

FOSTERING CO-CREATIVITY IN LEARNING THROUGH DIGITAL GAMING: EDUCATIONAL SCENARIOS DEVELOPED BY SCHOOL COMMUNITIES CO-DESIGNING THE C²LEARN SOLUTION

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Abstract

C2Learn (www.c2learn.eu) is an ongoing European research project aimed at fostering co-creativity in learning: learners, individually as well as mainly collaboratively and also communally, come up with novelty that has emerged through shared ideas and actions and which involves participants taking account of the impact of that novelty. Playfulness and in particular digital gaming constitute our chosen means for learner involvement. Game design defines the elements of learners' playful digital experiences and produces the specifications for the development of the corresponding digital games and other playful activities. Importantly, also, end-user school communities are engaged in iterative dialogic cycles leading to the various design decisions and their implementation. The paper particularly focuses on educational scenarios, i.e. the 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 remain open to elaboration and refinement throughout the project.

Keywords: co-creativity, co-creative thinking, digital games, educational scenarios, school-community-centred co-design.

1 OVERVIEW OF THE C2LEARN PROJECT

This paper reports on C²Learn (www.c2learn.eu), an ongoing European research project in which our understanding of creativity in education and creative thinking, on the one hand, meets with digital games and intelligent technologies, on the other hand, to provide young learners and their teachers with innovative opportunities for creative learning. The project is founded on a strong theoretical background, and aims at producing tangible research-based outcomes, readily available for use in classrooms and other educational settings. Overall, as Fig. 1 shows, C²Learn is a complex interdisciplinary project shaped as a 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.

1.1 C²Learn theory

The foundations of the project lie in a consolidated theoretical framework encompassing the theories of Wise Humanising Creativity (WHC) [1], [2], [3] and Creative Emotional Reasoning (CER) [4]. This framework is referred to in this paper 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 technological solution. 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 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: a) CER Techniques [4], [5], which offer ways for the application of CER in practice; b) Learning Design [6], [7], which describes how WHC and CER can be enacted in pedagogical practice; and c) co-creativity

assessment methodology [8], 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.

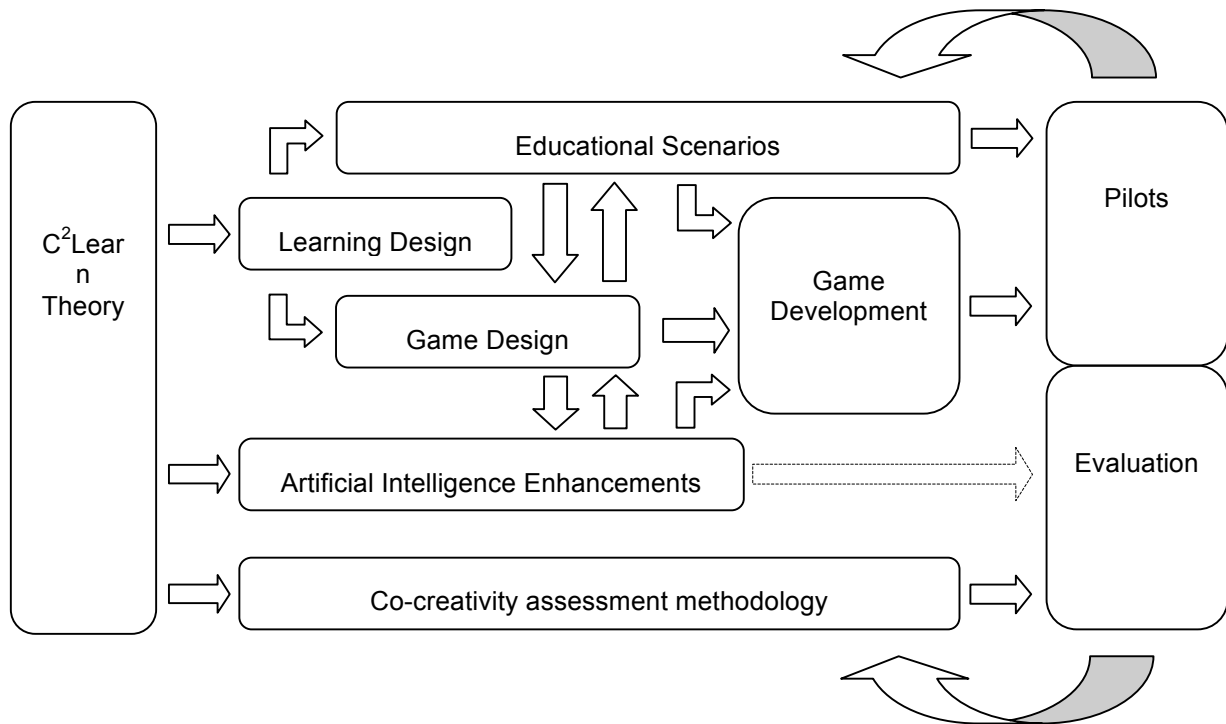


Figure 1: The flow of things in C²Learn.

1.2 C²Learn technology

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.

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. 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. 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 [6], [7], which constitutes the main initial input of game design. 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.

In addition, 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. Finally, elements of the background AI technologies can prove useful as secondary contributions to evaluation.

The designs delivered by game design are subsequently developed through the deployment of game technologies with AI enhancements integrated into them. These include various smaller digital games or other playful digital tools, and the C²Learn digital environment, a gameful 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 C²Learn pedagogical environment. It is noted that C²Learn technologies are implemented according to interoperability specifications based on Learning Technology standards as well as standards from other domains, so that they can be interoperable with other standard-conformant e-learning technologies.

1.3 Co-designing and piloting 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. The C²Learn 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.

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, which are further described in section 4 below. The aim is to create conditions for evaluation that can provide the project with feedback used for further refining design and development and for introducing adjustments and improvements. Evaluation is realized through the application of the 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 [8]. 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.

2 C²LEARN PEDAGOGICAL PRACTICE

In this section further insights are offered into how learning design defines C²Learn pedagogical practice, thus providing a pedagogical framework for the discussion of scenarios in section 4.

C²Learn theory defines co-creativity as educational activity in which learners, individually as well as mainly collaboratively and also communally, come up with novelty, new ideas. These new ideas: a) have emerged through asking 'what if' and 'as if' questions and through the use of disruptive techniques resulting in re-framing; b) have emerged from shared ideas and actions in an immersed dialogic rather than hierarchical pedagogical environment; and c) 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 gameful 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.

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 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 informed by learners' own and social dialogic engagement, drawing on a social constructivist foundation. Thus the learning model in C²Learn is aimed at affording unlimited, self-sustained discovery of new possibilities and one's own and others' creative potential.

2.1 Four elements of C²Learn practice

In a practical approach to C²Learn theory aimed at helping design, C²Learn pedagogical practice can be seen as an ensemble of four interwoven elements:

A. Co-creative Thinking, integrating Possibility Thinking and Creative Emotional Reasoning:

A1. 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'.

A2. 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.

B. 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.

C. 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.

D. 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.

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: a) shorter-term, focused and potentially more structured activities – the core episodes; and b) 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. The four elements of C²Learn practice described in section 2.1 above relate to the time-frame distinction as presented in Table 1.

Table1: The four elements and time frame of C²Learn practice.

	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 C ² Learn 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 C ² Learn 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 C ² Learn 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 C ² Learn 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 C ² Learn experience.

3 C²LEARN GAMEFUL DESIGN

The aim of this section is to provide some information on the aspects of playfulness in the project, thus framing the discussion of scenarios in section 4. The pursuit of playfulness is underpinning all aspects of the C²Learn experience, and is a priority served through explicit gameful design [9]. Both the C²Learn pedagogical environment and the C²Learn digital environment within it are gameful environments. The gameful pedagogical environment is an educational space in the widest sense in

which co-creativity as theorized in C²Learn occurs playfully. Similarly, the digital environment, including the technologies it incorporates, is a digital space built with the purpose to facilitate and enhance co-creativity playfully.

3.1 The architecture of playfulness in C²Learn

The C²Learn technological solution consists of digital gaming technologies as well as the background AI technologies. All these become available to the user through C²Space, an overall digital space which integrates all technological constituents into a unified user experience. C²Space is the central digital entity of the technological solution. It is a hybrid social networking environment designed gamefully to foster co-creativity as theorized in C²Learn. C²Space affords co-creativity through offering playful digital experiences which the learner can optionally engage with.

Digitally enabled C²Learn activity hosted in C²Space consists of playful digital experiences, the C²Experiences. C²Experiences are divided into two broad categories, C²Explorations and C²Quests. In C²Explorations learners freely explore ideas, concepts, and 'shared' knowledge in C²Space. In C²Quests, on the other hand, learners are given opportunities for 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: C²Games, i.e. structured games fostering co-creativity, and C²Fun, i.e. open-ended playful activities fostering co-creativity.

In addition, C²Assistants 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.

Overall, playfulness is manifested and facilitated through various means in C²Space and in the C²Experiences it hosts. Drawing on a distinction between 'game' and play', playfulness in C²Learn is constituted through both games and play. Fig. 2 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.

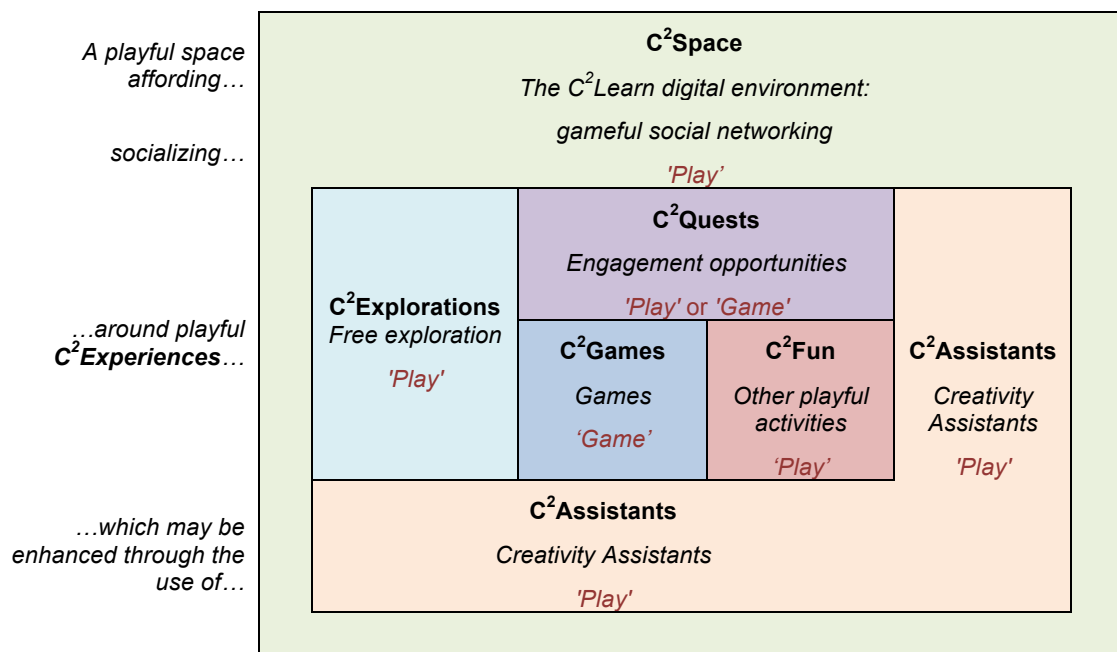


Figure 2: Architecture of digitally enabled playfulness in C²Learn.

3.2 Digital playfulness in C²Learn pedagogical practice

The four elements and two time frames of C²Learn practice described in sections 2.1 and 2.2 above 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, while C²Space is a digital space not only 'housing' C²Experiences affording core episodes of co-creativity, but importantly also affording longer-term, reflection-oriented experiences. Table 2 summarises how gameful design in C²Learn relates to the four elements and two time frames of C²Learn practice.

Table 2: Mapping gameful design with C²Learn pedagogical practice.

	Shorter-term core episodes of co-creativity <i>potentially including C²Experiences</i>	Longer-term reflection-oriented experiences <i>partially hosted in C²Space</i>
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. <i>Part of this can be enabled and enhanced digitally, through C²Experiences.</i>	Co-creative thinking that has taken place within core episodes is part of the wider C ² Learn 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. <i>Part of this can be enabled and enhanced digitally, through the use of C²Space.</i>
B. Social Engagement	Co-creators are involved in social engagement of various kinds within each core episode. <i>Part of this can be enabled and enhanced digitally, through C²Experiences.</i>	Social engagement that has taken place within core episodes is part of the wider C ² Learn 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. <i>Part of this can be enabled and enhanced digitally, through the use of C²Space.</i>
C. Ethics and Impact Awareness	Co-creators consider ethics and impact of novelty within each core episode. <i>Part of this can be enabled and enhanced digitally, through C²Experiences.</i>	Ethics and impact considerations that have taken place within core episodes are part of the wider C ² Learn 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. <i>Part of this can be enabled and enhanced digitally, through the use of C²Space.</i>
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 C ² Learn 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 C ² Learn experience. <i>Part of this can be enabled and enhanced digitally, through the use of C²Space.</i>

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.

4 EDUCATIONAL SCENARIOS: ORCHESTRATIONS OF C²LEARN EXPERIENCE

Educational scenarios [10], [11], [12] provide the integration of the various parts of the project into a coherent C²Learn user experience in a given educational setting, orchestrating the various technological and pedagogical parts of the project described in the previous sections. 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. Educational scenarios thus ‘translate’ learning design and game design into plans for the implementation of educational activities in real life, predominantly in the pilots run within the project, but eventually also in other educational settings. At the same time, scenarios present the world of education with the range of possibilities offered and examples of effective use of the C²Learn solution.

Educational scenarios are designed in close collaboration with the school communities, providing input into the design process directly from educational practice. Indeed, they 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 ensure that the innovative technologies deployed and practices introduced will correspond to the needs, circumstances, expectations and aspirations of the end users. Therefore, their development is interwoven with processes aiming at establishing user expectations and requirements.

4.1 A scenario-based design approach

As we have described elsewhere [13], setting out from a theoretical perspective and motivation, the project has deliberately adopted a scenario-based approach to engage teachers as designers of learning experiences. In summary, in our approach a scenario is an adequate but flexible structure for sustained engagement and learning within open-ended environments, like the ones designed in C²Learn. In addition, scenarios can also enable teachers to manage the change in the flow of classroom activity induced by the technology-enhanced pedagogical innovation. Further, by shifting the pedagogical emphasis from the transmission of subject matter to the orchestration of experiences around the subject matter, C²Learn scenarios focuses on a crucial dimension that is often neglected in discussing the curriculum: making the learning situation meaningful from the point of view of the students. Scenarios can turn our curricular objectives into personal goals that students understand and embrace. Finally, scenarios can generate useful user input to inform the design of the envisioned technological system, as well as serving as exemplars for communicating pedagogical innovation to a broader population of potential users and other communities of interest.

4.2 Scenarios maturing throughout the project

Educational scenarios serve different purposes in the course of the project, gradually maturing together with the project approach. They have been developed in three main iterations, while they remain open to elaboration and refinement throughout the project.

In the very early stages, scenarios [10] started as short narratives illustrating possibilities meaningful to users, aiming to present a range of potential directions without being prescriptive. Those early scenarios provided initial ideas for C²Learn activity and contributed to an understanding of user requirements and the given educational settings. Later on in the first project year, the original scenario ideas were critically examined and selected scenarios were further elaborated [11]. From the second project year onwards, as learning design and game design have produced mature outputs, 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 [12]. At this stage, scenarios are framed by the educational realities in the collaborating school communities, and inform the project about the pragmatic context of the pilots. In this sense, they are also becoming 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. This 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.

4.3 Scenarios as instantiations of the 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, describing 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 2 and 3 above.

An important aspect of this design is the distribution of C²Learn practice in the physical and digital spaces of C²Learn. In this context, educational scenarios propose appropriate configurations of the use of digital and non-digital C²Learn 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 C²Space and C²Experiences. In particular, while game design proposes the ways in which a particular C²Experience is integrated into C²Space, educational scenarios come to shed light on the pedagogical uses of these technological assets in the context of educational activities in the wider pedagogical environment. In doing so, they also exploit and further develop ideas generated through game design for the gameful design 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 C²Learn 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 C²Learn 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 C²Experience in context, to complex orchestrations of various C²Experiences and non-digital activities.

4.4 Concluding reflections on co-designing with teachers

Developing educational scenarios in C²Learn together with teachers has been a rich and rewarding experience for the teams of researchers involved. Here we summarise some of the important lessons learned and interesting questions arising from this experience [13].

We have considered the degree of formalism which is desirable in scenario templates provided as design tools for teachers. It is important to strike a balance between capturing scenarios at the desired level of detail in a common standard format, on the one hand, and avoiding the over-proceduralizing and overformalizing that kills the creativity of teachers and by extension of students, on the other. The goal is to have a framework that is simple, easy to use, transparent and allows for adaptation and variation, so that the researchers in collaboration with the user communities can capture all aspects that they consider important.

Another important issue that arose in our work is the relation between designing a game scenario and designing a scenario for orchestrating game-based learning. To some extent, these design processes overlap while also being different, and defining how teachers should be involved in them can become a challenge. Discussions with teachers often tended towards proposing designs for a digital game, and narrowing the design considerations to a technological solution. Further, there is the risk of equating playful learning with gaming, whereas we should always be mindful that digital games are only a subspecies of play and guard against elevating digital games to the predominance at the expense of other play forms that engender creativity and learning.

A further consideration that emerged is whether and to what extent game-based learning scenarios should be following the curriculum. Thinking too much in terms of circumscribed units of knowledge and skill corresponding to lesson units may result in forcing aspects of the curriculum into a game that cannot be well integrated into it and in missing opportunities to use games for fostering creativity. Instead of trying to incorporate the curriculum into a game, we may want to experiment with scenarios where players encounter challenges that are related to but broader than the curriculum in order to capture the special potential of games for learning and especially for fostering creativity.

Finally, introducing innovation in education requires a shift in practice and approach that cannot be effected top-down, but needs to include teachers. Nevertheless, teachers often do not have working models for the proposed innovation. The ideas and vocabulary used by researchers often seem far removed from their practice. As a result, though they are included as co-designers, when it comes to innovative concepts and not merely designing educational technology to meet given curricular objectives, a common language is hard to develop. We propose that a scenario-based approach can bridge this language gap to a great degree, but we are also mindful that careful elaboration and refinement of this approach is needed, lest it produces an obscuring language of its own.

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