Fostering **creativity** *in* **learning**
through digital **games**

C²Learn
creative learning

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

www.c2learn.eu

CO-CREATIVITY ASSESSMENT METHODOLOGY

C²LEARN PROJECT DELIVERABLE NO. D2.3.1

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EXECUTIVE SUMMARY

C²Learn at a glance

C²Learn (www.c2learn.eu) is a three-year research project supported by the European Commission through the Seventh Framework Programme (FP7), in the theme of Information and Communications Technologies (ICT) and particularly in the area of Technology-Enhanced Learning (TEL) (FP7 grant agreement no 318480). The project started on 1st November 2012 with the aim to shed new light on, and propose and test concrete ways in which our current understanding of creativity in education and creative thinking, on the one hand, and technology-enhanced learning tools and digital games, on the other hand, can be fruitfully combined to provide young learners and their teachers with innovative opportunities for creative learning. The project designs an innovative digital gaming and social networking environment incorporating diverse computational tools, the use of which can foster co-creativity in learning processes in the context of both formal and informal educational settings. The *C²Learn* environment is envisioned as 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 communities that they are part of. This innovation is co-designed, implemented and tested in systematic interaction and exchange with stakeholders following participatory design and participative evaluation principles. This happens in and around school communities covering a learner age spectrum from 10 to 18+ years.

About this document

Deliverable 2.3.1 is the first installment of a document detailing the **C²Learn Co-creativity Assessment Methodology,** its **rationale**, **method**, **tools** and accompanying **operationalisation**. Led by the UEDIN team in close collaboration with the OU team, and other appropriate consortium members, it sets out the over-arching theoretical frame of the project further developed from Deliverable 2.2.1 which closely integrates Creative Emotional Reasoning (Deliverable 2.1.1) and Wise Humanising Creativity, and argues in turn for an integrated approach to the assessment methodology which combines documenting change and lived experience. The Deliverable 2.3.1 firstly deals with theoretical and then methodological integration, and from this details the evaluation categorisation scheme. It goes on to detail the methodology, and its accompanying aims, indicators and data collection tools. The final part considers the methodology's operationalisation including the evaluation plan, inclusion of teachers, issues of analysis and synthesis, training needs and ethics.

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LIST OF ABBREVIATIONS AND TERMS

A) Abbreviated names of the project consortium partners

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

B) Other abbreviations

Abbreviation	Explanation
C²Learn	Acronym of the project (full title: Creative Emotional Reasoning Computational Tools Fostering Co-Creativity in Learning Processes)
CER	Creative Emotional Reasoning
DoW	Description of Work (Annex I of the Grant agreement no. 318480)
EC	European Commission
FP7	The Seventh Framework Programme for Research and Technological Development (2007-2013)
ICT	Information and Communications Technologies
LDS	Living Dialogic Space
LTC²	*C²Learn*'s Lateral Thinking
M#	#th month of the project (M1=November 2012)

Abbreviation	Explanation
MIA	Multimodal Interaction Analysis
TEL	Technology-Enhanced Learning
WHC	Wise Humanising Creativity

1. INTRODUCTION

Deliverable 2.3.1 is the first installment of a document detailing the ***C²Learn Co-creativity Assessment Methodology,*** its **rationale**, **method**, **tools** and accompanying **operationalisation**. The assessment methodology will be utilized to test the use of *C²Learn*'s computational tools, embedded within the pedagogical interventions and creative learning practices, in real-life educational settings. The core aim is to evaluate *C²Learn*'s impact on student's (co-)creativity.

In the introductory part we begin with a concise presentation of *C²Learn*'s creativity framework, as developed by the OU UEDIN teams (Section [1.1]). This integrated creativity framework is then analyzed into two dimensions of evaluating co-creativity, which provide the basis for specifying the research questions underlying and guiding the evaluation methodology (section [1.2]). Lastly we explicate the notion of a categorisation scheme, using an indicative example (Section [1.3]), premising our understanding for the exposition of the method that follows.

1.1 CREATIVITY WITHIN *C²LEARN*

Creativity within *C²Learn* emphasises collaborative and communal activity (co-creativity) whilst recognising the role of the individual. *C²Learn* co-creativity involves novelty emerging through a process of 'possibility thinking' (PT) – the transition from what is to what might be through 'what if' thinking (enquiry) and 'as if' thinking (imagining). Inherent within *C²Learn* co-creativity is attention to impact of creative outcomes in terms of the immediate and wider context. This ethically framed creativity therefore foregrounds the role of values in generating fundamental small-scale creative change (quiet revolutions). This conceptualisation also attends to how creative activity generates change in the makers as well as change by the makers (a process of becoming through making and being made). This ethically framed co-creativity or wise, humanising creativity (WHC[1]) involves within it, creative emotional reasoning (CER[2]).

CER is an umbrella term and refers to: a principled, unifying theory of non-linear thinking techniques that foster co-creativity within *C²Learn*'s computational tools. (*C²Learn*'s Lateral Thinking [LTC[2]] refers only to the theoretical part). CER is premised on a notion of creativity as an intervention resulting in reframing. Intervention involves 'stepping into' *C²Learn* participants' thinking and creative process in order to change how the participants are thinking and acting. With CER embedded within a set of creative learning tools (different LTC[2] techniques implemented in *C²Learn*'s computational tools) the aim is to disrupt established routines and patterns.[3]

With this role CER is embedded within WHC to foster co-creativity. The aim is to seek an organic fusion that will provide WHC with additional structured techniques taking advantage of and further enabling WHC's creativity opportunities. And in return CER is housed within a much-needed ethical and cultural framework and the most appropriate conditions for fulfilling its potential.

Developed theoretically alongside WHC is the idea of Living Dialogic Space (LDS). These spaces are

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[1] Chappell K., Craft A., Rolfe L. & Jobbins, V. (2013), "Humanising Creativity: valuing our journeys of becoming", *International Journal of Education and the Arts*, *13(8) 1*-35, retrieved 11.01.13 from http://www.ijea.org/v13n8/; Chappell K. (2008), "Towards Humanising Creativity", *UNESCO Observator*y, E-Journal Special Issue on *Creativity, policy and practice discourses: productive tensions in the new millenium* Volume 1, Issue 3, http://www.abp.unimelb.edu.au/unesco/ejournal/vol-one-issue-three.html; Craft A. (2008), "Trusteeship, wisdom and the creative future of education?", *UNESCO Observatory*, E-Journal, Volume 1, Issue 3, Special Issue: *Creativity, policy and practice discourses: productive tensions in the new millennium*.

[2] For a definition and analysis of CER, as well as an exposition of its theoretical foundations, see Deliverable [2.1.1]: *Creative Emotional Reasoning*.

[3] *C²Learn*'s Lateral Thinking [LTC[2]] refers only to the theoretical part of CER. CER is the implementation LTC[2] techniques into computational tools (which can include the game components).

characterised by debate and difference, openness to action, working 'bottom up', and different modes of idea exchange, and have been connected in previous projects with the facilitation of WHC. LDS' will be embedded in the game and also present in the environment outside the game to offer players high participation and shared control, individually, in collaboration and/or as part of a communal endeavour. Within and outside the *C²Learn* game-world interactions these spaces will be facilitated through creative learning conversations. The purpose of these is to flatten hierarchies, reposition players in different roles and allow spaces that promote a sense of equality through 'listening' to other players and even allow players to change their mind by identifying with the space of dialogue.

As CER heavily relies on brainstorming activities structuring the core parts of LTC² techniques, there is a particular relation with LDS. LDS' flattened hierarchies, manifested in an open space of dialogue, are an ideal environment within which to embed and evolve these brainstorming techniques, providing the opportunity to experiment with dynamic group management methods.

Within and outside of the *C²Learn* game-world, CER's set of core creative learning tools will thus support the manifestation of WHC which fuels the potential for **quiet revolutions[4],** the ultimate intention of the *C²Learn* process. The relationships between WHC and CER and their contribution to quiet revolutions, is shown in the Figure below which is reproduced from the first iteration of the project's learning design deliverable (July 2013). This seeks to show how quiet revolutions are ethically grounded as well as critical, aligning personal with wider values. A quiet revolution, emerging in and beyond the *C²Learn* game-world through collaborative and collective endeavour, is also grounded in excellence and engaged involvement from children and adults in the learning space.

Figure 1 (p. 9) shows **C²Learn Co-Creativity**, as emerging from the centre of the figure comprising the two related components discussed above, i.e. Wise Humanising Creativity (WHC) and Creative Emotional Reasoning (CER). As indicated in the learning design deliverable, co-creativity will manifest in five intertwined ways shown in the highlighted box within the WHC and CER sections of the graphic. Game-players will:

- Generate, explore and enact new ideas with a valuable impact on the community, discarding other ideas that lack such potential (**ethics and impact**)

- Pose questions, debate between new ideas, find ways to negotiate conflict or to go in a different direction to others if conflict is not resolved (**dialogue**)

- Take charge of different parts of the creative process, understanding the rules of the system[5] and how decisions have consequences, making decisions around new ideas and taking action(s)[6] through various scenarios and/or quests (**control**)

- Be immersed in the game and its environment, and possibly addicted to gameplay and/or the interactive drama played out in the game-world and in real-world spaces. Such immersion will sometimes lead to taking risks and generating surprising individual or collaborative ideas (**engaged action**)

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[4] Chappell, K., Craft, A., Rolfe, L. & Jobbins, V. (2011), "Not just surviving but thriving", in *Close Encounters: Dance Partners for Creativity*, pp. 143-159, Stoke on Trent: Trentham Books.

[5] Walsh, C.S. (2010), "Systems-based literacy practices: Digital games research, gameplay and design", *Australian Journal of Language and Literacy Education*, Vol 33, No 1, pp. 24-40. http://search.informit.com.au/documentSummary;dn=731555751906684;res=IELHSS ISSN: 1038-1562.

[6] Apperley, T. & Walsh, C.S. (2012), "What digital games and literacy have in common: A heuristic for understanding pupils' gaming literacy", *Literacy*, Vol 46, pp. 115–122. DOI:10.1111/j.1741-4369.2012.00668.x ISSN: 1741-4369.

- Have their thinking and action disrupted by the game's computational tools embedded within which are CER non-linear thinking techniques. This will them move them away from established routines and patterns (**intervention resulting in reframing)**

It is important to note that such activity is about these five elements in combination making more than the sum of their parts in order to generate co-creativity. This is about **new ideas** which are captured or selected because they are **valuable to the community**, and are generated with shared control in an immersed dialogic environment, fostering **ethical awareness** arising from the experience.

The key outstanding elements embedded within the environment are the 4Ps: pluralities (opportunities for learners to experiment with multiple pluralities of places, activities, personal identities, and people), possibilities (opportunities for possibility thinking, transitioning from what is to what might be, co-constructing with others through the C²Learn experience, designing, editing, extending and exploring content), participation (opportunities for learners to take action, make themselves visible on their own terms, and act as agents of change) and playfulness (opportunities for players to learn, create and self-create as active and connected players in their emotionally rich, virtual and actual play-worlds).

Over time, noticeable changes in players' dispositions, even small incremental personal changes, will result from their WHC. This is because there is a core reciprocal relationship within WHC between creativity and identity in which as creators make, they are also being made. And so players undertake **journeys of becoming**[7]. This is represented on the figure as an embedded on-going process from the 'how' of the enablers of co-creativity to the 'what' of the co-creativity.

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[7] Chappell K., Craft A., Rolfe L. & Jobbins, V. (2013), "Humanising Creativity: valuing our journeys of becoming", *International Journal of Education and the Arts*, *13(8) 1*-35, retrieved 11.01.13 from http://www.ijea.org/v13n8/.

C2Learn Co-creativity Conceptual Framework

Pedagogical context within and beyond C2Learn Game:
valuing learner agency, standing back, time and space, "meddling".

quiet revolutions

Wise Humanising Creativity

engaged action, dialogue, control, ethics/ impact

Creative Emotional Reasoning

Intervention, re-framing

C²Learn's Lateral Thinking

principles: **kinds:**

a)analogy   **a)semantic**
b)internalisation   **b)diagrammatic**
c)externalisation   **c)emotive**
d)negotiation

journeys of becoming

Living Dialogic Space

means:

a)individual   b)collaborative   c)communal

C2Learn gameplay harnesses:

intuition   reasoning   empathy

C2Learn gameplay involves:

pluralities   possibilities   participation   playfulness

C2Learn gameplay offers opportunities for:
Possibility Thinking
('what if ' and 'as if' thinking')

Pedagogic strategies are built into the game
and alongside it (in classroom) to enable WHC through LTC².

Figure 1: *C²Learn* **Co-creativity Conceptual Framework**

1.2 EVALUATING *CHANGE* AND *LIVED EXPERIENCE*

One of the main challenges in creating *C²Learn*'s Assessment Methodology is to productively integrate a mixed methodology which seeks to document *change*, as well as *the lived experience* of engaging in *C²Learn*'s game-based learning environment(s). The mixed methodology is informed by both the UEDIN team's experience in evaluation in cognitive science[8] and the OU team's experience in educational/arts informed evaluation[9]. It will be able to identify the changes and effects to students thinking habits, from their exposure to the *C²Learn* game-based learning environment(s), as well as facilitate an in-depth understanding of how participants interact with and experience this environment(s).

In particular:

- By *change* we refer to **specific changes** (following the protocol established in Deliverable [2.1.1] *Creative Emotional Reasoning*) to students' **thinking patterns** and **reasoning processes**, expressed primarily in **linguistic behavior** (but encompassing other modes as well) and manifested in their performance in *C²Learn*'s creative challenges/tasks.

- By *lived experience* we draw on qualitative research approaches which foreground meaning made by participants in living through something. In *C²Learn* we particularly refer to students' and teachers' **experience** and, in the case of students, **self-progression** (including the emergence of collaborative or communal ideas/identities) through *C²Learn*'s Educational Interventions, expressed through **dialogue**, **action** and **decision patterns**, in and around the game and social networking environment(s).

These two dimensions of evaluating co-creativity are integrated in the *C²Learn* approach to co-creativity evaluation, in reflecting the same fundamental understanding of our evaluation aim i.e. a focus on the **evolution** of participants, in terms of both habit acquisition and subjective experience/self-definition. This means, primarily, that participants' performance and products, which emerge through interaction with *C²Learn*'s creative challenges, are treated heuristically within the context of this evaluation methodology, as nodes *around which* our research takes place. We do not aim to evaluate end-results or products of creativity; we seek to employ these outcomes in evaluating our teaching methods/theories of co-creativity, through a precise documentation and analysis of their meaning and impact in relation to the ethical frame of the project which, as indicated earlier, seeks to foster wise, humanizing creativity through journeys of becoming and involving quiet revolutions.

The UEDIN and OU teams have developed a set of working principles common to both the documenting of *change* and that of *lived experience*. Both approaches require a number of data collection visits in order to track change and developing experience. Both approaches also need to seek data using a range of different methods including different kinds of interviews, observations and digital data capture. In terms of data collection both approaches need data to be sought in both open and closed ways. So, for example, within interviews, protocols will need to seek particular pieces of information whilst also being open enough to seek the emergent perspectives of participants.

Given these common principles to the two strands of evaluation of co-creativity the UEDIN and OU team have therefore sought to incorporate the needs of documenting *change* and *lived experience* within a unified

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[8] E.g. Stenning, K. & Michell, L. (1985), "Learning how to tell a good story: the development of content and language in the telling of one tale", *Discourse Processes*, 8 (3); Stenning, K. & van Lambalgen, M. (2004), "A little logic goes a long way: basing experiment on semantic theory in the cognitive science of conditional reasoning", *Cognitive Science*, 28 (4), pp. 481-530.

[9] E.g Craft, A., Chappell, K. & Best, P. (2007), *Analysis of the Creativity Action Research Awards Two Programme*, Leeds: CapeUK; Chappell, K., & Greenwood, M. (2013), "This is You", *Evaluation of Includance: English Strand* (Interreg funded), Attik Dance: Plymouth.

research visit design and onsite data collection methods plan (see Sections [1.2] and [3.1] for an analysis of the tools to be used and an exposition of the overall evaluation plan, respectively).

The unified research design will also need to be context-sensitive and acknowledge a perspective on knowledge as situated and relative, acknowledging the potent role of the participant in field-evaluation[10] as well as dispositions associated with creativity[11] such as curiosity, imagination, persistence, collaboration and being disciplined. Standardization between cases studies is of course equally important, to ensure the highest possible objectivity and reliability of the data, which is why we have opted to use tools that can combine high-structure and openness in response.

In order to structure this unifying research design the two teams have designed 3 main research questions that express the core and guide the development/implementation of *C²Learn*'s Assessment Methodology.

1. How do participants manifest co-creativity (WHC and CER) through *C²Learn* gameplay?

2. How does manifesting of co-creativity (WHC and CER) in *C²Learn* change over time?

[a] Assessment of the *change* in students' thinking patterns and reasoning processes along the CER dimension.

[b] Assessment of students' *lived-experience* in terms of co-creativity along the WHC dimension.

3. What role is played by *C²Learn* technological tools and corresponding pedagogical interventions, focusing in particular on students' experience?

The above research questions are complemented by a subsidiary aim, which will be prominent particularly in the early phases of designing the evaluation methodology.

4. Development and refinement of *C²Learn*'s Assessment Methodology tools with particular focus on:

[a] Tailoring of categories to *C²Learn*'s game(s)/gaming environment.

[b] Developing the *Socratic Method* type interview protocol in relation to *C²Learn*'s game(s)/gaming environment.

[c] Specifying the Computational Creativity metrics to be used[12].

[d] Refining the rest of the evaluation tools in relation to *C²Learn*'s game(s)/gaming environment.

In planning the above unified research design, the project will be addressing long-existing tensions between diverse fields, the combination of which aims to offer new insights into creative thinking and co-creativity in connection with learning. The UEDIN and OU teams are fully aware of the ambitious and highly challenging nature of this endeavor (which will become particularly evident at the analysis/synthesis phase of the data), and are planning accordingly, in constant dialogue with the rest of our partners in our consortium, to create the most appropriately designed methodology for the task at hand.

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[10] Amabile, T. (1997), "Entrepreneurial creativity through motivational synergy", *Journal of Creative Behavior*, 31, 18-26.

[11] Claxton, G.L., Edwards, L. & Scale-Constantinou, V. (2006), "Cultivating creative mentalities: A framework for education", *Thinking Skills and Creativity*, 1, 57-61.

[12] This is a particularly interesting and challenging field of research as due to the nature of the game(s) being developed, the end products of the creative processes/challenges may not be wholly digital. An important question we are faced with is how we can use computational creativity metrics to evaluate these type of products. For an explanation of what type of evaluation is meant here see Section [2.3.5].

1.3 EVIDENCING PROCESSES OF *CHANGE* AND *LIVED EXPERIENCE*

Evaluation largely depends on the application of **categories** by the evaluator. In a great variety of *pre-determined* categorisation schemes, for example schemes dealing with arithmetic problems, it is easy to categorise right and wrong answers. It is far harder to categorise creative and non-creative (or to some degree creative) responses in more open-ended tasks and challenges. Apart from the difficulty in creating such categories, innovative educational research poses further problems as few people are likely to know the categorisations that are new to the educational intervention. This problem, though, can be put to good use.

In order to teach evaluators a pre-determined categorisation scheme, we can get data on how well we have succeeded by using **inter-rater reliability measures**[13], i.e. "Do they categorise the same events the same way as we do?". This methodology is particularly useful for those concepts that invite the retort: "I can't define it, but I know it when I see it" of which creativity is a perfect example. Inter-rater reliability tells you whether you can teach others to recognise it when they see it. To some extent these categories can be allowed to emerge as the teaching develops. But the theoretical positions already held should be translatable into categories.

We will use here an example of a scheme that has already been used in the cognitive literature[14], and can provide some basis for constructing our categories, although they would of course need to be significantly adapted to the material at hand. This example utilises Raymond Brigg's story *The Snowman*. To give a brief summary: The little boy builds a snowman in his garden and goes to bed. In the middle of the night the boy wakes up and looks out his window and the snowman beckons him to come down to the garden. They fly away on an adventure, and return, when the boy shows the snowman his house. When they realise the Snowman is melting in the warm house, they have to part ways.

The aim here was to use this `book-without-words' as a platform to explore children's creativity in story understanding and telling. The children first spent quite a bit of time studying the cartoon picture book, and then `told the story' to one of the experimenters. After the children had told their story, the experimenters also held a *Socratic Method* type of interview (see Section [2.2.1]) with the children, in order to probe their understanding and elicit more information from them. The interest here was in a classification of children as **describers** or **explainers**, a categorisation that goes back through Peel (1971)[15] to Piaget (1964)[16], designed to find Piaget's cognitive categories in children's discourse 9ather than by using 'test situations' such as conservation experiments).designed to find Piaget's cognitive categories in children's discourse (rather than by using `test situations' such as conservation experiments[17]).

Extracts from two children's retellings of the story serve to illustrate how this particular categorisation scheme functions:

The children reach one of the crucial points in the story when the Boy and the Snowman have to part because the Snowman is melting.

Extract 1 (5 year-old child): "…and he said Goodbye and standed where he was again…he standed very still and very very still…"

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[13] Kilem Li Gwet (2012), *Handbook of Inter-Rater Reliability* (3rd Edition), Advanced Analytics, LLC, Gaithersburg, MD.

[14] Michell, L. & Stenning, K. (1983). "Explanations in the story-telling of 7 to 11 year olds", *Educational Review*, 35 (2), pp. 187—194; Stenning, K. & Michell, L. (1985), "Learning how to tell a good story: the development of content and language in the telling of one tale", *Discourse Processes*, 8 (3).

[15] Peel, E. A. (1971), *The nature of adolescent judgment*, Staples, London.

[16] Piaget, J. (1964), "Development and learning", *Journal of Research into Science Education*, 3.

[17] Piaget, J. & Inhelder B. (1941), *Le développement des quantités chez l'enfant* (The development of the idea of quantity in the child), Delachaux & Niestle, Oxford, England.

Extract 2 (7 year-old child): "…and then the snowman walks the little boy to his house and the boy says Goodbye and they wave Goodbye…and the boy goes back into the house and the snowman stays outside...and the boy looks out of the window and waves…"

Even from these very brief extracts it is possible to tell quite bit. Of course, it is much more vivid (and easier to categorise) at first-hand experience, or from recording, than from just these sentences. The first, younger child has understood that this episode is one of the emotional cruxes of the story. Boy and Snowman must part because they cannot inhabit the same world, and if the Snowman is not to melt, he must pretend to be inert in the garden. This 5 year-old has very little in the way of linguistic resources, but puts the point across brilliantly by emphasising the stillness the snowman must adopt by repetition. The older child has lots of words, but offers a more superficial description with no evidence of having understood the feelings involved.

Using the above categorisations, the younger child would be categorised as an *explainer* whereas the older child as a *describer*. This is, of course, not to say that these two children would be similarly categorised in other contexts. Of course, the describers are usually more common among 5 year-olds, and the explainers among 7 year-olds, but we chose the example exactly to make the point that the categorisation can cross-cut the averages.

The categories of *describer/explainer* can be reliably identified across children's telling of the story by teachers and researchers who have had some minimal explanation of what this means, and their judgments can be shown to correlate with all sorts of other, apparently distant, cognitive tasks (such as Piaget's conservation experiments[18]: "is there more water or less water when I pour it from this short fat glass into that long thin one?"). It thus ties into an important cognitive theory. The same distinction can be used for looking at adolescents' descriptions and explanations of road-traffic accident scenarios, for example.[19]

Although this example may seem far removed from the explicit aims of the *C^{2}Learn* project, it is not actually so. An *explainer* is someone who can go beyond a habitual response, as opposed to the *describer* who works within the limits of such responses, merely reshuffling what is already provided in the question. Creativity is very much related to the ability of transcending what is habitual. Also, story-telling games are a very valuable and quite standard approach to educational gaming, an approach that is being explored by the design teams of this project. Nevertheless, categories for *C^{2}Learn* will need to be developed in advance of the piloting. A preliminary tentative categorisation scheme is presented in Section [2.3]. Its basis is *C^{2}Learn*'s co-creativity theory, yet some tailoring to both the specific nature of the educational scenarios and game environment(s) currently under development, will be necessary to ensure the categories' complete applicability to the task at hand. It is also important that the *C^{2}Learn* categories will be to some small extent adaptable, given the fact that evaluation will take place at different times during the duration of the project and the actual content of the challenges involved in *C^{2}Learn* will evolve and change as the project matures. A further caveat is that these categories be easy to learn/use by the evaluators, which requires close collaboration with our partners in the educational fields. For what should be clear from the examples above is that the closer the categoriser is to the way the speaker makes meanings, the more likely they are to be able to understand what was happening for that participant and so to categorise their behaviour accurately. And in *C^{2}Learn*, teachers, who are immersed in the classroom, will act as the initial categorisers having collected recorded spoken data from key students through dialogue which emerges from the use of Socratic interviews (see Section [2.3.1]).

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[18] Ibid.

[19] Michell, L. & Lambourne (1979), R.D., "An association between high intellectual ability and an imaginative and analytic approach to the discussion of open questions", *British Journal of Educational Psychology*, 49.

2. METHODOLOGY

Based on the above considerations, we now move towards a first approximation and definition of *C²Learn*'s Co-Creativity Assessment Methodology under development, by a detailed exposition its constitutive elements.

We begin with a table correlating aims/indicators of creativity with evaluation tools (Section [2.1]) and provide a tentative categorisation scheme (Section [2.2]). We then examine the different tools that comprise the evaluation method (Section [2.3]). Lastly we take a critical look at other possible categorisation schemes (taxonomies) and provide an argument for not using control groups (Section [2.4]).

2.1 GOALS/INDICATORS OF CO-CREATIVITY IN RELATION TO EVALUATION TOOLS

The following table is a concise statement of the **goals**, defining C2Learn's co-creativity dimension (see Section [1.1]), correlated with the **indicators**, i.e. the signs expressing that the aim has been met (within and outside the game), and the evaluation **tools** we deem more appropriate to utilize in each case. In relation to each indicator, a number of tools are identified, to facilitate methodological triangulation and to anticipate the possibility of some tools being unexpectedly unusable.

Goals	Indicators	Tools
Attending to *ethics* and *impact of ideas*	Generating, exploring and enacting new ideas with valuable community impact (discarding other ideas that do not).	*Across all four of these categories (ethics and impact, dialogue, engaged action and intervention and reframing) four tools will be used:*
Engaging in *dialogue*	Posing questions, debating between ideas, finding ways to negotiate conflict or to go in a different direction to others if conflict not resolved.	Teachers' *Socratic Method* type interviews with students
Being in *control*	Taking charge of parts of the creative process (understanding rules of the system, decisions have consequences, making decisions, taking action).	Video data capture Creativity wheel
***Engaged action* – being immersed in the experience**	Being addicted, not able to stop, trying repeatedly. Such immersion sometimes leads to taking risks.	Researcher field notes and interviews with teachers
Intervention* and *reframing	Specific changes in thinking patterns, and in particular reasoning processes. Changes in expression, primarily in linguistic terms, but also encompassing other modes as well.	*Socratic Method* type interviews Video-data capture Computational data Creativity Wheel

Goals	Indicators	Tools
*4P*s	Evidence of high participation (engagement and involvement), high pluralities (taking on many roles, personae, perspectives), high playfulness (operating in an *as if* and playful manner) and high possibilities (generating many ideas through *what if* and *as if* thinking).	Axes Researcher field notes Video data capture
Undertaking a *journey of becoming*	Over time, noticeable changes in participants' dispositions and/or personalities. This may involve smaller incremental changes.	*In relation to journeys of becoming and quiet revolutions, four types of data will be collected:* Teachers' *Socratic Method* type interviews with students
Generating *quiet revolutions*	Over time more noticeable changes in the creative community stemming from creative ideas generated; might comprise smaller incremental changes.	Video data capture Researchers' interviews with teachers Researcher field notes
***Pedagogic* strategies**	Evidence teachers: • proactively valuing learners' ideas and actions • enabling learners to take the initiative • ensuring sufficient space and time for ideas and actions to emerge • getting alongside the learner and learning as fellow collaborator	Researchers' interviews with teachers Researcher field notes Video data capture

Table 1: **Aims/indicators of co-creativity in relation to evaluation tools**

2.2 TENTATIVE CATEGORISATION SCHEME FOR *C²LEARN*

Table 2, below, presents the research team's initial approach on the categorisation scheme to be used throughout the evaluation process. They have been designed to mirror and exemplify the core goals of the WHC/CER integrated creativity framework. These categories will be further developed and tailored to the specific curriculum that will emerge through the game(s) (and corresponding educational interventions) design process. The research team is planning to conduct extensive testing especially during the early phase of the 1st pilot, as well as organise smaller workshops with teachers to test the categorisation scheme's usability and applicability.

Category	Characteristics
Attending to *ethics* and *impact of ideas*	[1] Creates new associations between ideas [2] Actively explores the consequences of the newly created associations between ideas [3] Exhibits awareness of and concern / interest for the impact of new ideas on the group's values [4] Actively promotes ideas that are deemed valuable by the group
Engaging in *dialogue*	[1] Engages in debate over ideas [2] Promotes dialogue within group (poses questions, respects different viewpoints and/or encourages members of the group to voice their ideas) [3] Actively negotiates conflict and/or seeks alternate paths
Being in *control*	[1] Takes a leading role during different phases of the creative process [2] Exhibits a firm grasp of the rules in the system underlying the challenges facing the groups [3] Takes decisions and instigates action
Engaged action	[1] Immerses him/herself in the experience of the creative process [2] Facilitates immersion in the experience of the creative process for the rest of the group [3] Willing to take risks and/or leaving his/her 'comfort zone'
Intervention* and *reframing	[1] Creates new analogies as building blocks of the creative process [2] Actively experiments with re-combining elements of the creative challenge [3] Actively facilitates a shift of perspective: [a]Uncovers hidden aspects of the creative challenge [b] Goes beyond the material provided by the description (elements) of the challenge, recasting the challenge in a new light (as a whole or through re-formulating elements of it)

Table 2*: Tentative Categorisation scheme for *C²Learn

All 5 Categories come in 3 levels:

[1] Low

[2] Medium

[3] High

Introducing levels will help ensure we capture *C²Learn*'s impact on students on a wider spectrum, and in more detail. Each level will be associated with concrete examples (either hypothetical, created with reference to the game(s) that are currently being developed or taken from actual gameplay) that will guide the teacher in his/her categorisation.

2.3 CURRENT EVALUATION TOOLS IN DEVELOPMENT

There are 6 evaluation tools currently in development. These are:

- *Socratic Method* type interviews with students
- Interviews with teachers
- Video-data Capture
- Self and peer evaluation tools
- Use of computational data
- *Technology Evaluation* questionnaire

In the following pages we describe the different tools in detail, with an emphasis on the principles that govern their use as well as their utility value for *C²Learn*'s Co-Creativity Assessment Methodology. Through selected use of the different tools (see Section [3.1] for more details on selection) throughout the evaluation process, we aim to collect extensive, reliable and interrelated data that will allow us to conduct a rigorous analysis on all the relevant aspects of the *C²Learn* project.

2.3.1 *SOCRATIC METHOD* TYPE INTERVIEWS WITH STUDENTS

The **Socratic Method** consists of **highly structured interviews** (dialogues) with a student(s), utilising **open-ended questions**, in order to elicit **information concerning reasoning processes** on some identified subject.

As the name indicates the originator of this particular style and method of inquiry is Socrates himself. The Greek philosopher was famous for what he called **maieutic** (the Socratic *elenchus*). The basic mechanism of this method is questioning meant to probe, coax and allow Socrates' interlocutor to verbalise any implicit knowledge, better organise his/her thoughts and reach conclusions and insights that would otherwise be unavailable. The paradigmatic case of the method is Socrates' questioning of a slave boy, in order to 'demonstrate' that the child has knowledge of geometry.[20] To do this he breaks the process down to a number of intuitive questions, thus bringing out the right units of knowledge. The key feature of the method is here evident: the method of **maieutics** seeks to help one become conscious of what is already there.

We can use the example of *The Snowman* story experiment[21] (see Section [1.3]) to give a brief illustration of how a *Socratic Method* type of dialogue would work. One can, for example, imagine asking the 5 year-old child, who produced that very moving account of the story, questions such as, "What was the Boy (or the Snowman) feeling at this point?" Or, "Why did the Snowman leave?". When the child says "The boy is sad because the Snowman has to leave" one could follow up with "Why was that?", or other lines of questioning revealing of the child's understanding. With an older student, even with the same material, one could ask more abstract questions "What is the author trying to achieve at this point?" and so on. These types of questions aim at making the child's understanding explicit and reveal the ground upon which the subsequent categorisation will take place.

Another illustrative example comes from a famous reasoning experiment from Wason (1968)[22]. The subjects are presented with four cards face down on the table (they see A, K, 4 and 7 respectively on the four cards). They are also presented with a rule: "If there is a vowel on one side, then there is an even number on the other", and the following information: "There is a letter on one side of each card, and a number on the other side. Your task is to turn the cards you must turn in order to find out whether the rule is true."

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[20] Plato, Tr. Grube, G.M.A. (1976), *Meno*, Hackett Pub. Co.

[21] Stenning, K. & Michell, L. (1985), "Learning how to tell a good story: the development of content and language in the telling of one tale", *Discourse Processes*, 8 (3).

[22] Wason, P. C. (1968), "Reasoning about a rule", *Quarterly Journal of Experimental Psychology*, 20, pp. 273-281.

According to Wason, more than 90% of highly intelligent undergraduate subjects get the answer wrong. Whereas they should turn A and 7, most turn A and 4. The issue at stake in Stenning & van Lambalgen (2004)[23] was how the subjects interpret the rule. Wason assumes they interpret it as a classical logical material implication, for which a single counterexample is sufficient to falsify the rule. More than a hundred experiments had been run making this assumption. However, the most likely interpretation of a natural language conditional by logically naive subjects out of context is as a non-monotonic conditional which is robust to exceptions. "If the switch is down, the light is on" is not, as normally interpreted, falsified by a single instance of the switch being down and the light being off. There may be a power cut, a fuse or bulb blown, or numerous other abnormalities.

Socratic Method type dialogues with the subjects revealed a large amount of evidence that the subjects do not interpret the rule as material implication. After completing the task as Wason conducted it, the subject was taken through their reasoning and asked to justify their choices, or revise them if they now felt they had been wrong. So the experimenter would point at the 3-card and ask "What could be on the other side?". Subject 18, for example[24], replied (correctly) " There could be a K (consonant) or an A (vowel). The experimenter then asked "If it were an A, what would that mean?", and the subject replied "Well, it *might* mean that the rule was false, or it might just be an exception." When asked whether he would turn the 3, this subject reiterated that "No, it might be an exception". Here is immediate refutation (in this subject's case) of Wason's hypothesis about the classical logical interpretation of the rule.

It is common for experimental psychologists to dismiss such evidence as *post hoc* rationalisation which gives no evidence of why the subject acted as they did in the original task. But this is not adequate. They conflate such techniques as `Thinking aloud protocols' where the subject `externalises their thinking' during the task performance, with *Socratic Method* type dialogue where they justify their reasoning in the dialogue. Externalising thinking allows for all sorts of complications about the relation between what they externalise and what they would do if they perform silently. But *Socratic Method* type dialogues are informative as reasoning in themselves. Were the subject who `failed' to turn 7 in the task itself then to change their response in *Socratic Method* type dialogue to turning 7, we might pause and conclude that perhaps the dialogical situation was enabling `better reasoning'. But here the subject maintains exactly the stance they adopted in the task, in the dialogue. It is completely fanciful to say that this is not evidence that the subject adopted an interpretation of the conditional in which it is robust to exceptions, and therefore not falsifiable by a single counterexample. Exceptions are not counterexamples for this subject, and they reason perfectly rationally given their interpretation.

This is a very different application of the *Socratic Method* to the Snowman example. Here the focus of the task is more like Socrates' original concern with eliciting knowledge and its justification. It might seem very far from a focus on creativity, but that is perhaps misleading. These subjects who have not studied logic have very little explicit grasp of the interpretations they employ in using their native language. For them, finding an interpretation for instructions for a task in a complete vacuum is indeed a creative task. The *Socratic Method* type dialogues reveal the complexity of the thinking that goes into this exercise.

Drawing from the above the *Socratic Method*, as will be utilised within the context of *C²Learn*, serves two primary and interrelated functions:

- Allow the student to become aware of reasoning processes and decisions that were implicit in the way he/she handled the creative challenge(s), by making them explicit through probing questions.

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[23] Stenning, K. & van Lambalgen, M. (2004), "A little logic goes a long way: basing experiment on semantic theory in the cognitive science of conditional reasoning", *Cognitive Science*, 28 (4), pp. 481-530.
[24] Ibid, p. 502.

- Elicit the kind and amount of information that will allow the evaluator to implement the categorisation schema and use it as evaluation indexes.

The choice of this particular method reflects the overall aim of the *C²Learn* project, i.e. to foster co-creativity. The evaluation of creativity calls primarily for rigorous qualitative analysis[25] and multiple data collection tools. The type of questioning employed in the Socratic Method, is ideally suited as a key (although not the only) tool for this kind of endeavour. Creativity can often lie hidden in the implicit elements and structures of a reasoning process and even when made explicit it can appear in different guises. The versatility provided by the open-ended questions and overall dialogic form can facilitate the task of unearthing the creativity moments in one's reasoning. Of course the method will be accompanied, complemented and supported, by other evaluation tools for the purposes of enhancement and triangulation.

As primarily implicit experience is the main target of the questioning, it is important in this respect that the interview happens soon after the event. The questions should focus on topics raised by the experience that the student(s) just had, taking advantage of the vividness and live interest of the student(s). This is one of the main reasons why we have chosen to integrate our evaluation method with the educational intervention itself.

The two key characteristics of a *Socratic Method* type of interview are [i] a high level of structure, and [i] the use of open-ended questions.

[i] The emphasis on structure is meant to:

- Sufficiently standardise the process throughout the different educational interventions in respect to both the subject group and the evaluator.

- Facilitate the implementation of the categorisation schema (and inter-rater reliability measures).

- Facilitate the transcription and consequent analysis of the data acquired.

[ii] The questions comprising the method must be open-ended in order to:

- Provide the necessary space for the interviewee to fully express him/herself and explicitly articulate the reasoning processes structuring his/her decision making.

- Allow the interviewer to explore the reasoning processes, by creating opportunities for further questioning both vertically and horizontally.

- Facilitate the handling of any unforeseen contingencies and cases that do not fall under the categorisation schema. As the evaluation will take place at different stages throughout the project's duration, it is important that we acquire feedback on the evaluation method we use, especially as it concerns the categorisation schema we are developing. This form of interview will thus also allow us to further calibrate our initial schema, in view of the development of educational scenarios and creativity challenges.

The exact form and content of the *Socratic Method* is dependent upon the specifics of the context. This means that the method will have to be tailored to the specific challenges that the student(s) will face. As *C²Learn*'s game design progresses, we will be in a position to stipulate a number of questioning paths, which will serve as guides for the interviews. This means that our work will advance in tandem to the work being done in designing the educational scenarios, game environment(s) and overall structure of the challenges.

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[25] Armstrong, D., Gosling, A., Weinman, J. & Marteau, T. (1997), *The Place of Inter-Rater Reliability in Qualitative Research: An Empirical Study*, 31 (3), pp. 597-606.

We can at this early stage, though, provide some indicative examples of possible paths of inquiry, especially concerning one dimension of the type of creativity developed in *C²Learn*. Creativity as *intervention* and *reframing* is premised on the use of *stimuli* of different kinds and types. The *stimulus(i)* provided in each challenge is thus meant to feature extensively in the creative reasoning processes of the student(s)[26]. The questioning will have to bring this to the surface and help the student focus on his/her interaction and use of the *stimulus(i)* provided. Such line of questioning may include:

- Did you use the *stimulus* you were provided with in your creative activity? (How?) (What other possibilities were there?)

- Did the use of the *stimulus* help in combining elements of the challenge differently? (How did the new combinations differ?) (How did this help you?)

- Did the use of the *stimulus* help reveal hidden aspects of the challenge? (What were they?) (How did the challenge change after seeing it like this?)

- Did you find the use of the *stimulus* challenging? (In what way?)

- Did you find one type of *stimulus* more helpful than another? (Which one?) (Why?)

- Did you try out *x*? (Why not?)

- When you tried *x*, what happened?

- What do you think was the problem with that method? (Why didn't you try *y*?)

- If z had happened, instead of *w*, how would you have used the *stimulus(i)*?

These questions represent general headings under which sub-questioning paths can develop, and can serve as prototypes. For these paths (and sub-paths) of enquiry to be effective, they will have to be grounded and evolved within specific contexts that will become more available with the progression of the project, and of course be couched in a language suited to the particular context (the actual challenge, the age group of the students etc.). It is also of paramount importance that we extend these paths and create new ones in order to cover all of the creativity dimensions of the *C²Learn* project.

2.3.2 INTERVIEWS WITH TEACHERS (ACCOMPANYING FIELD-NOTES)

So as to evaluate pedagogies, brief (10-15 minute) interviews (one each) will be undertaken with the teachers themselves alongside a small set of field notes from observations of their practice by OU/EA and BMKK in the case study sites. These interviews will be undertaken toward the end of the pilot period each time with each teacher and will be audio-recorded. The interviews will be semi-structured and use both closed and open questions (Cohen, Manion and Morrison, 2007)[27]. They will use the lesson observation as a starting point and will probe aspects of pedagogy, in particular:

- teachers' perceptions of their students' agency

- teachers' perceptions of students' gameplay

- extent to which teachers blend 'standing back' with 'stepping forward' and 'meddling in the middle' in this *C²Learn* pilot

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[26] See Deliverable [2.1.1] for further details.
[27] Cohen, L., Manion, L. & Morrison, K. (2007), *Research methods in Education*, 6th Ed. London: Routledge Falmer.

- the role of time and space in how teachers support students' co-creativity in the C2Learn pilot

The interviews will also probe the teachers' perceptions of their students' co-creativity through the game and its environment, in particular their perceptions of:

- how actions taken by players, the design and redesign design of games, situations and contexts of gameplay and the game's system and rules help them assess their own and students' co-creative endeavours[28]

- how individual, collaborative and communal creativity have played out in the C^2Learn pilot

- -how undertaking journeys of becoming may be manifest in the C^2Learn pilot

- what evidence there is of Quiet Revolutions in the C^2Learn pilot and the dynamics of these

The interviews may include the use of conceptual drawing (Chappell and Craft, 2011)[29] where teachers themselves use diagrammatic mapping to explain their perceptions and perspectives.

Following interview data collection and analysis protocols developed by Halcomb and Davidson (2006)[30] the interview data will be processed through 6 steps:

1. Audio-recording and concurrent note-taking of teachers' responses

2. Reflective journaling immediately post interview

3. Listening to audio and amending notes

4. Preliminary content analysis using the co-creativity criteria as a deductive coding frame

5. Secondary content analysis

6. Thematic review

The results of the analysis will be to offer evidence of co-creativity from the teacher's perspective.

The researchers will undertake field-notes during a minimum of two C^2Learn sessions, capturing their own perceptions (Ely, Anzul, Friedman, Garner & McCormack, 1991[31]; Bogdan & Biklen, 1992[32]). The fieldnotes will inform the interviews with teachers and therefore will capture aspects of both pedagogy and learning during C^2Learn sessions. They will seek to capture evidence of the following aspects of pedagogy (and anything else which seems important to the nurturing of students' co-creativity):

- students' agency

- teachers 'standing back' to allow students to take a lead, but also 'stepping forward' and 'meddling in the middle'

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[28] Apperley, T. & Walsh, C.S. (2012), "What digital games and literacy have in common: A heuristic for understanding pupils' gaming literacy", *Literacy*, Vol 46, pp. 115–122. DOI:10.1111/j.1741-4369.2012.00668.x ISSN: 1741-4369.

[29] Chappel, K. & Craft, A. (2011), "Creative Learning Conversations: producing Living Dialogic Space", *Educational Research*, 53 (3), 363-385.

[30] Halcomb E. & Davidson, P. (2006), "Is verbatime transcription of interview data always necessary?", *Applied nursing research,* 19 (1) 38-42.

[31] Ely, M., Anzul, M., Friedman, T., Garner, D. & McCormack Steinmetz, A. (1991), *Doing qualitative research: Circles within circles*, London: Routledge Falmer.

[32] Bogdan, R. & Biklen, S. (1992), *Qualitative research for education: An introduction to theory and* methods, Boston, MA: Allen & Bacon.

- use of time and space to enable students' co-creativity

They will also seek to capture evidence of how students' co-creativity is evidenced, in particular:

- how individual, collaborative and communal creativity are manifest

- what journeys of becoming are evident

- what evidence there is of Quiet Revolutions and the dynamics of these

- what role seems to be played by intuition, feelings and empathy

Immediately after the observations, the interviewing researcher should identify from their notes, critical incidents which they perceive to be relevant to the pedagogy and learning involved in co-creativity. In opening the interviews with teachers, which should take place on the same day as the observed sessions, they will invite teachers to reflect on the observed session and to identify 'critical incidents' relevant to the pedagogy and learning involved in the co-creativity. This would then form a starting point for the interview. The researcher's own observations can then be brought into the interview as appropriate.

A protocol will be developed for both the observations and the interviews with teachers (and suggestions for journaling following interviews with teachers).

2.3.3 VIDEO DATA CAPTURE

It will be necessary to capture video of a sample of the dialogues between teachers and students in the classroom. These dialogues will include the *Socratic Method* type interviews (see Section [2.2.1]), that will take place in the course of *C²Learn*'s educational interventions.

There are three main reasons for video-data capture:

- As the categorisation of the students will take place during and through these dialogues, the teachers may want to refer back to them if they find a categorisation problematic;

- Video-data capture enables outside raters to make parallel categorisations of children's creativity. This will enable us to calculate inter-rater reliability kappa statistics. This is the main check for the project that the categories embodying the theory/teaching practice are communicable from teacher to teacher. It is, thus, the main check that we have on the objectivity of the results;

- The reason for video rather than simply audio recording is that the dual modality recordings are always much easier to categorise. Classrooms tend to be quite noisy, and poor recording quality imposes a major cost in the time of those who have to make judgments based on them;

- Video capture will enable multimodal analysis to extend the social interpretation of language and its meanings to the whole range of modes of representation and communication employed in a culture (Kress, 2009[33]; van Leeuwen, 2005[34]). With the option of multimodal analysis, the team can focuses on teachers' and students' process of meaning making, a process in which they make choices from a network of alternatives: selecting one modal resource (meaning potential) over another (Halliday, 1978[35]); &

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[33] Kress, G. (2009), *Multimodality: A social semiotic approach to communication*, London, Routledge Falmer.
[34] van Leeuwen, T. (2005), *Introducing Social Semiotics*, London, Routledge.
[35] Halliday, M. (1978), *Language as a Social Semiotic*, London, Edward Arnold.

- Video data capture will provide the team data to analyse multimodal aspects of teacher and student gameplay and/or interaction with C^2Learn's virtual and real-time learning environments.

Needless to say, such recording will have to be subject to the required ethical confidentiality guarantees and permissions at the university and school levels. If permissions can be obtained, a small sample of video recordings will prove extremely important in disseminating the results of the project and encouraging teacher uptake of the findings.

Multi-modal data collection and analysis

Video data capture of 1-2 instances of gameplay in each site (the first foray into C^2Learn's digital game and then again at a later time when players have more experience with the game and/or environment) will allow the team to author a descriptive account of the lesson – a video log. The log will be a synopsis of what was going (gameplay and more proudly examples of the 5 elements of co-creativity) on during the observations. We may include sketches of events, video stills, a map of the classroom layout and trails, and comments on the teacher and student movement and gameplay. Alongside, but separate from this account, we may also opt to undertake a Multimodal Interaction Analysis (MIA) of teacher and students' gameplay. MIA systematically examines multiple communication modes including gesture, proxemics, layout of hardware, body posture, head movement, gaze, handling of hardware, and talk[36]. Students' and teachers' perceptions of high intensity modes will be identified through analysis of their reactions to modal shifts as a result of engaging within and outside virtual environment that will house/host the C^2Learn digital game. This information, if analysed this way, can be used as evidence for inferring participants' moment-by-moment understandings of the affordances offered through the different tools and/or collaborative experiences made possible by the C^2Learn game.

Though dialogue, within and outside the digital game, is an important feature of collaboration and co-creativity through the 4Ps, embodied, material, and spatial cues are sometimes foregrounded by game-players. Small samples (30-45 minutes X 2) of gameplay can be analysed using MIA to develop more comprehensive understandings of the ways students and their teachers make sense of the multiple semiotic modes that are always present in face-to-face interaction, but also present as they interact with a machine. Our MIA analysis may involve repeated viewing of video data that captures the interaction between game-players (students and teachers) and the C^2Learn game (machine). We will view the video data as a research team to get a range of perspectives. We will view the video data with both sound and image, and sometimes without sound to focus on action or body posture or gaze when game-players are interacting with the hardware that will support the C^2Learn game. Viewing the data alongside the logs and organising it in light of the co-creativity research questions will better assist the research team in generating criteria for sampling the data, refining and generating new questions, and developing analytical ideas in relation to the C^2Learn Co-Creativity Conceptual Framework.

MIA as a research method is relatively new in terms of theory and in terms of practices of transcription, language of description and analysis, including video data. This is both exciting and challenging for C^2Learn. In one sense we have the potential to offer something very new and relevant to the field, but much does depend on how the game will be designed, how the game will be played, on what device and the ways the 4Ps will be made (not made) possible through its interface, design and the kinds of activities (puzzles, quests, both individual and collaborative, problems, etc) it offers gameplayers and the extent to which it will/will not sync with what we understand to be a living dialogic space. Thus, the MIA is a tentative and possible from of analysis that may be undertaken if possible.

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[36] See for example the work of Deborah Rowe (2012) who uses MIA to operationalize literacy learning events as not only linguistic and textual, but also as embodied, material, and spatial.

Additionally, the research team may, like Zhang, Newgarden and Young (2012)[37], use Communicative Project theory (Linell, 2009[38]), to identify and distinguish between the different coordination and language activities that emerged during an episode of gameplay. It is likely, yet uncertain at the present moment, the extent which *C²Learn* game or learning environments will bring narrative structure, interactional constraints, drama, fun and challenge to gameplay. But it is likely that these may be critical factors in engagement and learning that can potentially foster co-creativity through dialogue within and outside of the game. Using multimodal analytic tools and systematically applying ecological and dialogical concepts such as affordances, coaction, co-agency, dialogue and values realizing[39], the research team will be able to better identify what game-players will be skillful in doing in terms of the elements co co-creativity identified earlier:

- Attending to ethic and impact of ideas

- Engaging in dialogue

- Being in control

- Engaged action

We are hopeful that *C²Learn*'s digital game will provide multiple values-realising opportunities that engage students and teachers in real-time and authentic problem-solving activities (perhaps those that are similar to alterative reality gaming and/or augmented reality gaming[40]). These are important to fostering co-creativity and facilitating journeys of becoming—over time—that have the potential for realising WHC.

Screen-captured game-play (e.g. analysing what the avatars do inside the game)

We may also use multimodal analysis to make sense of how game-players coordinate their actions through the language (Baldry & Thibault, 2006[41]) the avatars use during gameplay. We may also decide to transcribe avatar actions instead of real life body gestures. Avatar embodied action and inter-actions will most likely be situated in the virtual environment of *C²Learns*' game. This will provide the research team an exceptional opportunity to investigate how game-players' meaning making and values realizing are relevant to time, location, and movements with in the game itself. This is a chosen method because we are interested in how perceptually salient features in such gameplay events (e.g. using CER's tools) contribute to the meaning- making process of that event (Baldry & Thibault, 2006).

It is possible we can use Transana[42] video transcription and analysis software, or another software recommended by one of the *C²Learn* partners who have greater experience and expertise in game design. If we do so we can code verbal language and action using the co-creativity elements that emerged from the OU's workshops with students and teachers in the UK.

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[37] Zhang, D., Newgarden, K. & Young, M.F. (2012), "Multimodal analysis of language learning in World of Warcraft play: Languaging as Values-realizing", *ReCALL* 24(3): 339–360. 2012 r European Association for Computer Assisted Language Learning 339 doi:10.1017/S0958344012000183.

[38] Linell, P. (2009), *Rethinking language, mind, and world dialogically: Interactional and contextual theories of human sense-making*, Charlotte, NC: Information Age Publishing, Inc.

[39] Values-realizing theory (Hodges, 2007) concerns how agents make a conscious choice among multiple values at play in any given moment of action and interaction, enables us to reveal a dynamic pattern of languaging across timescales. (Hodges, B. H. (2007a), "Values define fields: The intentional dynamics of driving, carrying,leading, negotiating, and conversing", *Ecological Psychology*, 19(2): 153–178.)

[40] See the work of Klopfer, E. (2008), *Augmented Learning: Research and Design of Mobile Educational Games*..

[41] Baldry, A. & Thibault, P. J. (2006), *Multimodal transcription and text analysis: A multimedia toolkit and coursebook*, London: Equinox Publishing Ltd.

[42] http://www.transana.org/

2.3.4 SELF AND PEER EVALUATION TOOLS

A] **Creativity Wheel**

Drawing on Redmond (2005)[43] and Spencer, Lucas and Claxton (2012)[44] – Appendix 1 - the OU team have developed a *C²Learn* specific co-creativity assessment wheel.

The aim is to encapsulate the key parts of the *C²Learn* goals from the co-creativity theoretical framework as defined above. This self and peer assessment tool uses a similar set of principles that underpin Redmond (2005) and Spencer et al's (2012) wheels. Collated together the following points can be said to characterise the creativity assessment wheels. They:

- Are not checklists.

- Are a way of involving pupils alongside teachers and/or facilitators in the creativity assessment process

- Are a way of allowing students and teachers to reflect on their creative development

- A way to better understand students' needs for appropriate experiences that will develop their creative behaviour

- Are different for each participant e.g. one might be neat and handwritten, another might have examples of activity physically stuck to it, another might be digitally created

- Are structured to represent a particular way of defining creativity (see above for *C²Learn* goals definition)

- Are divided into sections or themes which represent different aspects of the creativity definition

These themes are in turn divided into indicators of creative development. These indicators are:

- Described in teacher/adult language

- Described in participant appropriate language (in *C²Learn* case this needs to be adapted for different age ranges)

- Drawn from theoretical and practical work focused on the creativity definition, as well as potential development from members of the *C²Learn* team

Spencer et al's (2012) wheel also includes the capacity to capture progression for each participant which is not present in the Redmond (2005) version. This is done simply by dividing the triangle for each indicator into 3 or 4 sections where one section's completion can build on the one before it, building out from the centre.

In the first instance the OU team developed a hand-drawn 'mock up' of a *C²Learn* co-creativity assessment wheel as shown in *Figure 2* below.

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[43] Redmond, C. (2005), *The creativity wheel: assessing creative development teacher resource*, Creative Partnerships: Arts Council.

[44] Spencer, E., Lucas, B. & Claxton, G. (2012), *Progression in Creativity: developing new forms of assessment – Final Research Report*, Newcastle: Creativity Culture and Education.

Figure 2: Exploratory *C²Learn* co-creativity assessment wheel

As can be seen in the Figure, the wheel includes the five elements of co-creativity related to WHC and CER defined in Section [1.1] above. It is designed to represent the core characteristics of creativity wheels as detailed above with the additional option to show development in different elements over time as per Spencer et al's (2012) wheel. For clarity, Appendix 2 contains the text from the wheel set out as a list.

This wheel was piloted in the UK pilots and during *The Creativity and Games in Education Summer School* early July 2013. In the pilots, 10-11 year olds and 11-14 year olds in four schools used the wheel individually and collaboratively in the format above as a colour copied A4 and A3 sheet. They used it to assess both their own co-creativity and as a tool to assess whether the serious games they were playing contained the *C²Learn* co-creativity characteristics in anyway. Their feedback has been compiled within the internal project analysis document[45]. Summer School participants used the wheel to evaluate their own co-creativity in small groups having chosen scenario seeds being explored by the *C²Learn* Consortium. Their feedback will be compiled with that of the UK pilots to develop the wheel further.

During the same period the UEDIN team have also offered amendments to the 'intervention and reframing' questions, as well as the OU team having their own comments on the wheel from using it practically with the students. Drawing on all of this feedback, the text and format of the wheel are currently being developed. Once this is done the wheel will be digitised ready for use within the next pilot phase.

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[45] Chappell, K., Walsh, C. & Craft, A., *C²Learn* Pilot 1 Internal Project Document: Analysis of UK data.

B] **Axes**

In Section [1.1] above, it is proposed that the 4P's inherent in digital contexts (participation, pluralities, playfulness and possibilities)[46] (Craft, 2011) will be embedded within the game environment. The assessment methodology is seeking ways to enable individual players and peers to self- and peer- evaluate the extent to which the *C²Learn* context allows for the 4Ps. Continua could be used by which to plot the extent to which *C²Learn* offers playfulness and pluralities as shown in *Figure 3*.

Playfulness

-   +
_____

Pluralities

-   +
_____

Figure 3: **Playfulness and possibilities continua**

Axes (developed within the Exeter University Aspire project)[47] for plotting participation and possibilities could also be embedded within the game and environment, enabling students and staff to co-evaluate the opportunities offered and instantiated in C2Learn and ways to develop both where necessary.
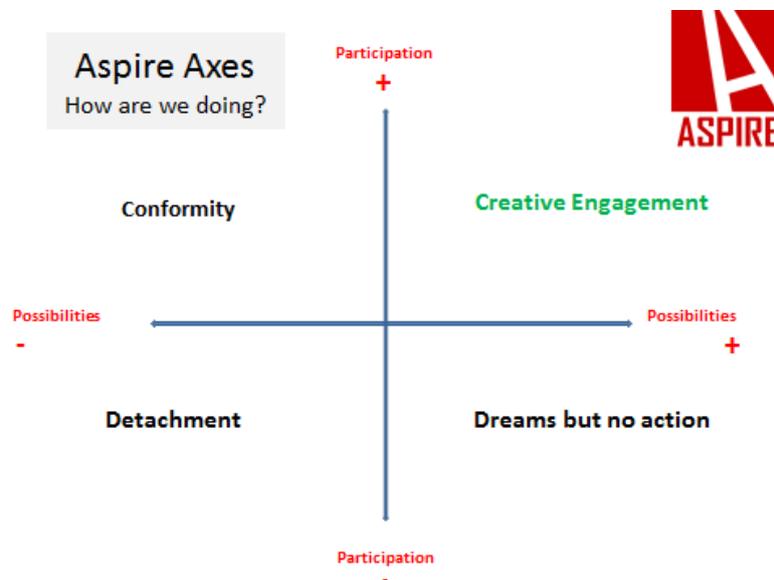

Figure 4: **Axes for documenting participation and possibilities**

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[46] Craft, A. (2011), *Creativity and Education Futures*, Stoke on Trent: Trentham Books.
[47] Chappel, K. & Craft, A. (2011), "Creative Learning Conversations: producing Living Dialogic Space", *Educational Research*, 53 (3), 363-385.

Offering students a means by which to locate their lived experience of participating and generating possibilities by marking their position on the chart, the axes can be used as a prompt for dialogue between peers and also between peers and teachers. They also offer students and staff opportunities to chart change in lived experience over time.

Alongside the wheel, the axes were piloted in the UK pilots and during The Creativity and Games In Education Summer School in early July 2013. 10-11 year olds and 11-14 year olds in four schools used the axes individually as an A4 sheet and collaboratively as a giant axes marked on the floor on which they physically positioned themselves. They used it to assess their participation and capacity to explore possibilities within a task developed as part of the *C²Learn* Learning Design[48]. Their feedback has been compiled within the internal project analysis document[49] from which the axes and continua are currently being developed for use within the next pilot phase.

In addition teachers participating in the *C²Learn* Summer School used the axes across a giant floor grid to evaluate digital games that they were devising for use with their own pupils as shown below.
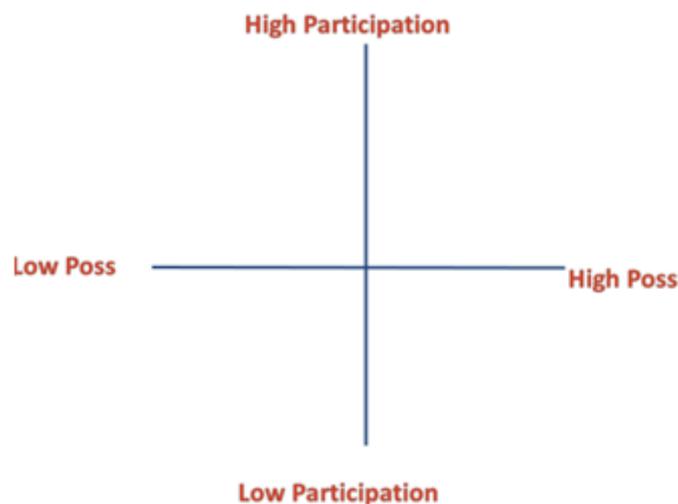
High Participation

Low Poss ———————————————— **High Poss**

Low Participation

Figure 5: **Axes grid**

Their reactions confirmed their usefulness in evaluating the extent to which these were designed to enable pluralities, playfulness, participation and possibilities.

2.3.5 USE OF COMPUTATIONAL CREATIVITY METRICS

The educational intervention is an organic fusion of a variety of activities with the technological tools, which implies we will, de facto, be evaluating the technology, as the students' primary access to our theories/techniques will be through the use of the game(s) and other computational tools.

We will be able to capture human-machine interaction and co-creativity through the evaluation of *lived experience*. *Lived experience* is a dimension of co-creativity that emphasizes engagement and playfulness and is ideal to pick up the important role that technology plays. Through video data of gameplay and screen capture data in the virtual learning environment (VLE) - supported by field-notes and the data collected from interviewing the teachers - as well as through the *Socratic Method* type interviews, we expect to gather

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[48] Craft, A., Chappell, K. & Walsh, C., Learning Design *C²Learn* Project Deliverable [2.2.1].
[49] Chappell, K., Walsh, C. & Craft, A., *C²Learn* Pilot 1 Internal Project Document: Analysis of UK data.

information detailing the use of the game(s) and other computational tools. This data will further enhance the pool of data and provide insights into the actual use of the tools.

The research team is very much interested in exploring and adapting research conducted on computational creativity. A variety of metrics, such as *novelty* (Boden 2003 and Gero, 1996)[50], *rarity* or *impressiveness* (which is defined through rarity and recreational effort ,Lehman and Stanley (2012)[51]), *value* in terms certain constraints set in our case by the game (Boden 2003)[52] etc., have been proposed[53]. We are currently developing an approach to productively introduce similar metrics in our evaluation methodology, the general outline of which is as follows:

- Our evaluation (particularly the *Socratic Method* type interviews) will focus around and be structured by key moments in gameplay (and classroom interaction), which the teacher identifies as exhibiting signs of co-creativity. These *creativity nodes* will form the backbone of the teacher's subsequent investigation and categorisation. We can use a selection of computational creativity metrics, heuristically, as further guides to identify these creativity nodes. Through the specification of these metrics, our aim is to enable the machine to provide us with a selection of key or critical incidents in gameplay, which are deemed as possible moments of creativity. The metrics therefore will help shape the space of interest, that the teacher and potentially the researchers will then examine closely using the definition of creativity advanced in *C²Learn*[54]. So although creativity is understood primarily as an acquisition of skills or habits (extending Colton's 2008[55], definition of computational creativity to include not only productive, but also conceptual skills, for human creativity), the metrics allow us to pinpoint the critical incidents associated with the exercise of these skill(s). The teacher is not constrained by the machine's selection, but can use the machine's selections as starting points to focus his/her investigation into the student's creativity status/progress. It would be potentially productive to further tailor, eliminate some of, or add to the machine's selections using the WHC principles.

It is important to note that computational creativity metrics can be used not only as a heuristic set of human creativity during human-machine co-creation, as described above, but also for the reaction of the game (agent, content etc.) to human responses and an assistive tool of the co-creative process (e.g. by offering novel and valuable recommendations to the student and the teacher). One of the challenges facing us is in choosing and using these metrics in relation to gameplay products that may only have some elements of them in the digital environment (for example stories in a story-telling game). This is still work in progress, undertaken in close collaboration with our partners from UoM, SGI and NCSR-D, and forms one of the most important strands of Part 4 of our research questions.

2.4 OTHER EVALUATION METHODOLOGICAL TOOLS CRITICALLY CONSIDERED

A] **On the use of control groups**

The first requirement of any evaluation of ongoing research into a new educational intervention is that it establish that it makes some contribution to its stated goals---do the students get `better' at doing what the intervention sets out to `improve'. This is most obviously achieved by comparing the young people's responses to early `observations/interventions' with late ones, and hopefully observing a general improvement as

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[50]Boden, M.A. (2003), *The Creative Mind - Myths and Mechanisms* (2. ed.), Routledge; Gero, J.S. & Kazakov, V.A. (1996), "An exploration-based evolutionary model of a generative design process," vol. 11, pp. 211–218, Blackwell Publishing Ltd.

[51] Lehman, J. & Stanley, K.O. (2012), "Beyond Open-endedness: Quantifying Impressiveness", in *Artificial Life*, vol. 13, pp. 75-82.

[52] Boden, M.A. (2003), *The Creative Mind - Myths and Mechanisms* (2. ed.), Routledge.

[53] For a more in depth discussion see Section [2.1.1] of Deliverable [4.4.1].

[54] See Section [0.1] for an overview.

[55] Colton, S. (2008), "Computational Creativity", *AISB Quarterly*, 126, pp. 6-7.

captured in the categorisation scheme, based on the theory of what constitutes the desired goal. So the methodology proposed here is aimed at precisely this goal.

Controlled experimental comparisons are always highly focused in the questions they answer and the conclusions that can be drawn. *C²Learn* is very much exploratory research, and sharpening the questions to the degree required would almost certainly mean answering too narrow a question. For example, assessing the impact of teaching logic on thinking, with and without specific kinds of diagram, is a very different problem.[56] Even though it is also a study of an educational intervention not-unrelated to creativity, the logic curriculum is very highly developed, as are several alternative diagrammatic and sentential methods of teaching. There are well accepted tests of success, and ideas about how the skills learned should transfer to neighbouring material, as well as, a well-developed semantics for both diagrams and sentential formulae. It is possible to engineer random assignment of students to educational treatments (with and without diagrams). Highly developed software in support of teaching is already available, and can log and evaluate students' performances.

Experiments using control groups would require a rigorous creativity curriculum analogous to a mathematics or a logic curriculum (or any other analogous curriculum) , alongside the epistemologically appropriate theoretical ideas about what creativity is, how it might be taught/learned, and what part computers might play, etc. In light of the state of creativity curriculums, and the fact that *C²Learn* theoretical framework derive from a differently configured epistemological framing, any sharply focused experimental evaluation is wildly unlikely to be answering the right highly focused question or questions. Based on the above, we opted not to further encumber our assessment with a methodological and logistical burden, unsuited to our particular type of curriculum and research.

B] A review of major taxonomies (relating to cognitive etc. categorisations)

The approach to co-creativity developed in *C²Learn* builds on the cognitive and philosophical work of UEDIN and the critical theory-influenced educational, socially and ethically situated approach of OU, to generate an organic fusion of theory. The theory generated foregrounds Wise Humanising Creativity and Creative Emotional Reasoning in fostering journeys of becoming and quiet revolutions as discussed earlier in this deliverable.

The *C²Learn* co-creativity approach lends itself to applied work in the classroom and in digital worlds, and so may appear to share elements in common with models of learning associated with particular pedagogies. One of these is problem-based learning. In the *C²Learn* Learning Design deliverable (D2.2.1), however, the key differences between the efforts of this ethical creativity-focused study (*C²Learn*) and problem-based learning (which does not focus on ethical creativity though it does include communities of activity) were highlighted.

Other widely known work within learning science might also appear to overlap with the efforts of *C²Learn*. For example, examples of learning styles (such as models by Kolb[57], Honey and Mumford[58], Gregorc[59] and others), classifications of cognitive styles (such as Myers-Briggs Type Indicator[60], Kirton's[61] adaptors and innovators,

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[56] Stenning, K., Cox, R. & Oberlander, J. (1995), "Contrasting the cognitive effects of graphical and sentential logic teaching: reasoning, representation and individual differences", *Language and Cognitive Processes*, 10 (3/4), pp. 333-354.

[57] Kolb, D.A. (1976), *The Learning Style Inventory*, Boston, MA: McBer.

[58] Honey, P. & Mumford, A. (1982), *Manual of Learning Styles*, London: P Honey.

[59] Gregorc, A.F. (1982), *An adult's guide to style*, Maynard MA: Gabrial Systems Inc.

[60] For example, Myers-Briggs; McCaulley M.H., Quenk, N.L. & Hammer, A.L. (1998), *MBTI Manual (A guide to the development and use of the Myers Briggs type indicator)*, Consulting Psychologists Press, 3rd editon.

[61] Kirton, M. (1976), "Adaptors and innovators: a description and measure", *Journal of Applied Psychology* (61:5), pp. 622–629; Kirton, M.J. (2003), *Adaptation and innovation in the context of diversity and change* Routledge, London, p. 392.

Sternberg'[62]s triarchic model and others). There are also other well-known approaches which may appear relevant such as Bloom's[63] taxonomy of learning and Gardner's[64] theory of multiple intelligences.

In considering the possible relevance of any of these bodies of work, it is important to acknowledge the focus of *C²Learn*, on co-creativity and to consider whether any of these studies focuses on the same terrain. Not one of these studies has a particular focus on co-creativity, even though some include creativity (at an individual level) within them. *C²Learn* is therefore NOT anchored in these approaches but rather draws on the particular range of literatures which frame their work (ie philosophy, cognitive science, educational studies, critical theory-oriented social psychology, social anthropology and social geography), to create a shared delineation of **co-creativity.**

The approach to creativity developed in the *C²Learn* project is distinct from other approaches which encompass a range of epistemological, ontological and therefore methodological perspectives. Such approaches include psychodynamic approaches which foreground the role of the unconscious[65], cognitive approaches which seek the development of models[66], humanistic approaches concerned with human potential[67], psychometric approaches[68] concerned with testing, social-personality approaches concerned with personality trait[69], evolutionary approaches concerned with explanations of novelty in a wider system, and confluence approaches recognising the existence of concurrent influences in creativity. In addition there are a-theoretical approaches which foreground pragmatics.

The approaches to studying creativity delineated above are all concerned with the study of individual creativity although several lines acknowledge the social context. By contrast however, and situated in the interpretive paradigm with a focus on the transformation of lived experience in a social context, through generating novel and valuable outcomes, the approach developed in *C²Learn* acknowledges the interplay between individual, collaborative and communal creativity (grounded in Chappell, 2008[70], drawing on John-Steiner, 2001[71]). Chappell et al (2013[72]) clearly position humanising creativity and, by association wise humanising creativity, in relation to current theories of creativity *in education*. The concept has connections to the notion of humane creativity (Fischman, 2007[73]) and wise creativity (Craft et al, 2008[74], Craft, 2009[75]), as well as the kind of

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[62] Sternberg, R. J. (1985), *Beyond IQ: A Triarchic Theory of Intelligence*, Cambridge: Cambridge University Press.

[63] As reviewed here: Bloom, Benjamin S., *Reflections on the development and use of the taxonomy* in Anderson, Lorin W. & Lauren A. Sosniak, eds. (1994), *Bloom's Taxonomy: A Forty-Year Retrospective*. Chicago National Society for the Study of Education.

[64] Gardner, H. (1983; 1993), *Frames of Mind: The theory of multiple intelligences,* New York: Basic Books.

[65] Freud, S. (1959), "Creative writers and daydreaming", in J. Strachey (Ed.), *Standard edition of the complete psychological works of Sigmund Freud*, volume 9, pp. 143–53, London: Hogarth Press; Winnicott, D. W. (1971), *Playing and reality*, New York: Routledge; Jung, C. J. (1995), *Memories, dreams and reflections* (recorded and edited by Aniela Jaffe, translated from the German by R. & C. Winston), London: Fontana.

[66] For example, Wallas, G. (1926), *The art of thought,* Hartcourt Brace, New York, NY.

[67] Maslow, A.H. (1943), "A theory of human motivation", *Psychological Review, 50*(4), 370–96; Rogers, C.R. (1954), "Towards a Theory of Creativity", *ETC: A Review of General Semantics*, 11: 249-260.

[68] For an overview, see Plucker, J. & Renzulli, J. (1999), "Psychometric Approaches to the Study of Creativity", in R. J. Sternberg (ed), *Handbook of Creativity*, Cambridge: Cambridge University Press.

[69] Some key social/personality approaches were summarised by Brolin, C. (1992), 'Kreativitet och kritiskt tandande. Redsckap for framtidsberedskap' [Creativity and critical thinking. Tools for preparedness for the future] in *Krut*, 53, pp. 64-71.

[70] Chappell K. (2008), "Towards Humanising Creativity", *UNESCO Observator*y, E-Journal Special Issue on *Creativity, policy and practice discourses: productive tensions in the new millenium* Volume 1, Issue 3, http://www.abp.unimelb.edu.au/unesco/ejournal/vol-one-issue-three.html.

[71] John-Steiner, V. (2000), *Creative collaboration*, Oxford: Oxford University Press.

[72] Chappell K., Craft A., Rolfe L. & Jobbins, V. (2013), "Humanising Creativity: valuing our journeys of becoming", *International Journal of Education and the Arts*, *13(8) 1*-35, retrieved 11.01.13 from http://www.ijea.org/v13n8/.

[73] Fischman, W. (2007), "A call to serve: an exploration of humane creators", in Gardner H. (Ed.), *Responsibility at Work. How leading professionals act (or don't act) responsibly*, pp. 81-106, San Fransisco: Jossey-Bass.

[74] Craft, A., Gardner, H., Claxton, G. et al (2008), *Creativity, Wisdom and Trusteeship. exploring the role of education*, Thousand Oaks: Corwin Press.

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democratic creativity described in Banaji, Burn and Buckingham (2010[76]). Focusing on everyday creativity (Craft[77], 2001), *C²Learn* reflects Beghetto and Kaufman's[78] (2007) notion of both 'mini-c' and 'little c' creativity, or Boden's[79] (2004) 'personal creativity'. It is quite distinct from Gardner's high-c (1993, ibid). Humanising creativity is embedded in an embodied understanding of an integrated thinking body-mind (Chappell, 2006[80]; Shusterman, 2008[81]) which is in contrast to creativity driven by dominant cognitive approaches that distinguish strongly between mind and body (eg Cropley, 2001[82]). Humanising creativity also exists in tension with conceptualisations of creativity with an economic imperative. These perspectives suggest advancing the economy through a creative workforce made up of flexible, personally responsible problem solvers (e.g. Seltzer and Bentley 1999[83]).

Grounded in this theoretical position and with its focus on co-creativity between humans and between humans and machines, *C²Learn* cannot, therefore, meaningfully draw on any of the existing tests of creativity – even if they were compatible with the epistemological and ontological perspectives that make up the fused creativity framework of WHC and CER at the heart of *C²Learn*. Thus, well known measures of creativity such as the Torrance Tests[84] developed in North America, or Lubart[85]'s tests developed in France both of which focus on individual creativity and the latter of which also seeks to identify creative giftedness, are not appropriate instruments for measuring the success of the *C²Learn* digital environment in fostering ethical everyday (or little c) co-creativity. It is the hope of the project team that by identifying and refining criteria for the evaluation of such co-creativity the basis of a future assessment tool or tools may emerge from the study.

3. OPERATIONALISATION

Having examined in detail the tools that comprise the basic elements of our methodology, we seek in this part to bring everything together in a concrete evaluation plan (Section [3.1]), by addressing the different operationalisation dimensions: We examine the role of teachers in more detail (Section [3.2]), and then proceed to explicate our approach to analysis and synthesis of the data to be gathered (Section [3.3]). Finally we address the issue of training the teachers/researchers for the task at hand (Section [3.4]) and the relevant ethical considerations (Section [3.5]).

3.1 EVALUATION PLAN

The evaluation process will consist of 4 in-depth case studies, realized in 3 pilot cycles, and divided amongst the 3 countries that comprise *C²Learns*'s core testing focus.

The time frame for the 3 pilot cycles is as follows:

[75] Craft A. (2008), "Trusteeship, wisdom and the creative future of education?", *UNESCO Observatory*, E-Journal, Volume 1, Issue 3, Special Issue: *Creativity, policy and practice discourses: productive tensions in the new millennium*.

[76] Banaji, S., Burn, A. & Buckingham, D. (2010), *The rhetorics of creativity: A review of the literature*, London: Arts Council England (2nd edition).

[77] Craft, A. (2001), "Little c creativity", in A. Craft, B. Jeffrey, & M. Leibling (Eds.), *Creativity in education*, London: Continuum.

[78] Beghetto, R. A. & Kaufman, J. C. (2007), "Toward a broader conception of creativity: A case for 'mini-c' creativity", *Psychology of Aesthetics, Creativity and the Arts*, 12, 73-79

[79] Boden, M.A. (2003), *The Creative Mind - Myths and Mechanisms* (2. ed.), Routledge.

[80] Chappell, K. (2006), "Creativity as individual, collaborative & communal", in *Proceedings of dance and the Child international conference*, The Hague, pp. 42-53.

[81] Shusterman, R. (2008), *Body Consciousness: A philosophy of mindfulness and* somaesthetics, New York: Cambridge University Press.

[82] Cropley, A. J. (2001), *Creativity in education & learning. A guide for teachers and educators*, London: Kogan Page.

[83] Seltzer, K. & Bentley, T. (1999), *The creative age: Knowledge and skills for the new economy*, DEMOS.

[84] E.g. Torrance, E.P. (1974), *Torrance Tests of Creative Thinking*, Scholastic Testing Service, Inc.

[85] Lubart, T., Besançon, M., & Barbot, B. (2011), *EPoC: Evaluation du Pötentiel Créatif*, Paris: Hogrefe. See more at: http://www.mic-conference.org/lubart#sthash.pw0RzqQM.dpuf.

- 1st pilot cycle from M(onth)16 to M21 (i.e. 6 months duration)

- 2nd pilot cycle from M25 to M30 (i.e. 6 months duration)

- 3rd pilot cycle from M34 to M36 (i.e. 3 months duration)

For each pilot cycle all 4 case studies will take place concurrently. Of the 4 case studies, 2 will be held in Greece, 1 in Austria and 1 in the UK.

The evaluation data will be collected by specially trained teachers (supported by the researchers), the same teachers responsible for administering the C²Learn Educational Interventions (see Sections [3.2] and [3.4]) and also by the researchers. The data will be analysed by the researcher teams in each country though in the case of the Socratic interviews, teachers will categorise the initial data collected for each interview before passing these to the researchers (possibly in an online environment).

Each case study will consist of a group of about 20 students (30 maximum-20 minimum), which will be further divided into smaller subgroups groups (with age-group and classroom distribution still to be decided).

For the two longer cycles we aim for the students to have around 18-24 hours of exposure in total to the C²Learn Educational Interventions and unified gaming and creative learning environment, spread throughout the 6-month period. We believe this will be adequate time for the to test the use of the designed technology and corresponding pedagogical interventions and evaluate their impact in real-life educational settings, provided of coursed the group remains as constant as possible although logistics of and other commitments of staff and students in individual sites and the nature of what is available from the game-world to pilot at each point will to some extent determine this in practice. The third shorter pilot cycle will most likely function as a much more focused, subsidiary/complementary to the second one since it starts during the summer holiday and ends with the end of the project.

Standard approach in each of the first two pilot cycles: The evaluation for each pilot will consist of 2 phases, taking place at the beginning and the end of each pilot cycle. The first phase seeks to establish a base of comparison for each group, whereas the second phase seeks to record and evidence the progression/evolution of the group, within C²Learn's co-creativity dimensions.

In the first phase of the evaluation process for each pilot, we will utilize:

- *Socratic Method* type interviews with students by the teachers

- Video data capture

- Self and peer evaluation tools

- Field-notes by the researcher

In the second phase all the different evaluation tools will be used to obtain the widest and most complete set of data:

- *Socratic Method* type interviews with students by the teachers

- Interviews with teachers (and accompanying field-notes) by the researchers

- Video-data capture

- Self and peer evaluation tools

We expect the use of Computational data to be ubiquitous throughout the process, informing the *Socratic Method* type interviews, and facilitating the categorisation process (see Section [2.2.5]).

We aim to cover all 4 age groups, and we are currently in dialogue with the rest of our partners in the consortium (especially in game design) to see how this can be achieved. It is most likely that we will start with the lower age group first, and use the second (and third) pilot cycle to address the higher age groups. The Standard approach outlined above will be followed for the 3 lower age groups, whereas for the highest age group (i.e. 18+) the research is likely to be will be conducted using smaller focus groups.

All the data gathered will be subsequently analyzed by the *C²Learn* research team (see Section [3.3]) as indicated above, with the local research team taking a lead in each case and a system for triangulation and also calibration across sites, in place.

3.2 TEACHERS' ROLE

Teachers have an integral role in *C²Learn*'s Co-Creativity Assessment Methodology, as already indicated. There are a number of key interrelated functions that teachers will be responsible for:

- **Teachers will be responsible for administering *C²Learn*'s educational interventions.** This means that they will inevitably develop a solid grasp of the underlying theories and methodologies driving creativity within the context of the project, which coupled with their pedagogic expertise, makes them ideal candidates for evaluating students.

- In order to capitalise on teachers' natural pedagogic role, but also facilitate the evaluation process (both logistically and in terms of quality of data, see Section [2.2.1]), **the evaluation will essentially be embedded within the educational intervention**.

- **Teachers' primary function as evaluators is to conduct the *Socratic Method* type interviews with the students.** Their familiarity with the students (as we aim to keep the groups constant throughout each pilot), supported by their long experience in communicating with students (which includes helping children absorb and verbalise information) will greatly facilitate the administration of the interviews, and provide for better results.

- Corollary to the above is **teachers' application of the categorisation scheme** which we are developing, which forms our main evaluation index and expression (see Section [1.3]).

- **Teachers will also be administering the self and peer evaluation tools**, although we are exploring the possibility of embedding these tools completely within the educational intervention, thus making their application as seamless and effortless as possible.

- **Teachers will perform inter-rater reliability tests** on each other's groups, using the video-data collected throughout each pilot cycle.

- At the end of each pilot, **teachers will be interviewed by the researchers** in order to evaluate the pedagogic dimension of the intervention (see Section [2.2.2]).

- Finally we count on **teachers' invaluable feedback** both on the applicability/utility of the educational interventions, and *C²Learn*'s Co-Creativity Assessment Methodology throughout the project's duration.

In order to prepare teachers for their role as evaluators we will be conducting specially designed workshops (see Section [3.4]). We will, of course, be in close collaboration, providing constant assistance and support to every teacher engaged in C²Learn, throughout the evaluation process.

3.3 *ANALYSIS* AND *SYNTHESI*S

Data analysis for C²Learn's Co-Creativity Assessment methodology will use the qualitative constant comparative method[86]. This allows for both a *deductive* and an *inductive* process. Deductively analysis is shaped by the core elements of the C²Learn co-creativity framework (see Sections [1.1 and [1.3]).Inductively themes are allowed to emerge from the data. The constant comparative method involves a 'conversation' between these two processes which will allow analysts to offer insight into how *change* and *lived experience* are reflected within C²Learn dimensions of co-creativity, as well as allow for other creativity features to emerge in action.

In particular, the core deductive process centres on the application of the categorisation scheme. The categorisation scheme tailored to C²Learn's Educational Interventions will yield data of teachers' categorisations of students' dialogues, indexed to student, date, and teaching intervention. These will be passed back to researchers for data entry and analysis. A form for teachers to record the data and a scheme to make the data computer readable will be devised by the researchers. Once the data is thus formalised, analysis will be the responsibility of the researchers. The central deductive analysis will be of time series of children's categories of dialogue. This core data will be enhanced by many complementary inductive analyses, which will also grow from the application of the different evaluation tools (see Section [2.2]), both independently and in response to the deductive analysis results.

Trustworthiness, quality and rigour will be ensured via adherence to the principles of credibility, transferability, dependability and confirmability[87], with particular attention paid to data and colleague triangulation techniques, negative case analysis and evidence of clear data trails for all coding and categorisation. The constant comparative analysis will involve cycles of open, selective and axial data coding and categorisation (similar to Halcomb and Davidson's preliminary content analysis, secondary content analysis and thematic review) integrated with triangulation. This will result in the deductively and inductively derived findings in relation to the experience of creativity within the C²Learn game/environment.

3.4 DATA COLLECTION/ANALYSIS TRAINING FOR RESEARCHERS AND TEACHERS

Prior to the implementation of the first cycle of co-creativity evaluation a training workshop will be held (early in New Year 2014, probably in January) for the key researchers involved in the data collection and analysis, from BMUKK, EA, OU and also UEDIN. Led by UEDIN and OU, it will afford all core research staff the opportunity to use and refine the draft data collection instruments and approaches to analysis, by trialling these with teachers and students in a school environment.

Following the training workshop, the format of each instrument will be finalised (in writing as appropriate) and a written protocol for each developed and stored centrally within the Project. Core staff in EA, OU and BMUKK will then train teachers with whom they are to work, on how to use the instruments which require teacher leadership i.e. the *Socratic Method* type interviews with audio-recording and subsequent categorisation. Teachers will also be briefed on the other instruments including how the creativity wheel and 4Ps axes are to be used by students in their classrooms, and any computer-generated monitoring of their students' gameplay. Instruments to be used by the researchers will also be introduced in such teacher training, i.e. the field notes,

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[86] Strauss, A. & Corbin, J. (1990), *Basics of qualitative research. Grounded theory procedures and* techniques, London: Sage.
[87] Lincoln, Y.S. & Guba E.G. (1985), *Naturalistic* inquiry, Beverly Hills, CA: Sage; Ely, M., Anzul, M., Friedman, T., Garner, D. & McCormack Steinmetz, A. (1991), *Doing qualitative research: Circles within circles*, London: Routledge Falmer.

semi-structured interviews of teachers and video data of a small sample of students interacting with the game-world both within and outside of the game.

3.5 ETHICS

The assessment methodology will be underpinned by a clear set of ethical principles. These will in part be derived from Data Protection Regulations and will comply with Directive 95/46/EC to ensure correct handling of data and privacy. The consortium members involved in the assessment will take all the necessary steps to ensure that all participants, teachers and students, understand the objectives of this project and the processes employed during *C²Learn* to achieve them.

All assessment activities will follow local and national regulations regarding data protection and will obtain approval from the local/national authority in charge of data protection if applicable. The members of the consortium will provide the Commission a written confirmation that it has received favourable opinions of the relevant ethics committees and if applicable, the regulatory approvals of the competent national or local authorities in the country in which the research is to be carried out. Copies of the official approvals from the relevant national or local ethics committees will be provided to the EC prior to the start of the respective research.

In practice, at a minimum, this will mean that where research is taking place with *C²Learn* project participants, parents will be informed and authorization from the head of the school or institution will be obtained. In instances where data is being collected for use by the Open University team, British ethical procedures will come into play. These follow the guidelines of the British Educational Research Association (2011)[88]. In brief this means that all evaluation procedures are carried out subject to voluntary informed consent gained using participant-specific letters and informed consent forms. For any young people under the age of 16 years this means seeking informed parental consent as well as the consent of the young people themselves. The *C²Learn* team will operate in an open way at all times and disclose what purposes collected data will be used for. Participants all have the right to withdraw their participation in the assessment at any time – they will be assured that if this occurs data relating to them will be destroyed. The *C²Learn* team will also aim for anonymity and confidentiality. This means using pseudonyms in publications and securely storing all evaluation data, particularly digital data on password protected servers where only authorised staff will have access.

The guidelines also mean that these ethical procedures, including copies of all information letters and informed consent forms will be submitted to the Open University Ethics Committee for approval before they are implemented.

All copies of consent forms and information sheets will also then be available, if required by the EC, prior to the commencement of the relevant part of the research. Detailed information on privacy/confidentiality of data collected will be provided to the EC and will be clearly explained to participants.

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[88] http://www.bera.ac.uk/publications/Ethical%20Guidelines

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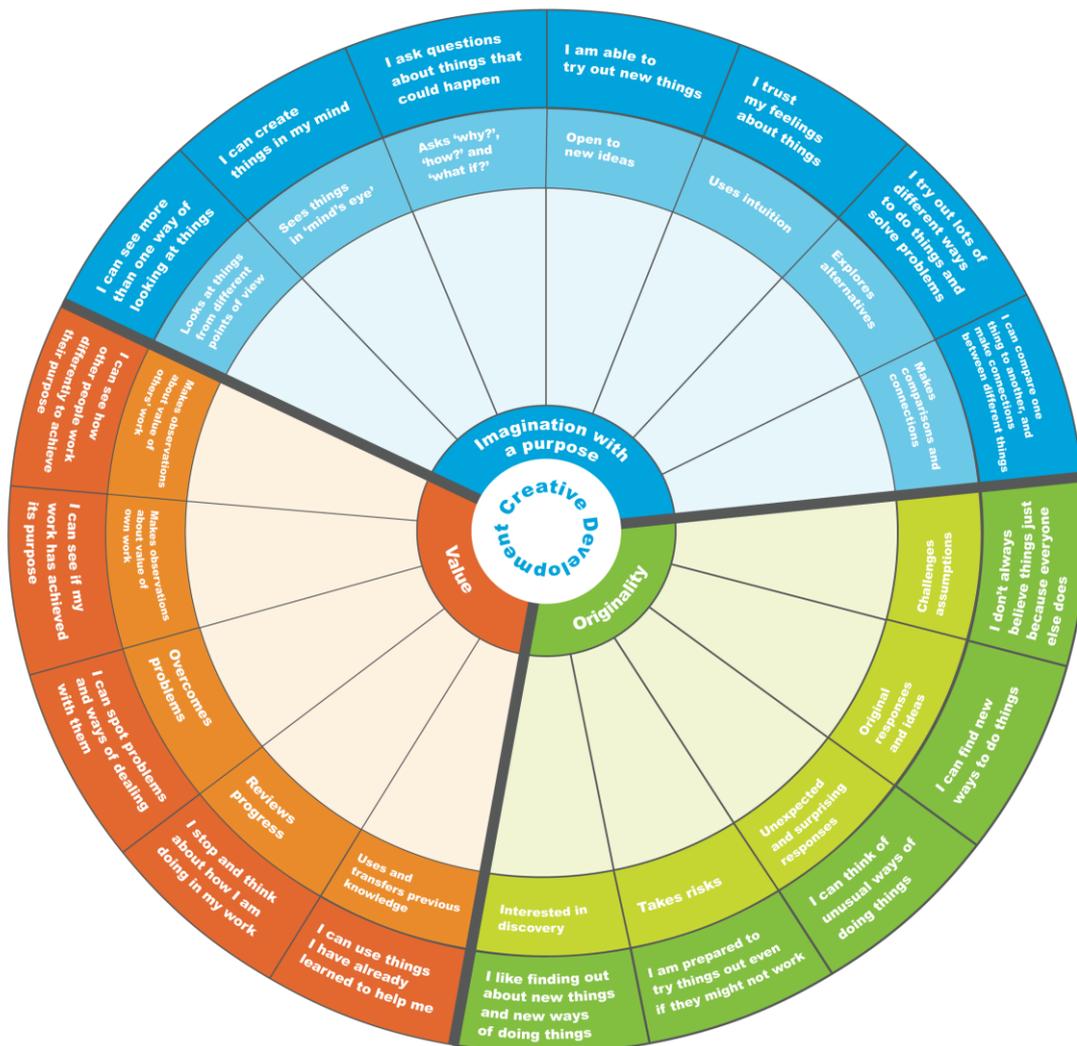
APPENDIX 1

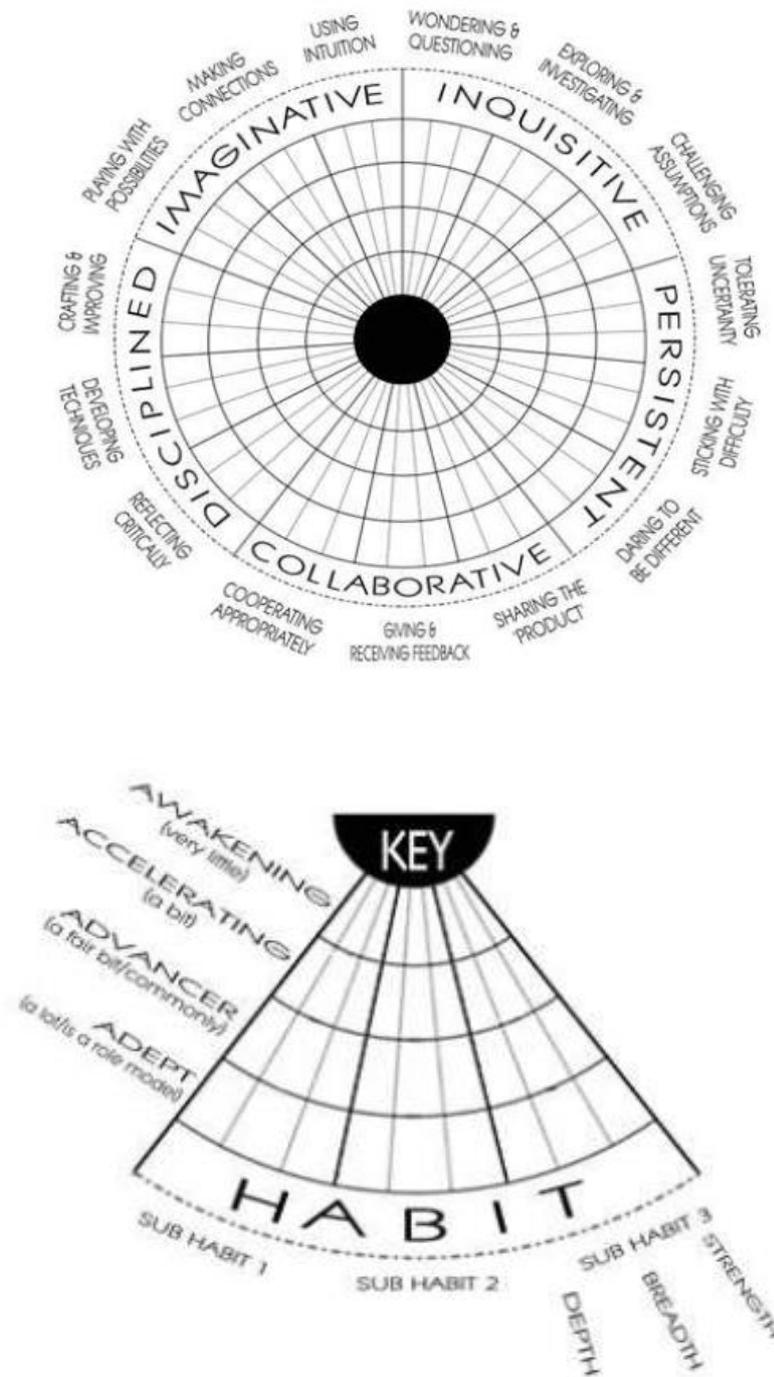*Figure 6*: Redmond (2005) Creativity Wheel

Figure 7: Spencer, Lucas and Claxton (2012) Creativity assessment wheel

APPENDIX 2

Intervention and Reframing

Self	Peer/teacher/facilitator
I was thinking differently to normal when I used the techniques	Thought differently to normal
I asked questions like 'what if' and 'how can we do this as if'	Questioned 'what if' and 'as if' possibilities
I came up with new ways of questioning in drawings	Generated new questions in drawing

Ethics and Impact

Self	Peer/teacher/facilitator
I try out new ideas + different ways to do things	Explores and actions new ideas
I can come up with new ideas	Generates new ideas
I can decide between ideas that are valuable or not	New ideas have a valuable impact on the community

Being in control

Self	Peer/teacher/facilitator
I lead others in part of the creative process	Takes charge of different parts of the creative process
I can see how rules work and what happens because of them	Understands rules and that they have consequences
I am confident to decide what to do and to do it	Makes decisions and takes actions

Engaged action

Self	Peer/teacher/facilitator
I like to do things which take me out of my comfort zone	Takes risks
I come up with ideas that surprise me and others	Delivers surprising ideas
I can't stop doing parts of the activity again and again	Does parts of activity addictively

Engaging in dialogue

Self	Peer/teacher/facilitator
I ask questions with and of others	Poses questions with and of others
I question others' different ideas and compare them with mine	Debates between ideas
I try to find ways to work with others or to work differently if not	Negotiates conflict or goes in a different direction

Table 3: Questions within Co-Creativity Wheel D1