well as the lived experience of engaging in C²Learn-enabled activity.

The co-creativity assessment methodology is applied in fieldwork during the pilots with the purpose to collect mainly qualitative data. The data collected is then analysed to lead to critical descriptions of the activities, evaluative findings and conclusions.

The methodology for the assessment of co-creativity is defined in deliverables D2.3.x 'Co-creativity Assessment Methodology'. Data analysis and evaluation findings are documented in deliverables D5.4.x 'Co-creativity Evaluation Analysis'.

2.6.2.1 Computational metrics

Evaluation in C²Learn is carried out by humans applying the co-creativity assessment methodology of the project, as described above. However, the use of the various background AI technologies in the project may offer some potential for secondary computer-generated contributions to this evaluation, which the project is currently investigating. Such contributions involve adaptation of creativity metrics originating in work on computational creativity.

The use of computational metrics does not question and does not affect the application of the richer, qualitative framework of co-creativity assessment as theorized and operationalized in the project. However, such metrics may be useful tools fostering co-creativity by contributing to the gamification of user experience, e.g. through computer-generated measurements in playful devices such as user scores and activity gauges.

Finally, there is an additional link between the co-creativity assessment methodology of the project and the background AI technologies, especially user profiling. Categories of manifestation of co-creativity as defined by the co-creativity assessment methodology are needed as a starting point for the initial modelling of C²Learn user behavior in the manually designed user stereotypes, which will be later refined or replaced as user data become available and machine learning techniques can be applied.

Relevant developments and achievements are reported in the project deliverables describing the background AI technologies (cf. section 2.3 of the present document).

3 Focus on C²Learn pedagogical practice

As became evident in section 2, learning design decisively shapes the final products of the project, by framing both game design and educational scenarios, which subsequently guide technology development and piloting in educational settings. In this part of the document, some further insights are offered into how learning design defines C²Learn pedagogical practice, thus providing a pedagogical framework for the discussion of playful elements and scenarios in sections 4 and 5 respectively. The definition of C²Learn pedagogical practice is documented in greater detail and more closely linked to C²Learn theory in deliverable D2.2.2 'C²Learn Learning Design for CER'.

3.1 C²Learn learning and teaching

C²Learn is about fostering co-creativity in learning. Learners, individually as well as mainly collaboratively and also communally, come up with novelty, new ideas. These new ideas:

- Have emerged through asking 'what if' and 'as if' questions and through the use of disruptive techniques resulting in re-framing
- Have emerged from shared ideas and actions in an immersed dialogic rather than hierarchical pedagogical environment
- Are captured or selected because they matter to the community and have a valuable impact on it.

In this, learners take into account the impact of that novelty on the individual, collaborative and communal dimensions of their community.

C²Learn co-creativity is mainly about collaborative and communal creative processes in gamified learning contexts, including digital ones, and about creative outcomes generated and shared with others. Learners are collaborators and co-creators within their groups and their wider communities, without though forgetting their own wishes, interests, and needs.

Learners are motivated to be creative not just for the sake of creativity in isolation (*'I am being creative on my own and don't care if the others value this or not'*); rather, they are motivated co-creators because they recognize the value of their creativity for themselves and the others. They also have an interest in getting others to recognize and appreciate their creative activity, since the real value of this creativity materializes mainly in the group and the community through dialogue, action, immersion and being in control and not merely within the creator.

C²Learn co-creativity is not bound to any specific subject area in the curriculum. What is more, fostering this co-creativity in educational settings does not involve the teaching of factual knowledge about it. Co-creativity is rather a learner disposition within the C²Learn pedagogical environment, cutting across the curriculum and other learner competences and conditions.

C²Learn co-creativity, after all, is about changing pedagogy and learning, unleashing learners' and teachers' creative potential, revolutionising education. This has been illustrated very clearly in the 'Impact' section of Part B of the DoW (B3.1.2.2 Scientific Impact from the Pedagogical Perspective').

A *C²Learner* moves away from learning about unquestionable facts, to thinking differently and questioning the obvious and widely believed, toward generating new ideas, proposing new solutions and implementing changes, feeling, understanding and responsibly managing the usefulness and impact of novelty on themselves and the others - being intrinsically motivated to do these things through gameplay and interacting with other players and the machine.

In addition, a *C²Learner* actively helps to make all this a playful experience in which everyone is having a good time, relaxing and letting themselves 'immerse' in an activity which is more of a game and less of a lesson, considering it fun but at the same time important to them and the others. This playful experience, which has digital gameplay inherent within it, will involve challenges, quests, consequences and, we anticipate, a trajectory.

Finally, reflection on their co-creativity is important to *C²Learners*. They reflect on the value and impact of their creativity, as well as on how they and the others may be changing little by little during this adventure, what this change looks like, what has enabled it and where it is taking them next.

The C²Learn teacher intervenes as little as possible in learners' co-creative process, standing back, observing, enabling and facilitating as well as getting alongside students to share ideas as a co-learner or 'meddler' when appropriate, rather than instructing.

Clearly, then, learning for C²Learn co-creativity in some of its aspects is intrinsically different from what might in some classrooms be 'conventional' learning aimed at the transmission of knowledge. C²Learn co-creativity rather assumes *construction* of knowledge. The view of learning seen in terms of construction, informed by learners' own and social dialogic engagement draws on Piagetian and Vygotskian theory that has influenced pedagogy worldwide in the last fifty years. With a social constructivist foundation, the learning model in C²Learn is aimed at affording unlimited, self-sustained discovery of new possibilities and one's own and others' creative potential.

3.2 What C²Learn practice could look like

To help game design and the development of educational scenarios, this section offers a practical approach to C²Learn theory, which focuses on what learners and teachers may typically do in in C²Learn practice. This does not substitute C²Learn theory, an accurate representation of which is offered in deliverables D2.1.x 'Creative Emotional Reasoning' and D2.2.x 'C²Learn Learning Design for CER'. The effort here is to remain faithful to that theoretical framework, making at the same time a shift closer to practice.

3.2.1 Four elements of C²Learn practice

For these purposes, C²Learn practice can be seen as an ensemble of four interwoven elements:

- **Co-creative Thinking**, integrating Possibility Thinking and Creative Emotional Reasoning:
  - Possibility Thinking: Learners come up with new ideas through asking 'what if' and 'as if' questions. This enables them to shift from 'what is' to new possibilities of 'what might be'.

- Creative Emotional Reasoning: Learners come up with new ideas through the use of disruptive techniques for semantic, diagrammatic and emotive lateral thinking, resulting in re-framing.

- **Social Engagement**: Learners think individually as well as mainly collaboratively and also communally, in an immersive, collaborative pedagogical environment defined by flattened hierarchies enabling dialogue.
- **Ethics and Impact Awareness**: Through dialogue, learners evaluate novelty (the originality inherent in ideas, actions, and outcomes) for its ethical impact, generating or selecting and enacting ideas because they matter to the community and have a valuable impact on it.
- **Wider Picture of Change**: Over time, cyclical developments between creativity and identity occur. Learners enable change and reflect on change in longer periods of co-creative activity.

For brevity and quick reference:

A. Co-creative Thinking

A1. Possibility Thinking

A2. Creative Emotional Reasoning

B. Social Engagement

C. Ethics and Impact Awareness

D. Wider Picture of Change

These four elements are defined in greater detail and closely linked to the underlying theoretical framework in deliverable D2.2.2 'C²Learn Learning Design for CER'.

The following tables provide descriptions of possible learner and teacher practice falling under each of these elements. This constitutes part of work carried out for deliverable D2.2.2, which will provide an updated, final version of these descriptions.

A1. Possibility Thinking

The learners:	The teacher:
• Think about possibilities rather than approach learning as solely acquisition of factual knowledge('what is') • Both find and solve problems – being not only 'consumers' but also 'instigators' of problem-solving • Aim to 'think differently' and generate new ideas by exploring possibilities and perspectives: ▪ engaging in inquiry, asking 'what if' questions ○ experimenting with pluralities of places, activities, people ▪ imagining, engaging in 'as if' situations ○ experimenting with pluralities of personal identities, e.g. repositioning selves in different roles ▪ exploring and co- constructing (designing, editing, extending) content ▪ applying CER non-linear thinking techniques (see below).	• Provides challenges provoking learners to get involved in possibility thinking • Encourages and facilitates learners to pose problems to others and solve problems posed by the teacher and others • May ask learners 'what if' questions, and provide opportunities for students to engage in 'as if' activity, predominately encourages and facilitates learners to ask their own 'what if' questions and to engage in 'as if' activity • Ideally, devises learner activities that can only be satisfactorily completed if learners actively experiment with pluralities of places, activities, people, and personal identities, and/or exploring and co- constructing (designing, editing, extending) content • Integrates into the activity the use of CER non-linear thinking techniques (see A2 below).

A2. Creative Emotional Reasoning

The learners:	The teacher:
• Address given challenges (problems, dilemmas, difficult issues) • Reframe these problems, dilemmas, issues and come up with new responses to given situations: ▪ Engage in activities aiming to disrupt established routines and patterns of thought and action ▪ Create new analogies as building blocks of the creative process ▪ Actively experiment with re-combining elements of the creative challenge ▪ Actively facilitate a shift of perspective, by uncovering hidden aspects of creative challenge, going beyond the material provided by description (elements) of the challenge, recasting challenge in a new light (as a whole or re-formulating elements of it) • Generally, use CER lateral thinking techniques and engages in brainstorming tasks.	[as in A1 above] and • Intervenes (directly or indirectly) to trigger learners' new responses by disrupting students' established routines and patterns • Assigns and facilitates brainstorming tasks

B. Social Engagement

The learners:	**The teacher:**
• Co-create, that is: ▪ Create individually AND ▪ Co-create by collaborating with others within their group AND ▪ Do the above by consciously placing themselves, their groups and their creative activity in the wider frame of the community (whole class, school, local community, society at large, the world) – in other words co-create communally.	• Divides the class into groups, aiming at 'balanced' group composition (e.g. mixing 'more' and 'less' creative or active learners but also possibly mixing groups to enable different ages and capabilities, interests etc to work together) ▪ May keep the groups stable over time, or may change grouping patterns • Assigns/facilitates: ▪ individual learner work ▪ collaborative learner work ▪ whole class work • Agrees the rules with learners, and acts as facilitator, 'meddler' as appropriate and rule-keeper.
• Engage in dialogue and negotiation: ▪ Pose questions ▪ Debate between ideas ▪ Promote dialogue and respect of different viewpoints within their group, encouraging their peers to voice their ideas ▪ Actively negotiate conflict and seek alternate paths, going in a different direction if conflict is not resolved although accepting sometimes conflict is not commensurable ▪ Are generally prepared to change their mind in the space of dialogue.	• Enables and facilitates learner dialogue and debate, by assigning relevant tasks: ▪ E.g. sets challenges, poses questions and dilemmas to learners which afford different viewpoints and debate. • Encourages all learners to express their opinion and critique in a variety of forms. • When conflict occurs, allows it to be openly expressed and negotiated by the learners: ▪ Encourages learners to seek alternative paths and be prepared to change their mind.

(B. Social Engagement continued)

The learners:	**The teacher:**
• Are in control: ▪ Take charge and leading roles during different phases of the creative process ▪ Share control/leadership with others, in a context of equality and flattened hierarchies ▪ Understand the rules of the system underlying the challenges facing them and their group ▪ Understand how decisions around new ideas have consequences ▪ Make decisions around new ideas ▪ Instigate action.	• Designs ways to manage leadership within learner groups, aiming to avert domination by one or more individuals (including themselves s teacher) while encouraging individual initiative ▪ Agrees the rules with the learners ▪ May set learners the task to decide about leadership in their group ▪ May design a mandatory rotation of leadership into the tasks, or may allow for (individual or joint) leadership to emerge from the interaction ▪ Seeks to live out a flattened hierarchy where they engage with students as their equals; this means both standing back to observe carefully how students are responding and also stepping forward alongside students to 'meddle in the middle' as a collaborator as appropriate • Encourages and facilitates each learner group to explore the challenges and systemic relations underlying their immediate task, and the possible consequence of decisions that the group will make • Ensures decision making and subsequent action is an integral part of the learner task.
• Make themselves visible on their own terms: ▪ Have control of their own identity and image to others ▪ Have an interest in getting their creative activity and/or creative outcomes appreciated and valued by the others	• Facilitates the learners to become aware of being in charge of their own image to others • Designs peer/group/community evaluation into the activities, so that learners can 'promote' their creative solutions to others and peers can co-evaluate their creativity

(B. Social Engagement continued)

The learners:	The teacher:
• 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) ▪ Learn, co-create and self-create as active and connected players in emotionally rich, virtual and actual play-worlds.	• 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

C. Ethics and Impact Awareness

The learners:	The teacher:
• Consciously and systematically position themselves, their generated new ideas and their decisions about how to use these new ideas, in relation to the values of their own, of their group, and of the community, through dialogue • Explore through dialogue the good and bad consequences of the novelty on them, their peers, their group, the community • Select through dialogue ideas driven by values, and actively promote those which are deemed valuable by the group • Generally, make and evaluate through dialogue decisions which are ethically grounded and act responsibly.	• Enables and facilitates learners to: ▪ Clearly define and express their shared values ▪ Explore the impact of the new ideas and of the overall creative activity ▪ Define and express their decisions in relation to this impact.

D. Wider Picture of Change

The learners:	The teacher:
• Set goals for themselves, their group, their community, aiming at creative change of for example rules and behaviours and thus may become 'quiet revolutions'. • Act as agents enabling change in longer periods of co-creative activity (although shorter periods or one off experiences are also possible) • Reflect on their, their group's and community's activity and achievements: the 'journeys of becoming' and eventually the 'quiet revolutions'.	• Facilitates the learners to set goals aspiring and enacting creative change, thus to act as change agents, and to reflect on their activity and achievements.

3.2.2 Time-frame of C²Learn practice

In the wider C²Learn pedagogical environment, i.e. the educational space in which C²Learn co-creativity occurs, several core episodes of co-creativity may take place. Such core episodes may, for example, be one or more teaching sessions, or instances of playing a game or conducting another learning activity. Thus, core episodes are defined very broadly, to include different instantiations of C²Learn learning and teaching.

Their definition, however, helps illustrate two time frames in pedagogical orchestrations of C²Learn practice:

- shorter-term, focused and potentially more structured activities – the core episodes; and
- longer-term, reflection-oriented experiences in the C²Learn pedagogical environment.

The core episodes of co-creativity may be characterized by a faster pace and increased playfulness, while the wider environment of co-creativity may afford a slower pace of taking stock of the activity that has taken place in the core episodes and of the overall experience.

It is useful for game design and the development of educational scenarios to explore how the four elements of C²Learn practice described in section 3.2.1 relate to the above time-frame distinction:

	Shorter-term core episodes of co-creativity	**Longer-term reflection-oriented experiences**
A. Co-creative Thinking	Co-creative thinking lies in the heart of each core episode of co-creativity; core episodes are formed around tasks or initiatives of creative thinking. Part of the creative thinking in a core episode may be formalized, applying CER techniques.	Co-creative thinking that has taken place within core episodes is part of the wider C²Learn pedagogical environment. In this wider context, co-creators may reflect on and possibly re-frame the co-creative thinking that has taken place within a particular core episode.
B. Social Engagement	Co-creators are involved in social engagement of various kinds within each core episode.	Social engagement that has taken place within core episodes is part of the wider C²Learn pedagogical environment. In this wider context, co-creators may reflect on and possibly re-frame the social engagement that has taken place within a particular core episode.
C. Ethics and Impact Awareness	Co-creators consider ethics and impact of novelty within each core episode.	Ethics and impact considerations that have taken place within core episodes are part of the wider C²Learn pedagogical environment. In this wider context, co-creators may reflect on and possibly re-frame the ethics and impact considerations that have taken place within a particular core episode.
D. Wider Picture of Change	Each core episode contributes to the wider change, but the wider change is not (necessarily) an explicit focus in each core episode.	In the C²Learn pedagogical environment, co-creators may make wider plans for change, setting relevant goals. Elements of the core episodes may provide evidence of wider change. Co-creators reflect on these and more generally on the C²Learn experience.

4 Focus on C²Learn playfulness

Playfulness and in particular digital gaming are central to C²Learn, and the design leading to these is central to the definition of the C²Learn experience. The aim of this section is to provide further focus on the aspects of playfulness in the project, framing game design (as defined in section 2.2.) in C²Learn pedagogical practice as discussed in section 3.

4.1 Ubiquitous playfulness

The pursuit of playfulness is underpinning all aspects of the C²Learn experience, and is a priority served through explicit gamification strategies. Both the C²Learn pedagogical environment and the C²Learn digital environment within it (cf. the distinction made in section 1 of the present document) are playful, gamified environments. The gamified pedagogical environment is an educational space in the widest sense in which co-creativity as theorized in C²Learn occurs playfully. Similarly, the gamified digital environment, including the technologies it incorporates, is a digital space built with the purpose to facilitate and enhance co-creativity playfully.

For clarity, it is repeated here that the gamified pedagogical environment encompasses the gamified digital environment, i.e. playfulness in the wider pedagogical environment includes the playfulness of the digital environment.

4.2 Digitised C²Learn playfulness

The main purpose of game design in C²Learn is the design of digital products. Game design defines the elements of learners' playful digital experiences and produces the specifications for the development of corresponding digital games and other digitally-enabled playful activities.

However, the process of game design may also generate ideas for playful elements which will be chosen for implementation in the C²Learn pedagogical environment through non-digital means. Clearly, though, specifying non-digital playful activity in the C²Learn pedagogical environment falls within the scope of collaborative work between learning design and the development of educational scenarios.

The present discussion focuses on playfulness in the digital aspects of the C²Learn experience, which in this document are referred to as playful digital experiences. In the following sections, first the playful digital technologies are described which have been envisioned since the conception of the project. This is followed by a discussion of the 'architecture of playfulness' in C²Learn as a framework for game design. Subsequently the links are explained between the playful digital aspects of the project and C²Learn pedagogical practice as discussed in section 3.

4.3 The C²Learn digital environment: a playful, intelligent digital space fostering co-creativity

4.3.1 The vision

The C²Learn project set out with the vision to provide learners and their teachers with an innovative digital gaming and social networking environment incorporating diverse tools the

use of which can foster co-creativity in learning processes in the context of both formal and informal educational settings.

According to this vision, the C²Learn digital environment ought to be an open-world 'sandbox' (non-linear) virtual space enabling learners to freely explore ideas, concepts, and the shared knowledge available on the semantic web and the virtual communities in which they participate. It ought to be open-ended, fostering co-creativity without pre-sets or barriers, housing non-restrictive opportunities for learners to engage playfully in creative problem-finding and creative problem solving, affording and generating playful experiences which the learner can optionally engage with. No pre-set knowledge to be discovered is envisioned, nor any prescribed learning or thinking to take place. Rather, the C²Learn vision wants the learners to be enabled to explore while the system is 'learning' together with them through their learning and thinking, proposing resources and routes that the learners may wish to explore in order to further their creative adventure.

This vision has been driving early design decisions in the project, which have refined the C²Learn digital environment and its constituent parts as described below.

4.3.2 Realizing the vision through the C²Learn technologies

The C²Learn technological solution consists of digital gaming technologies as well as the background AI technologies. All these become available to the user through the C²Learn digital environment, an overall digital space which integrates all technological constituents into a unified user experience.

4.3.2.1 C²Space: an integrated digital space

For ease of reference and a more user-friendly approach, the present document introduces the name 'Co-creativity Space', or C²Space in short, for the C²Learn digital environment. This alias, as well as all aliases used further below, is temporary and provisional, intended more as a reminder of eventually offering the C²Learn solution as an inspiring, education- and kids-and-youngster-friendly product.

C²Space is the central digital entity of the technological solution. It is a gamified social networking environment designed to foster co-creativity as theorized in the C²Learn project. It is the digital space hosting all digitally enabled aspects of C²Learn activity.

As envisioned from the conception of the project, C²Space affords co-creativity through offering playful digital experiences which the learner can optionally engage with. These playful digital experiences are defined further below. In summary, and as envisioned, they include opportunities for the learner to freely explore ideas, concepts, and 'shared' knowledge, to engage in creative problem-finding and problem-solving, and be intelligently assisted in all this by the system.

Further, the definition and design of C²Space is anchored on the following core concepts emerging from the vision of the project:

- **Playfulness:** A main priority for C²Space, as well as for all its integral constituents, is to offer playful experiences to the learner. The 'architecture of playfulness' in which C²Space is positioned, is discussed in detail in section 4.4.

- **Exploration:** C²Space should afford a feel of a little-explored space, in which the learner seems to have met only part of what is available and possible and is motivated to explore what else there is.
- **Open space, freedom, nonlinearity:** C²Space should intuitively afford free 'roaming' through it, enabling the learner to choose freely how and when to approach content and activities, in a varying sequence and order.
- **Sandbox**: The learner should be allowed some flexibility to modify and personalize C²Space, to some extent creating how they interact ('play') with it.

In addition, the definition and design of C²Space, as well as of the whole C²Learn technological solution, is framed by learning design, as described further below in section 4.5.

4.3.2.2 C²Experiences: playful digital experiences

Digitally enabled C²Learn activity hosted in C²Space has been envisioned as playful digital experiences fostering co-creativity. These are provisionally termed in this document as 'Co-creativity Experiences', or C²Experiences for short.

Following the distinctions made in the vision of the project (section 4.3.1 above), C²Experiences are divided into two broad categories, which are also given provisional short names in this document:

- 'Co-creativity Explorations' or C²Explorations: Learners' free explorations of ideas, concepts, and 'shared' knowledge in C²Space
- 'Co-creativity Quests' or C²Quests: Opportunities for learners' more structured engagement in co-creative problem-finding and problem-solving. In the course of the project it has become evident that it is useful to further divide C²Quests into two types, to make the distinction between 'strictly defined games' and other non-game playful activities:
    - 'Co-creativity Games' or C²Games: structured games fostering co-creativity
    - 'Co-Creativity Fun' or C²Fun: open-ended playful activities fostering co-creativity.

4.3.2.3 'Co-creativity Assistants' or C²Assistants: intelligent digital agents

The conception of the C²Learn project also foresees that in their C²Experiences in C²Space learners are offered opportunities for intelligent assistance from the system. These digital facilities are termed 'Co-Creativity Assistants' or, provisionally here, C²Assistants. They are responsive digital agents 'personifying' the background AI technologies in learners' digital experience. They are embedded both in C²Experiences and C²Space, creating an animated environment by:

- Facilitating learners to use mechanisms of creative thinking, and generally by proposing resources or practices to learners
- Informing or alerting learners, and generally by expediting tasks and processes so that learners can effectively engage in C²Experiences.

4.4 The architecture of playfulness in C²Learn

Playfulness is manifested and facilitated through various means in C²Space and in the C²Experiences it hosts. To define this further and thus offer a clearer framework for game design, a useful distinction to make here is between 'game' and play':

- **Games**: Activities which are more structured, predictable, focused on progression, geared towards a resolution.
- **Play**: Activities which are more open-ended, less predictable, focused on presence rather than progression, geared less towards a resolution and more towards emergence, novelty, surprise.

Playfulness in C²Learn is constituted through both games and play. Figure 3 provides an overview, marking each of the above described elements of digital playfulness in C²Learn with a characterization as either 'play' or 'game', to help illustrate the overall architecture of digitally enabled playfulness in the C²Learn solution.

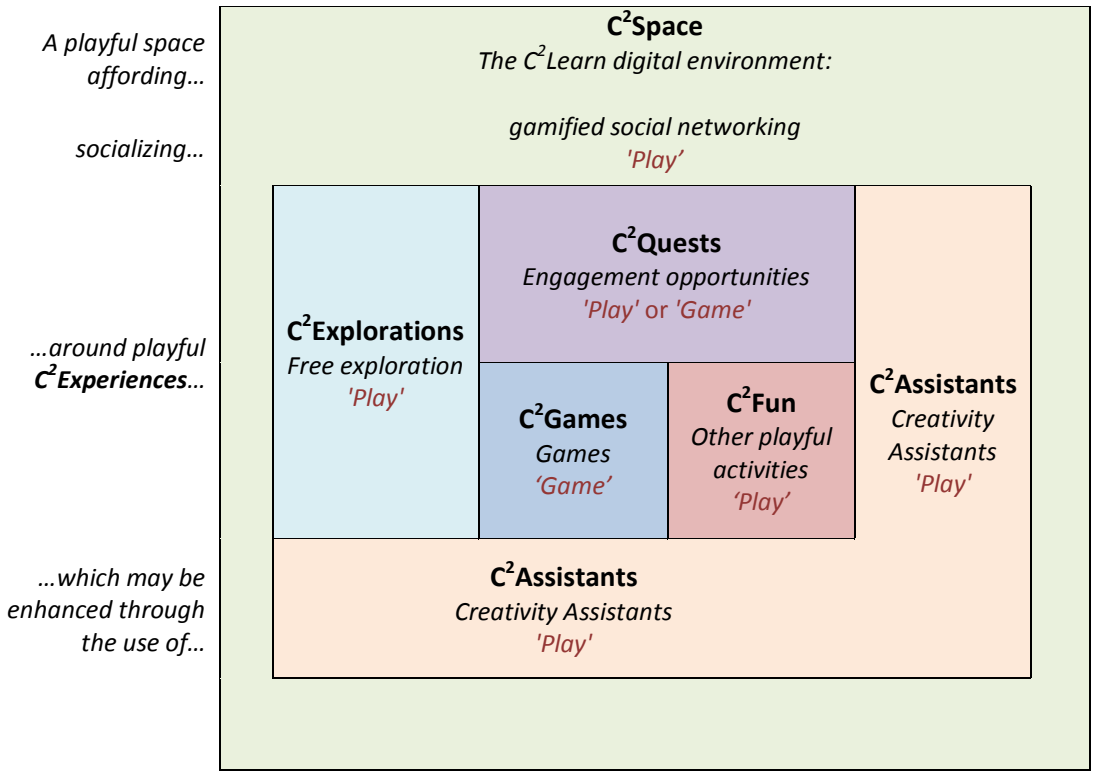

Figure 3: Architecture of digitally enabled playfulness in C²Learn

4.5 Digital playfulness in C²Learn pedagogical practice

This section describes the links between, on the one hand, the playful digital aspects of the project (sections 4.3 and 4.4), and, on the other hand, C²Learn pedagogical practice and more generally learning design and the underlying C²Learn theory (section 3).

4.5.1 Attention to the implicit 'stance' of the technologies

The design of C²Space and all C²Experiences within it should pay attention to the implicit 'stance' pedagogical of the technology. Like C²Learn teachers, C²Learn technologies should enable learning processes without becoming intrusive and prescriptive. Rather, their design should attend to means of valuing learner agency, standing back, offering time and space, and at times engaging with learners by 'meddling in the middle'.

4.5.2 Links to the pedagogy of C²Learn practice

The four elements and two time frames of C²Learn practice described in sections 3.2.1 and 3.2.2 can help define the ways in which C²Space and the C²Experiences within it can facilitate and further empower learners and teachers to engage in C²Learn practice. At large:

- C²Experiences are realized in digital spaces affording core episodes of co-creativity.
- C²Space is a digital space not only 'housing' C²Experiences affording core episodes of co-creativity, but importantly also affording longer-term, reflection-oriented experiences.

Clearly, the aim is not to digitize all C²Learn practice. Elements of both the core episodes of co-creativity, as well as of the longer-term reflection-oriented experiences, may well remain non-digital in the wider C²Learn pedagogical environment, depending on the pedagogical decisions that shape the orchestration of C²Learn experience in a particular educational setting. Overall, however, all aspects of the intended C²Learn practice will be materialized in the C²Learn pedagogical environment: some of them in digital space and other in the physical space of the educational setting. Relevant decisions are based on appropriate configurations of affordances and opportunities offered by the digital and non-digital media.

Thus, the table from section 3 relating the four elements of C²Learn practice with the two time frames can be updated as follows:

	Shorter-term **core episodes of co-creativity** *potentially including C²Experiences*	**Longer-term** **reflection-oriented experiences** *partially hosted in C²Space*
A. Co-creative Thinking	Co-creative thinking lies in the heart of each core episode of co-creativity; core episodes are formed around tasks or initiatives of creative thinking. Part of the creative thinking in a core episode may be formalized, applying CER techniques. ***Part of this can be enabled and enhanced digitally, through C²Experiences.***	Co-creative thinking that has taken place within core episodes is part of the wider C²Learn pedagogical environment. In this wider context, co-creators may reflect on and possibly re-frame the co-creative thinking that has taken place within a particular core episode. ***Part of this can be enabled and enhanced digitally, through the use of C²Space.***
B. Social Engagement	Co-creators are involved in social engagement of various kinds within each core episode. ***Part of this can be enabled and enhanced digitally, through C²Experiences.***	Social engagement that has taken place within core episodes is part of the wider C²Learn pedagogical environment. In this wider context, co-creators may reflect on and possibly re-frame the social engagement that has taken place within a particular core episode. ***Part of this can be enabled and enhanced digitally, through the use of C²Space.***
C. Ethics and Impact Awareness	Co-creators consider ethics and impact of novelty within each core episode. ***Part of this can be enabled and enhanced digitally, through C²Experiences.***	Ethics and impact considerations that have taken place within core episodes are part of the wider C²Learn pedagogical environment. In this wider context, co-creators may reflect on and possibly re-frame the ethics and impact considerations that have taken place within a particular core episode. ***Part of this can be enabled and enhanced digitally, through the use of C²Space.***
D. Wider Picture of Change	Each core episode contributes to the wider change, but the wider change is not (necessarily) an explicit focus in each core episode.	In the C²Learn pedagogical environment, co-creators may make wider plans for change, setting relevant goals. Elements of the core episodes may provide evidence of wider change. Co-creators reflect on these and more generally on the C²Learn experience. ***Part of this can be enabled and enhanced digitally, through the use of C²Space.***

In addition, the following tables provide insight into how C²Space and C²Experiences can nurture the elements of C²Learn pedagogical practice. This constitutes part of work carried out for deliverable D2.2.2, which will provide an updated, final version of these descriptions.

A1. Possibility Thinking

C²Space may help in:	**C²Experiences may:**
• Providing the learner with a digital space which intuitively affords problem-finding and problem-solving and foregrounds exploration of possibilities and perspectives: ▪ Navigating through challenges ▪ Addressing and posing challenges ▪ Encouraging/motivating learners to keep thinking differently and address challenges creatively (e.g. through gamification elements). • Keeping 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.	• Facilitate learners to get involved in playful exploration of a given possibility space, or co-construct a new possibility space, e.g. by: ▪ Presenting them with 'what if' questions and 'as if' environments ▪ 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 ▪ Enabling/enhancing the application of CER non-linear thinking techniques (see below).

A2. Creative Emotional Reasoning

C²Space may help in:	**C²Experiences may:**
[as in A1 above] and: • The design of more innovative/interesting '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 what digital technologies can offer.	[as in A1 above] and • Include elements disrupting learners' established routines and patterns: ▪ without teacher's intervention/trigger ('automatically') AND/OR ▪ facilitating teacher's intervention • Playfully realise brainstorming tasks.

B. Social Engagement

C²Space may help in:	**C²Experiences may:**
• Teacher's management of individual, group, whole class learner activity • Opportunities for individual, collaborative and communal activity • Teacher's decisions on learner grouping (e.g. through information on learners' activity and co-creativity profile) • Providing access to, organization, and overview of the creative activities to the learner, the group, the community.	• Provide opportunities for individual creativity BUT PREDOMINANTLY • Afford collaborative and communal activity realized within the group and placed within the wider community: '*I am playing here within my group, but I know there is more at stake out there, in the wider picture (e.g. in the whole class)*'.
• Keeping track of the dialogue and negotiation activities (e.g. of their timing and subject, and of their results) so that learners can reflect on them both in their efforts to discuss and negotiate, as well as in their evaluation of the experience afterwards. • Although dialogue and negotiation will expectedly take place predominantly face-to-face in the classroom, hosting such activities online (e.g. asynchronously and at a distance) is an option too.	• 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, e.g. through opening up ways to explore alternate paths, but also allowing conflict to be unresolved where appropriate.
• Expecting learners to take and lead initiatives (rather than just exposing them to teacher-instigated activity) • Reflecting/representing social relations in the environment so as to make leadership and flattened hierarchies transparent to the learners; this includes the teacher's role • Keeping trace of leadership, decision making and action 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.	• Involve (changing) leadership roles, or leadership negotiation quests • Emphasize equality of opportunities within the group • Involve exploration of what is lying behind a given challenge or situation, including hidden consequences • Include moments of decision making and of translating decisions into action.
• Enabling control of personal identity representation, and peer/group/community evaluation, in a social-network-style fashion.	• Offer students opportunities to be visible through avatar and expression of this • Enabling students to engage/disagree/challenge with one another/each other to gain feedback during digital gameplay.

[B. Social Engagement continued]

C²Space may help in:	C²Experiences may:
• Enacting a playful, game-like (gamified) experience of the wider activity (i.e. beyond, between, around the core games and playful activities) • Helping learners feel as players engaged in a longer-term challenge and not just within the core games and playful activities • Providing game-like triggers and information, such as gauges, scores, etc. • 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.	• Allowing safe experimentation with pluralities.

C. Ethics and Impact Awareness

C²Space may help in:	C²Experiences may:
• Learners expressing and sharing their values • Learners expressing and sharing their evaluations and decisions in relation to the impact of their novelty • Keeping track of activities so that learners can reflect on them in their evaluation of ethics and impact both during the activities and afterwards.	• Provide ethically challenging situations/choices/dilemmas/problems which allow students to develop, position and evaluate new ideas in relation to their own values, those of the group and of the community and which help them to act responsibly. • This would also allow them to collaborate with each other in new ways as they will bring diverse skills and experiences to their gameworld identity.

D. Wider Picture of Change

C²Space may help in:	C²Experiences may:
• Enabling shared goal setting • Keeping track of activities so that learners can reflect on them in their evaluation of wider change.	• Offer scope for students to set goals for themselves and their community which aim at creative change of e.g. rules and behavior, and which thus may become 'quiet revolutions'.

4.5.3 Priorities in the design of C²Space

The tables in the previous section describe desired elements of C²Space, so that it can facilitate and enhance C²Learn practice. The design of the digital environment takes into account and prioritizes these requirements, so that C²Space is can be concretely defined as a digital product which can be produced and appropriately tested within the time and resource frame of the project.

The following definition of C²Space guides its design and development: C²Space is a gamified social networking environment specifically designed to serve the purposes of C²Learn as described in previous sections of this document.

In the design and development of C²Space, and in collaboration with the corresponding design of the educational scenarios, the following priorities set from the perspective of learning design are respected; many of these apply more generally to the design of all technologies integrated in C²Space:

- C²Space is a coherent mix of digital tools and spaces with non-digital gamified classroom practice, which elicits immersion and engagement, and in which users understand the purpose of their involvement.
- Decisions about which elements of C²Learn practice to facilitate and enhance digitally in C²Space, and which to retain as non-digital in the wider pedagogical environment, are based on exploiting the affordances and opportunities offered by each medium. Not all elements are to become digital; the digital products may not reproduce tools and activities that can be equally well implemented through non-digital means, that is, digital products will bring significant digital added value.
- C²Space offers teachers an open content space for applying material to their own learner age and/or curriculum contexts and offers sufficiently useful creative processes to be able to foster co-creativity in their classrooms and beyond.
- There are clear instructions and rules for learners and different, but related instructions for teachers to foster co-creativity.
- C²Space includes social networking that allows inter-participant negotiation of knowledge for testing understandings.
- C²Space fosters independent and collaborative motivated learning.
- In C²Space there are authentic problem solving tasks of relevance to users.
- C²Space offers appropriate opportunities to engage in relation to age / culture.
- C²Space provides most tasks as challenging and scaffolded.
- C²Space offers learners plenty of space for leadership and autonomy, such that they are not dependent on teachers, creativity assistants or other triggers and supports, though they may be very well informed by these.
- Experiences available in the digital and social networking environment are not just relevant to the curriculum, but also students' lifeworlds (otherwise the motivation to play is only about pleasing the teacher/getting good grades, but if activities available in the environment are meaningful, hopefully they will use the environment outside of school as well).

- C²Space provides short paths of gameplay (a number of equal weighted activities) and longer more exploratory paths.
- C²Space does not require users to engage in narrowly-focused skills but a unique experience (e.g. possibility for a 'journey of becoming').
- C²Space enables elements of WHC triggering quiet revolutions.
- C²Space satisfies psychological needs for competence, autonomy, relatedness.
- C²Space is not boring, stimulates curiosity in terms of its look and feel.
- C²Space includes elements of fantasy.
- C²Space visual feedback is cool and savvy, not stick figures.
- In C²Space immediate feedback is available.
- C²Space users can push and test the boundaries/rules of the system.
- Most importantly, C²Space is playful; it is *gamified*.

Gamification is fundamental to the conception and design of C²Space. This is discussed in the following section in greater detail.

4.5.3.1 C²Space gamification: play in a social context

C²Space is a *gamified* social networking digital environment. Learner's experience of using it is a strongly playful experience. Therefore, the design of C²Space is predominantly a task of game design, in the sense that game design is conceived in the project as multidisciplinary work.

Playfulness and social networking are intrinsic and integrated elements of C²Space, with playfulness highlighted. In this gamified social networking environment learners have opportunities to socialize playfully.

In the gamification of C²Space the following important points are taken into account:

The appeal of the digital environment is important. A central intention of its gamification is to motivate users to want to use C²Space.

Gamification design also seeks to align C²Learn theory with users' intrinsic motivations (drive to do something, or pursuit of activities that are rewarding in and of themselves). Through the use of extrinsic rewards and intrinsically satisfying design, it moves the players through their journeys of mastery. This journey requires elements such as desire, incentive, challenge, reward and feedback to create engagement. Differentiation for the various age groups is probably required.

C²Learn theory sees co-creativity as equally individual, collaborative and communal – which aligns, to some extent, with the notion that games appeal on three levels: personal, organizational, and societal. Gamification of C²Space, as well as of all C²Experiences, ought to enable learners to engage at these three levels.

Learners can act both as independent individuals and as members of teams - each one of them being a member of more than one team. Belonging to a team is encouraged (e.g. through the reward system). Learner teams can be formed spontaneously on learner initiative, or can be teams defined by the teacher in the context of more formal learning

activities. C²Space enables users to form teams to compete in quests, puzzles, dilemmas gaining experience points to move on to more difficult challenges.

Learners and teams set and pursue their own goals; this is meant to afford an element of strong personal commitment. Apart from collaborating on goals which they define themselves, teams may also collaborate on goals defined for them by the teacher. A possibility could be that learners need to gather resources from the digital environment to help them pursue their goal.

C²Space makes performance data available; users are aware of what constitutes 'good' performance, understand whether their actions are 'good', know how they can improve performance and learn from mistakes.

A system or rewards affords an element of mild competition between individuals and between teams, incentivising certain activities. Possible elements include points, badges, rewards, resources to collect, progression, levels, leaderboards, avatars and social graphs, quests, etc.

Learners strive for rewards from their peers and from the system. These may include:

- A system of '*like*' tagging by peers, adapted to C²Learn concepts
- Points, badges, specific rewards for desired behaviours and accomplishments from peers and/or from the system
- Virtual gifts learners can give each other in the environment, as rewards or help.
- System-generated playful measurements of user activity (e.g. in the form of points earned or gauges), based on the available computational metrics derived through the background AI technologies.
- There may be potential in linking the system of rewards, users' achievements and generally system analytics and user activity tracking with the co-creativity assessment criteria. However, the clear priority is to make virtual awards important to the players rather than to research.

Finally, the metaphor/personification of C²Assistants can prove very useful overall in the gamification of C²Space. For example, they can be used to incentivise certain activities (e.g. by awarding credits, gifts, etc. for desired behaviours, and more generally to provide user-friendly paths to the exploitation of the background AI technologies for the purposes of gamification.

4.5.4 Priorities in the design of C²Experiences

The priorities for the design of C²Space presented in section 4.5.3 are also relevant for the design of C²Experiences. In this section some further details are added specifically relating to the design of C²Experiences.

The design of C²Experiences integrates several aspects of C²Learn pedagogical practice into playful and valuable learner experiences. In this design effort, it is understood that the elements of C²Learn practice are interwoven parts of a whole and are not to be selected and used in isolation from the other elements. On the other hand, of course, considering the coverage of all aspects of C²Learn pedagogical practice as necessary for every C²Experience may well lead to difficult design problems and, in particular, to a weakened gaming experience.

Therefore, the design of each C^{2}Experience explicitly states which aspects of C^{2}Learn pedagogical practice it attempts to facilitate and enhance and in what ways. In doing so, the design of that C^{2}Experience explicitly also defines the remaining aspects of C^{2}Learn pedagogical practice that will need to be addressed at a higher level, i.e. in the ways in which that particular C^{2}Experience will be integrated into the use of C^{2}Space and within the wider C^{2}Learn pedagogical environment.

The integration of every designed C^{2}Experience into C^{2}Space is an integral part of the game design for that C^{2}Experience. In other words, the game design for each C^{2}Experience does not only focus on the C^{2}Experience itself, but also provides a concrete understanding of how this C^{2}Experience fits into the wider picture of digital and non-digital C^{2}Learn pedagogical practice. Of course, as game design is predominantly concerned with producing designs appropriate for technological development, it mainly devises the ways in which a particular C^{2}Experience will be integrated into C^{2}Space. The integration of this into the wider C^{2}Learn pedagogical environment is defined in educational scenarios.

It is a priority in the design of C^{2}Experiences to exploit possibilities offered for the integration of the background Artificial Intelligence (AI) technologies into the gaming or otherwise playful experience. The aim is to meaningfully and purposefully use the background AI technologies to enhance the playfulness and learning value of the experience. The integration of AI technologies offers strong technological added value which moves C^{2}Experiences far beyond what could be similarly implemented through non-digital means. Not integrating the use of AI technologies in a C^{2}Experience remains a possible design decision which, however, needs to be explicitly justified.

Overall, the C^{2}Experiences designed include a variety of C^{2}Explorations and C^{2}Quests, so that the educational scenarios, and more generally the end user, can choose from and combine these to address specific educational needs and priorities, in various educational settings. While the design of C^{2}Explorations focuses mainly on designing appropriate gamification mechanisms to yield playful free explorations of ideas, concepts, and 'shared' knowledge in C^{2}Space, the design of C^{2}Quests involves designing a number of different approaches to learners' structured playful engagement in co-creative problem-finding and problem-solving. These include both strictly defined games (C^{2}Games), and open-ended playful activities (C^{2}Fun).

The initial game design document (deliverable D4.1.1) explored various game patterns as options for the design of C^{2}Quests. Among the various game patterns explored there, deliverable D5.1.2 highlighted those which work on scenarios and user requirements showed as worth exploiting in game design. Work so far has concentrated mainly on experimenting with story-telling game patterns, while experiences based on a number of other patters are also being elaborated. The final list of game patterns used in C^{2}Quests is defined in deliverable D4.1.2 'Game Design'.

5 Educational scenarios: orchestrations of C²Learn experience

Educational scenarios orchestrate the various technological and pedagogical parts of the project into coherent C²Learn user experiences. They are concrete designs of pedagogical practice in the context of given educational settings specified in terms of learner age group, curriculum links, the degree of formality of the learning activities, and the wider cultural/country setting. They are designed in close collaboration with the school communities, providing input into the design process directly from educational practice.

5.1 Maturing throughout the project

Educational scenarios serve different purposes in the course of the project, gradually maturing together with the project approach.

In the early stages, the educational scenarios provided initial ideas for C²Learn activity, contributing to an understanding of user requirements and the given educational settings.

Subsequently, at the current stage, as learning design and game design are producing their outputs, educational scenarios are becoming use cases describing the concrete framework for the implementation of pilot activities. At this stage, they are framed by the educational realities in the collaborating school communities, and inform the project about the pragmatic context of the pilots. Simultaneously, the educational scenarios developed around the pilots also serve as examples illustrating to the world of education the range of possibilities offered and examples of effective use of the C²Learn solution.

Eventually, in the long term and beyond the end of the project, educational scenarios are provided to teachers and learners as open-ended tools encouraging them to develop their own designs of C²Learn activity. This latter use of educational scenarios entails the development of detailed non-prescriptive guidelines to learners and educators for the use of the C²Learn solution, including ideas and examples of effective use originating from the pilots. In this sense, the educational scenarios gradually evolve into an integral part of the final C²Learn solution, accompanying the digital products.

Deliverables D5.1.x 'C²Learn Scenarios, Use Cases and User Requirements' provide the educational scenarios up to a level of maturity appropriate for the pilots. Their final shape, with a horizon wider than the pilots and the project, is provided in deliverables D6.4.x 'Knowledge Kit'.

5.2 Instantiations of C²Learn pedagogical environment

Throughout the project and at all stages of their maturity, educational scenarios place the pedagogical and technological aspects of C²Learn experience in the frame of the C²Learn pedagogical environment. They describe certain instantiations of this pedagogical environment.

All aspects of C²Learn pedagogical practice defined through learning design are represented in educational scenarios. Each scenario constitutes a concrete design for the orchestration in a given educational setting of the elements and time-frame of C²Learn practice as described in sections 3 and 4 of this document.

An important aspect of this design is the distribution of C^{2}Learn practice in the physical and digital spaces of C^{2}Learn. In this context, educational scenarios propose appropriate configurations of the use of digital and non-digital C^{2}Learn assets in the pedagogical environment, based on the affordances and opportunities offered by the various media and how those can be best used in a given educational setting. Thus, they describe activities which include, but are not limited to, the use of C^{2}Space and C^{2}Experiences.

In particular, while game design proposes the ways in which a particular C^{2}Experience is integrated into C^{2}Space, educational scenarios come to shed light on the pedagogical uses of these technological assets in the context of educational activities in the wider gamified pedagogical environment. In doing so, they also exploit and further develop ideas generated through game design for the gamification of the wider pedagogical environment through non-digital means.

Attention is paid to the representation in the scenarios of a wide variety of configurations of C^{2}Learn experience, including the use of different combinations of digital and non-digital assets, in various time frames, so as to illustrate the versatility, flexibility and adaptability of the C^{2}Learn solution.

Each educational scenario includes at least one core episode of co-creativity, while some scenarios may constitute series of core episodes spanning over shorter or longer periods of time, realizing longer-term reflection-oriented experiences. Similarly, the scope of a scenario may vary from describing the application of a single C^{2}Experience in context, to complex orchestrations of various C^{2}Experiences and non-digital activities.