



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

CREAT-IT PEDAGOGICAL FRAMEWORK

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Short Description: CREAT-IT intends to create a workable methodology for designing, communicating and representing creative science education approaches for late primary and early secondary schools in Europe. The foundation for this project is presented within Work Package 2 in the three deliverables D2.1 (Pedagogical Framework), D2.2 (Effective Creative Science Teacher Profile) and D2.3 (CREAT-IT Training Scheme and Implementation Scenarios).

This deliverable, **D2.1, Pedagogical Framework**, sets out the current theoretical field, current good practice; and discusses what is known about the needs of teachers working in this field. The deliverable then goes on to discuss the University of Exeter team's perspective on creative education, which will drive the pedagogical framework of the study. Examples of existing good practice are integrated with what is gathered from the CREAT-IT Effective Science Teacher Profile documenting further existing practices. This has been compiled from the project survey of all participating partner countries, which is formally reported in deliverable D2.2. Together these generate the pedagogical framework and principles for the project. Which will become the foundation used to develop a series of teacher training workshops, resources, demonstration activities and contribute towards creating an online users' community for teachers.

Part 1 outlines what is currently happening in research, practice and policy within and beyond Europe across the domains of creativity, education and science. Finally it proposes the CREAT-IT definition for creativity in science education.

Part 2 comprises a literature review, and an introduction and discussion of the main creativity theory, which is being drawn on within the CREAT-IT project and integrates this with key information from the CREAT-IT survey, full details of which are published in D2.2.

Part 3 draws from Parts 1 and 2 to offer a description of the essential features of the CREAT-IT pedagogical framework, analysing the three CREAT-IT cases studies represented in the project; Write a Science Opera (WASO), Science and Theatre and Junior Science Café, in relation to the 12 CREAT-IT principles behind the pedagogical framework. This section concludes with the CREAT-IT team's recommendations for concrete approaches to continuing professional development (CPD) that will be considered when developing its CPD workshops in Work Package 3.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Table of Contents

Glossary.....	5
Executive Summary	8
1. Establishing the field.....	10
1.1. Policy & Curriculum in science education in Europe.....	10
1.1.2 The evolving nature of scientists and the future of science education.....	15
1.1.3 Nature of creativity	18
1.1.4 Creativity in education.....	21
1.1.5 Creative teaching and teaching for creativity in science education.....	32
1.1.6 Science curriculum in Europe	35
1.1.7 What good practice is already happening with regard to creativity and science teaching?	37
1.1.8 Emerging Tensions / Dilemmas in fostering creativity in science education.....	40
1.1.9 Summary from Part 1	46
2. Literature review of University of Exeter theory and survey outcomes.....	47
2.1 Analysis of University of Exeter theory	47
2.1.1 Living Dialogic Space.....	48
2.1.2 Wise Humanising Creativity	56
2.1.3 WHC and Quiet revolutions	63
2.1.4 Possibility Thinking.....	64
2.1.5 WHC, Quiet Revolutions, PT and the 4Ps.....	69
2.1.6 Summary.....	71
2.2 What we know from the survey.....	72
2.3 Summary of Part 2.....	76
3. The essential features of the CREAT-IT Pedagogical Framework and their application	77
3.1 Integrating the above to offer a description of the essential features of CREAT-IT Pedagogical Framework Principles	77
3.1.1 Narrative and visualisation of ideas and practices synthesised within the CREAT-IT pedagogical framework.....	78
3.1.2 The 12 Key CREAT-IT Pedagogical Framework Principles	80
3.2 The Case Study scenarios in relation to the CREAT-IT narrative, visualisation and principles	83
3.2.1 Case Study 1: Write a Science Opera (WASO).....	83
3.2.2 Case Study 2: Science and Theatre (S&T).....	93



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

3.2.3 Case Study 3: Junior Science Cafè/'Caffè Scienza Junior' (JSC/CSJ).....	101
3.3 Approaches to Continuing Professional Development: From across Europe	109
3.3.1 Emerging themes, recommendations and guidance for the CREAT-IT team to consider in relation to the 12 CREAT-IT Principles	116
3.3.2 Further recommendations not related to the 12 CREAT-IT Principles	118
3.4 Summary of Part 3.....	118
Reference List.....	120
Appendix	137
Appendix A: C2Learn co-creativity conceptual framework.....	137
ADDENDUM TO CREAT-IT PEDAGOGICAL FRAMEWORK	138

List of figures

Figure 1 Definitions of Creativity From http://www.creative-little-scientists.eu/node/57 (21st January 2014)	13
Figure 2 Aspire students and teachers construct Snakes and Ladders whilst other students document.....	50
Figure 3 Example of student documentation	50
Figure 4 Inviting multiple perspectives	51
Figure 5 Ecological model of CLCs	54
Figure 6 Creative learning conversations create Living Dialogic Spaces.....	55
Figure 7 Creativity as Individual, collaborative and communal as originally represented in Chappell (2006).....	57
Figure 8 the interrelationship of creativity and identity	58
Figure 9 Question-posing and responding and context.....	66
Figure 10 Pedagogy nurturing possibility thinking.....	67
Figure 11 Professional co-enquiry as meddling in the middle	68
Figure 12 Integrated CREAT-IT theories and practices.....	78
Figure 13 Facebook snapshot advertising Science Cafe	107

List of tables

Table 1 Difference between Harlen (2008) and Levy et al (2011)	35
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D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Table 2 The CREAT-IT three key case studies.....	39
Table 3 Pedagogical comparison between Part 2 literature review and survey outcomes	75



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Glossary

C2Learn – (C2L) the C2Learn project introduces new ways to understand creative thinking by fusing technology and digital gaming to foster co-creativity in the learning processes, both within the different contexts of formal and informal educational settings.

Creative Little Scientists – (CLS) aims to bring together creativity, science and mathematics in early years primary school education. CLS have proposed various guidelines, curricula and teaching materials for applicable teacher training in Europe.

Continuing Professional Development – (CPD) refers to the way teachers / educators / professionals keep up to date and maintain their knowledge and skills which relate to their chosen career.

Guide on the Side – refers to when teachers support learners by working and engaging closely alongside them but allowing the student to work independently.

Humanising Creativity – (HC) developed by Chappell (2008) and Chappell, Craft, Rolfe, and Jobbins (2012), humanising creativity emphasises the blend of individual, collaborative and communal engagement in creativity and highlights the importance of communal creativity to the humanising process through its strong focus on shared ownership, group identity and empathy. Humanising creativity is an active process of change guided by compassion and reference to shared values.

Inquiry Based Science Education – (IBSE) a teaching strategy that aims to develop learning by establishing investigations that students participate in to solve a scenario or problem. Thus, resulting in the student identifying questions or solutions to the task.

In service training day – (INSET) typically teachers in the UK have to participate in 5 days' worth of training which will be designed and delivered by the school they work at.

Living Dialogic Spaces – (LDS) developed by Chappell & Craft, 2011; Craft with Chappell, Rolfe and Jobbins, 2012 and alongside their theorising of WHC, LDS refers to research spaces which are characterised by debate and difference, openness to action,



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

working 'bottom up' and different modes of idea exchange.

Little 'c' creativity – part of the creative spectrum as defined by Beghetto and Kaufman 2007, Boden, 2004, Craft, 2000, 2001, mini 'c' refers to intrapersonal meaning making, little 'c' refers to everyday creativity, big 'c' refers to paradigm-shifting creativity.

Meddling in the Middle – a term coined by McWilliam (2008) referring to what is involved when the teacher engages in dynamic learning with learners.

Performativity – Ball (2003: 16) definition of performativity: 'performativity is a technology, a culture and a mode of regulation that employs judgments, comparisons and displays as means of incentive, control, attrition and change based on rewards and sanctions (both material and symbolic)'.

Possibility Thinking – (PT) coined by Craft (eg 2002, 2005, 2013), in its simplest form refers to the posing of 'what if' questions or taking on 'as if' roles, and involves the transformation or transition from what is to what might be.

Quiet Revolutions – builds on the work of alternative education specialists Fielding and Moss (2010), and arts education philosopher Elliot Eisner (2004), suggesting that incremental, cumulative change within the community can have a quietly revolutionary influence

Sage on the Stage – McWilliam (2008) defines this strategy to mean when the expert passes on 'knowledge and expertise in a one-way process from teacher to learner'.

STEM - Science Technology Engineering and Mathematics.

The 4P's – defined by Craft (2011) respectively as 'the plurality of identities (of people, places, activities and literacies), possibility-awareness (of what might be invented, of access options, of learning by doing and of active engagement), playfulness of engagement (the exploratory drive), and participation (all welcome through democratic, dialogic voice)' (Craft, 2011, p33).

Wise Humanising Creativity – (WHC) coined by Chappell and Craft (2011) is described



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

as being central to understanding and navigating the practical, theoretical and policy tensions between creativity and performativity.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Executive Summary

Overall the CREAT-IT project intends to create a workable methodology for designing, communicating and representing creative science education approaches for late primary and early secondary schools in Europe. The foundation for this project is presented within Work Package 2 in the three deliverables D2.1 (Pedagogical Framework), D2.2 (Effective Creative Science Teacher Profile) and D2.3 (CREAT-IT Training Scheme and Implementation Scenarios).

This deliverable, D2.1, Pedagogical Framework, sets out the current theoretical field, current good practice; and discusses what is known about the needs of teachers working in this field. The deliverable then goes on to discuss the University of Exeter team's perspective on creative education, which will drive the pedagogical framework of the study. Examples of existing good practice are integrated with what is gathered from the CREAT-IT Effective Science Teacher Profile documenting further existing practices. This has been compiled from the project survey of all participating partner countries, which is formally reported in deliverable D2.2. Together these generate the pedagogical framework and principles for the project. Which will become the foundation used to develop a series of teacher training workshops, resources, demonstration activities and contribute towards creating an online users' community for teachers.

Part 1 of this present deliverable, then, outlines what is currently happening in research, practice and policy within Europe across the domains of creativity, education and science. To set this in a wider context, this section also draws information on work from beyond Europe. It discusses creative pedagogies currently being used in primary and secondary schools and explores current policy and curriculum constraints in science education in Europe. It also offers examples of good practice and discusses emerging tensions and dilemmas from the literature. Finally it proposes the CREAT-IT definition for creativity in science education.

Part 2 of the deliverable comprises a literature review, and an introduction and discussion of the main creativity theory, which is being drawn on within the CREAT-IT project. In section 2.1 the ideas behind wise humanising creativity (WHC), living dialogic space (LDS), possibility thinking (PT) and the 4Ps are articulated. Section 2.2 introduces and integrates appropriate key information from the survey, full details of which are published in D2.2.

Part 3 draws from both Part 1 and Part 2 to offer a description of the essential features of the CREAT-IT pedagogical framework. Section 3.2 presents an extensive analysis of the



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

three CREAT-IT cases studies represented in the project; Write a Science Opera (WASO), Science and Theatre and Junior Science Café. The case studies have been analysed by engaging with the theory behind the framework to draw out the 12 CREAT-IT principles behind the pedagogical framework. Section 3.3 then analyses the CPD provision in Europe with integration from the CREAT-IT survey presented in D2.2. This section concludes by applying the 12 CREAT-IT principles to present the CREAT-IT team's recommendations for concrete approaches to continuing professional development (CPD) that will be considered when developing its CPD workshops in Work Package 3.

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D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

1. Establishing the field

This section summarizes the current practice in Europe across the domains of creativity, education and science. The nature of creativity is debated within and across different domains; this section can only present a brief summary of the many arguments surrounding creativity and then offers the CREAT-IT Project's definition of creative science education.

1.1. Policy & Curriculum in science education in Europe

European Context

The research and policy literatures bear witness to economic factors driving the focus on developing creativity in science education.

From a research perspective Osborne and Dillon (2008) claim that across Europe there is a significant problem with engaging students in learning science. They suggest that a potential cause of this is the lack of clear vision across Europe for science education and that the content of educational curricula is framed by 'scientists who see school as preparation for entry to university rather than education' (Osborne and Dillon, 2008: 21).

Rocard (2007) has also identified that across Europe insufficient numbers of young people are entering science careers and fully engaging with their potential. Rocard (2007) argues that lack of appropriate teacher skills are a key element in this and highlights the motivational potential in inquiry-based and interdisciplinary work, including that which involve the arts, as a solution to dealing with lack of student engagement.

From a policy perspective the early years of the 21st century have seen a twin pillared approach from the European Commission toward fostering creativity in science education. One pillar emphasises the need for all countries to develop innovative scientists in a global knowledge economy (European Commission, 2006) and therefore the need to teach for creativity in science. The other pillar proposes the need for greater understanding of science in the population as a whole, towards a more scientifically literate population who can use their skills in everyday life. This view proposes scientific literacy as an aspect of democratic citizenship, alongside the need for creative and innovative scientists (European Commission, 2004). As the rising need for creative scientists becomes increasingly recognized, the need to assume a democratic approach to science education in schools is



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

increasingly recognized by policy makers. This is reflected in the European Commission documents (2007a, 2007b) which identify basic competence in science as a part of the spectrum of key attributes contributing to individuals' personal fulfilment and development, active citizenship, social inclusion and employment.

Fostering creativity in science education, whether focused on the need for creative scientists, or on the need to be better-informed citizens who are literate in science, has increasingly attracted attention from policy makers across Europe (and indeed in other parts of the world) in relation to how the arts in particular can articulate with the sciences. For example, the European Ambassadors' Manifesto of the European Year on Innovation and Creativity (held throughout 2009) underlined the need to integrate science education, creativity, culture and the arts. The European Commission recognizes scientific inquiry as an integral part of increasingly complex, globalized life in which the need for innovation and entrepreneurship along with a sense of initiative and a commitment to continued learning is emphasized as being as important as specific knowledge of any particular subject. Schools have a vital role to play in developing creativity in science education (Official Journal of the European Union, issue 13/12/2008).

This recognition has been reinforced in more recent European documentation for example the "Report of Council conclusions on increasing the level of basic skills in the context of European cooperation on schools for the 21st century" (Brussels, 11/2010): which argues that attaining the new, ambitious benchmark set under the "ET2020" strategic framework will require more effective national initiatives. This was emphasised in the European Commission (2011) report stating that, teachers need to be competent not only to teach science with confidence but also in their ability to reflect on their teaching and students' learning.

In 2013 a survey undertaken by Avissati et al, an OECD team (focused on higher education) argued that policies for innovation in science and engineering need a broader disciplinary focus from beyond STEM (Science, Technology, Engineering and Mathematics) and should involve greater integration of specialists (i.e. graduates) from beyond the sciences.

The CREAT-IT team also conducted a survey (see Deliverable 2.2) with the consortium members and teachers from across the partnership and beyond (from now on referred to as the survey participants). Teachers from across Europe were invited to participate in the CREAT-IT survey entitled 'Creative approaches in Science Education', this survey was available online between the 31st of January to the 21st of February 2014. 130 people



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

responded to the survey, the United Kingdom had the greatest number of participants, followed by Italy, Serbia, Greece, Norway and Belgium. 84% of respondents were or have been teachers, other participants defined themselves as scientists, curriculum developers or were general members of the CREAT-IT consortium.

One part of the survey aimed to discover to what extent the participants considered the national level governmental policies promoted creativity in science education in their home countries. Participants from the UK indicated that they believed current policy actually prevents creativity in science education, and that school ethos is the strongest way to promote creativity. All countries suggested that assessment practices had a significant impact on the promotion of creativity, and half of the countries suggested that performance indicators were also a barrier. However, Belgium and Serbia contradicted this result suggesting that performance indicators may actually be a strategy that promotes creativity in science.

The participants were also asked to what extent they thought current national level practical strategies – including those from non-governmental organisations, promote creativity in science education. Overall, the participants from across Europe responded strongly to this question, suggesting that schemes promoting creativity in science education are having little effect.

Policy makers are beginning to recognize the potential role creativity can have in science education, yet the survey results demonstrate that although schemes are available to help promote the cause, teachers and schools are struggling to either engage with the work or need support to access the good practice that is available to them. The research call for Horizon 2020, which seeks to build a competitive and strong Europe with particular reference to the sciences, technology and innovation, explicitly acknowledges the potential for the arts and humanities to help foster the development of creativity integrated with the development of products and services built on scientific knowledge (Horizon 2020, 2014). Here there is the potential to help rectify the situation identified in the survey, yet the results suggest that further work is needed to understand why schemes that promote creativity in science education are having little to no effect on the ground.

Policy makers are acknowledging that there is a potential to use the arts as a way to foster scientific creativity, however across the literature there was no recognized or agreed definition of what creative science education means. As part of this literature review CREAT-IT wish to propose a definition for the meaning of creativity in science education.

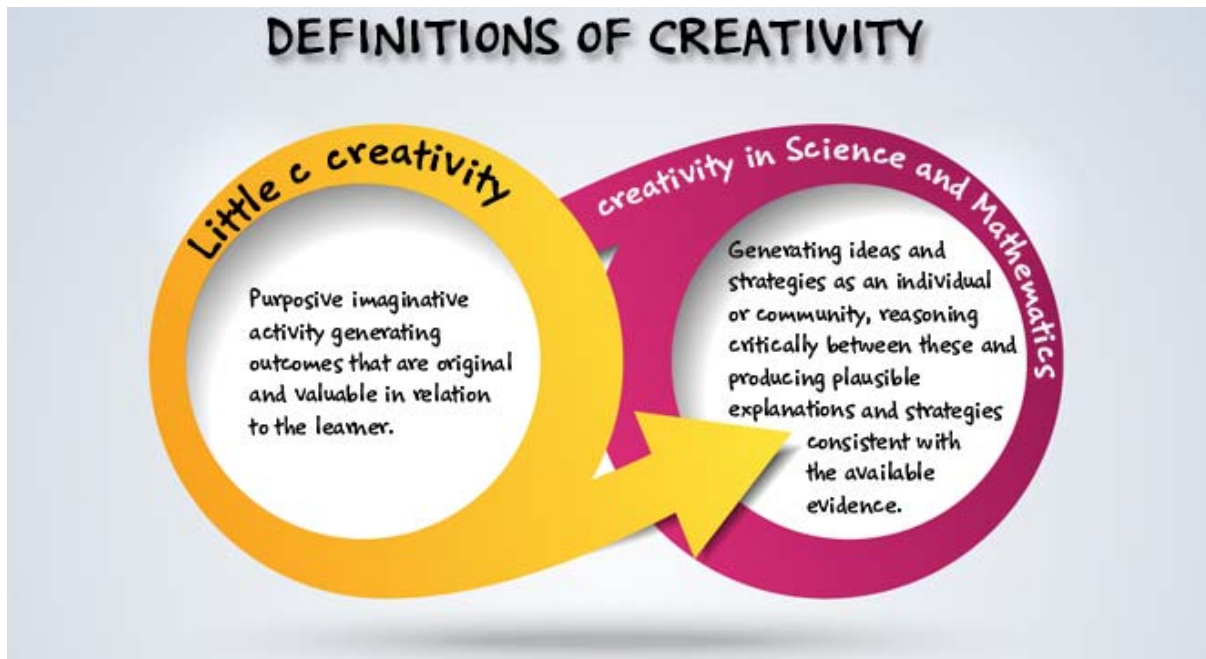


D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Our proposed CREAT-IT definition for creativity in science education:

A recently completed European project, *Creative Little Scientists*¹, which focused on creativity in science and mathematics education in early years education, offers a useful working definition for creative science, based on its own literature review, and is adopted as the starting point for the CREAT-IT project: “Generating **ideas and strategies** as an individual or community, **reasoning critically between these** and **producing plausible explanations and strategies consistent with the available evidence.**” Such scientific creativity is seen as fuelled by ‘little c’ creativity, i.e. **purposive and imaginative activity generating outcomes that are original and valuable in relation to the learner.**

These definitions are represented in the diagram below.



(Figure 1) Definitions of Creativity From <http://www.creative-little-scientists.eu/node/57> (9th May 2014)

¹ The project CREATIVE LITTLE SCIENTISTS received funding from the European Union Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no. 289081. Website: <http://www.creative-little-scientists.eu/>

The definition for creative science education adopted by CREAT-IT was developed by the FP7 *Creative Little Scientists* project. After the CREAT-IT survey was administered, the *Creative Little Scientists* group adjusted this definition, following robust debate at the project’s final event held in March 2014 in Greece. The new definition, which CREAT-IT has now adopted, foregrounds the evaluation of evidence: “Generating **ideas and strategies** as an individual or community, **reasoning critically between these** and **producing plausible explanations and strategies consistent with the available evidence.**” As before this definition of scientific creativity is seen as fuelled by ‘little c’ creativity, i.e. **purposive and imaginative activity generating outcomes that are original and valuable in relation to the learner.**



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Building on this definition, the CREAT-IT project consortium proposes to define creativity in science education, provisionally, as this final definition from Creative Little Scientists, i.e. “Generating **ideas and strategies** as an individual or community, **reasoning critically between these** and **producing plausible explanations and strategies consistent with the available evidence.**” This is driven by a commitment to fostering everyday creativity in learners, such that they engage in **purposive, imaginative activity generating outcomes that are original and valuable in relation to themselves.**

At the time of undertaking the CREAT-IT survey (February 2014), however, the definition used by Creative Little Scientists was slightly different: **generating alternative ideas and strategies within scientific enquiry as an individual or community, and reasoning critically between these.** Although it too was driven by everyday creativity, the original definition placed less emphasis on use of evidence. At that point, the CREAT-IT survey participants were asked if they agreed with the (earlier) proposed definition of creative science teaching. 86% agreed with the proposed CREAT-IT definition of creative science teaching, 7% did not. However, of the 130 participants in the survey the overwhelming majority agreed with the statement.

Some reasons given for why the participants agreed with the definition were that the statement acknowledged “**divergence and convergence, openness and criticality within the domain of science**” (consortium member, UK) and that it reflected how science can “engage children in possibilities whilst broadening their experience and understanding of scientific concepts through **collaborative exploration**” (consortium member, UK). Given that the new definition of scientific creativity in education emerged later from Creative Little Scientists, and subsequently replaced the original definition within CREAT-IT, it will be important during the CREAT-IT project, for educators to engage critically with the newer, more evidence-oriented, definition and to consider what resonances it offers in relation to their practice.

The CREAT-IT definition is fuelled by ‘little c’ creativity (this does not alter from the older to the most recent definition of scientific creativity). The survey asked the participants if they agreed with this definition of everyday ‘little c’ creativity. Once again an overwhelming response from those participants surveyed (87%) agreed with this statement. The majority of reasons given by participants as to why they agreed with this statement reflect the current trends in science curricula. Governments and schools recommend that teaching in science be connected to the everyday world around students who are learning about the topic. This was reinforced in the comments from the participants, that ‘little c’ creativity “acknowledges that creativity in everyday classroom science involves **curiosity**, and the



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

generating of original outcomes in relation to learners". A participant from Serbia went further to discuss how through the "various explorations that are connected with **everyday phenomena and processes**, children can grasp and understand the things that surround them with ease". Although one teacher from the UK, commented on how teachers need to be clear that there is an important distinction to be made regarding something that is "**original to the child** and something **original to science**".

1.1.2 The evolving nature of scientists and the future of science education

A longitudinal study by Archer et al (2013a) of 9000 English upper primary and lower secondary children found that 70% of students questioned enjoyed science but only 17% would consider science as a career option. The strongest reasons given by children for not wanting to be a scientist was the stereotypical image they held of scientists. The children were influenced by media especially TV, cartoons and books where scientists were portrayed in a stereotypical way. The children thought that to be a scientist would mean you would need to be "clever", "brainy" and "geeky". This gave them the impression that science as a subject was "hard" and they considered themselves not clever enough to study it, therefore they were unlikely to pursue a career or further study in the sciences.

Archer et al (2013a) are not the first to suggest the need to readdress the image and perception of science, indeed work has been on-going in this field for over thirty years - however there are two clear and current lines of argument within the literature for why we need to readdress this stereotypical image: the economic imperative argument and the notion of science for all.

Economic Imperative: A number of reports (in Europe: Harlen et al, 2010, Gago, 2004, Millar, 2011, Roberts, 2002, Lord Sainsbury of Turville, 2007, in America: Donovan et al, 2014, Barrow, 2010, in Australia: Tytler, R. 2007, Schmidt 2011, 2010) stress the importance of maintaining and developing the scientific infrastructure, as this will 'ensure national security and economic prosperity in the future' (Millar, 2011: 174). One of the shared arguments across the various reports is that the education system needs to provide a flow of students with advanced scientific knowledge and expertise to ensure the growth of nations and economies. However, Gago (2004) recommends that to achieve this there needs to be an 'international discussion about fostering aspects of scientific literacy in all students – as an addition rather than a replacement for preparation for future careers' (Gago, 2004: 112). An in-depth report by Harlen et al. (2010) into science, technology, engineering and mathematics (STEM) subjects and 5 – 14 year olds,



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

claims that children's future enjoyment and interest in science is 'strongly influenced by their primary school experiences' (Harlen et al, 2010: 30). It recommends that investment needs to be made and sustained for science in primary schools as specialists are underrepresented in the workforce. The report argued that an increase in funding for science in primary schools will 'reap dividends in terms of producing the scientists, engineers and mathematicians needed to help secure our future prosperity in the new scientific century' (Harlen et al, 2010: 85).

Science for all: However, Archer et al (2013a) argue that education needs to broaden and diversify the perpetuating view that to study science means, necessarily, becoming a scientist. They want to promote the message that science 'keeps your options open and is useful for a wide range of careers, at both graduate and technical levels, both in and beyond science' (Archer et al, 2013a: 4). This emphasis on the value of science in everyday life is reflected in national curricula and other policy documents across the EU, (for example in Wales, Northern Ireland the science curriculum is entitled 'The World Around Us', in Italy science is referred to under the heading 'Knowledge of the World' and in Belgium science is again referred to under the heading 'World Orientation', these countries do not refer to Science as a stand alone subject rather as part of a bigger picture), and there is a strong argument made across the literature, that science is for all (see Gago, 2004, Murphy et al, 2006, Harlen et al, 2010, Hofkins & Northen, 2009, Orion, 2007, Kolstø, 2008, Jorde and Bungun, 2003). Harlen et al (2010) who makes both the economic and the "science for all" argument, summarises that the main 'purpose of science education should be to enable every individual to take an informed part in decisions, and to take appropriate actions, that affect their own wellbeing and the wellbeing of society and the environment' (Harlen et al, 2010: 5). This proposal is echoed by Millar (2011) who recommends that the purpose of the school science curriculum should be 'scientific literacy for all' rather than as a 'foundation for more advanced study by the minority' (Millar, 2011: 177). Both comments indicate the argument that science should be for all and reflect the aims and expectations of policies in the UK; that schools need to develop informed citizens of the world around them; and that science needs to be relatable to them and their everyday life.

Educational research also suggests that gender is a significant factor in how students respond to the teaching of science teaching (see, Archer, 2013a, 2013b, Graf, 2013, Watermeyer, 2012).



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

What are the concerns about gender differences?

It is well established within the literature that gender affects engagement with the science subjects and as children grow older their interests in the sciences change, (see: Archer 2013a, Archer 2013b, Rocard et al, 2007, Harlen et al, 2010, Osbourne and Dillon, 2008, Reid and Skryabina, 2002, Murphy, 1991, Green 1997). Murphy (1991) suggests the reasons for this result is that culturally 'girls are not encouraged or expected to achieve as well as boys in science' (Murphy, 1991: 206) and can become disengaged with science education from a young age.

Rocard et al (2007) led a European Commission study examining a cross section of on-going European initiatives of good practice in science teaching and discovered that in general girls are less interested in science education than boys. This is reflected in the Trends in International Mathematics and Science Study (2011) that reports a strong gendered pattern across most countries.

If gender is affecting a student's ability to engage with science education can teaching science creatively readdress this problem and possibly offer a solution to teachers? There seems to be some evidence that this may be the case.

The subjects of Ayverdi et al (2012) study participated in a series of tests including a Divergent Thinking Exercise and a Scientific Creativity Test, with the aim to determine if there was a relationship between gender and scientific creativity. The data was then analysed using ANOVA and X2 statistical techniques. They discovered that the mean score for general creativity was significantly higher for girls when compared to boys, yet in contrast there was no significant difference between the genders when the scores for scientific creativity was compared. Baram-Tsabari and Peleg's (2011) creative and theatrical approach to teaching the topic of Matter contradicts Ayverdi et al (2012) study and found that female students showed greater gains in conceptual knowledge than boys.

This fact is something that the CREAT-IT team must consider but is beyond the scope of this research project. It may be, then, that with a sensitive approach to teaching for creativity in the science classroom, the gap between girls' and boys' achievement in terms of creative science could be reduced or closed but we must also recognise that this teaching approach might not be an advantage for boys when working in the creative science classroom.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Creativity in education is often invoked without clarity about what is meant by this. The next section addresses the nature of creativity as a foundation to discussing creativity in education more widely - and then in science education.

1.1.3 Nature of creativity

There is a great deal of work on the nature of creativity, which spans many centuries and multiple disciplinary perspectives (Craft, 2001). This review is informed by research in the social sciences, arts, and science. Whilst there are, and have been over the ages, many approaches to the nature of creativity there is also broad agreement across disciplines that at its most fundamental, inherent to creativity is generating new approaches or questions that facilitate transition from what is known ('what is) to what is new ('what might be). Manifestations of creativity are outcomes (which may be products but equally may be ideas) that are considered both original and novel and also valuable (or useful) (see for example Boden, 2004; Craft, 2005; Csikszentmihalyi, 1996; Mumford, 2003; and Sternberg & Lubart, 1999). Creativity may also be encompassed in the very framing of new questions, in the making of new ideas, and in reflecting on these.

Creativity is widely recognized as occurring along a continuum, at one end of which is what might be called everyday, or 'little c' creativity, which may be defined as inherently low in originality and low in wider impact. 'Little c' creativity involves having an idea which is novel to the person who has generated it or the small group surrounding them – but which may not be novel more widely. Examples might be: working out a new or alternative way to travel from A to B, planning a novel menu with unusual ingredients, proposing a change intended to improve a school community, or generating a group question for investigation in a science lesson. There are various ways in the literature of referring to such everyday creativity. In the United Kingdom, the personal-level novelty is referred to by psychologist Boden (2004) as 'psychological' creativity, and thus for Boden the idea is 'P-creative'. For social scientist and educator Craft (2001) the term is 'little c' which she relates to life-wide resourcefulness and personal effectiveness. In the United States, meanwhile, psychologists Kaufman and Beghetto (2009) separate what they call 'mini-c' creativity (for them meaning personal meaning-making) from 'little c' or everyday creativity (for them meaning creativity shared with others). Kaufman and Beghetto also introduce the interesting concept of 'pro-c' or professional creativity.

At the other end of the creativity continuum, reflecting high originality and high impact, is 'big c' creativity (such as that possessed by physicist Albert Einstein, or dancer Martha Graham). For Boden this is 'H' creativity in other words historical creativity, which actually generates such novel ideas that a paradigm shift occurs or the world is changed.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

This present-day continuum of creativity reflects the perspective that human beings are highly creative and that creativity is generated by them working individually and together. But this perspective was not always the dominant one; in pre-modern perspectives, the source of creativity was seen as what Sawyer (2006: 12) calls a 'superhuman force'. Sternberg (1999) discusses how Plato, for example, from his classical perspective, saw the creator as 'receiving' divine inspiration passively. According to Sternberg, Plato referred to the creator whether artist, scientist, musician, poet, sculptor etc., being 'an empty vessel that a divine being filled with inspiration' (Sternberg, 1999:90). This mystical perspective was, Sternberg points out, a barrier to the exploration of creativity since it was seen as mysteriously 'emerging' from a divine place and being impervious to explanation.

In stark contrast, since the Renaissance this perspective has been turned upside down, as Sawyer discusses (2006): human beings being recognized since this time as highly creative in and of themselves, and as a consequence, the study of creativity grew from this historical point. Psychology is perhaps the most developed field of the study of creativity and the next part of this review considers three particularly influential traditions of psychological enquiry into the nature of creativity, that have developed during the 20th century: cognitive, psychometric and humanistic.

The cognitive approach: Wallas (1926) undertook some of the earliest cognitive psychology work with a focus on modelling. He highlighted four vital parts to the creative process, which he named as preparation, incubation, illumination and verification. Since Wallas's work this creative process has been added to by other researchers who, following Rhodes' (1961) seminal work have identified four dimensions: creative outcomes (or **product**), characteristics of creative individuals (or **person**), habits or patterns involved in being creative (**process**) and finally convincing others that something is creative (**persuasion**, also sometimes referred to as 'press'). In 2007, Watson added the role of culture and environment (**place**) and more recently Kozbelt, Beghetto and Runco (2010) recognized that creative ideas are sometimes unexpected and may be dismissed, especially in a classroom – yet may signify **potential**. Some cognitive studies of creativity drawing on psychology as applied to other related disciplines, explore how creative habits arise, and tensions between automatic reflex behaviour and habitual creativity.

The psychometric approach: Guilford was the first researcher, in the 1950s, to apply measurement, using psychometric tests, to creativity. He was interested in everyday creativity and how individual differences could be measured. As Sawyer (2006) reports, such tests were and have been over many years very popular, as they are easy to administer and score, and offer the opportunity to work with large populations. Some of



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

the most widely used tests are the Torrance Tests of Creative thinking (TTCT) (1974). Translated into many languages (Baer and Kaufman, 2006) these tests are for use with adults and children and involve verbal and figural components. Responses to the tests, which essentially foster divergent, thinking using uncontextualized test papers (like all psychometric tests), are scored for originality, flexibility, fluency, elaboration, abstractness of titles, and resistance to premature closure. Other tests have been developed more recently by Lubart, Besancon and Barbot (2011), which go beyond the initial focus on divergent thinking in the Torrance Tests. These new tests encompass convergent (or integrative) thinking as well as divergent (or exploratory) thinking and are designed for use with children between the ages of 6 and 14. Scored by trained judges through an online system, a creativity profile is generated for each participant.

Proponents of the psychometric approach argue that such tests can, by measuring creativity, also provide a starting point for enhancing it. On the other hand critics challenge the fact that context is not recognized, and that they adopt a far too narrow definition of creativity which correlates weakly with other creative behaviour indicators. Yet, because of their ease of administration the tests remain popular and, with its promise of 'test outcomes', the psychometric stance is one that retains influence.

Humanistic approaches: Initiated by Maslow (1943) and Rogers (1954), this line of enquiry into creativity foregrounds personal perspectives and is concerned with motivation. In his 'hierarchy of needs', Maslow modelled how creativity can only be enacted once all basic needs are satisfied. Rogers (1954) meanwhile foregrounded the role of unconditional and positive regard in the development of psychological safety for creative behaviour.

Current directions in creativity research

Early twenty-first century research is strongly influenced by these three traditions; the cognitive, the psychometric and the humanistic. But increasingly the emphasis is turning to many disciplines, as Caselli (2009) argues (drawing from literature from psychology, but also neurobiology, cognitive science and neuroeconomics), to the social dimension of bridging the gap between what already exists (i.e. 'what is') to the enactment of imagination (i.e. 'what might be'). This reflects Craft's and others' work on Possibility Thinking through 'what if?' questions and 'as if' behaviours. Possibility Thinking is discussed further in Part 2.

Creativity in the 21st century is increasingly recognized by creativity scholars as a social phenomenon with emotional, or perhaps conative dimensions. Key elements are recognized as being motivation, interaction and mood. Some (for example, Craft, Gardner and Claxton, 2008 and Chappell and Craft, 2011) argue that the 21st century badly needs



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

creativity that attends to its potential impact and indeed that sustaining futures require wise, humanising creativity (Chappell and Craft 2011, Chappell, Craft, Rolfe and Jobbins (2012), Craft, 2013) discussed in Part 2.

1.1.4 Creativity in education

Approaches to creativity in education

As indicated above, creativity is a multi-faceted, complex entity debated across multiple fields. As discussed, approaches to creativity in education emerging from European research and practice and the United States, foreground a belief in the capacity of all children to be creative at an everyday level. Such approaches recognize that novelty may be applicable only to the creator/s (Boden, 2004, Craft, 2000, 2001, 2002, 2005, Kaufman and Beghetto, 2009). It could be argued that the long line of the progressive education movement stretching back to philosophers such as Dewey, but also Pestalozzi (1821, 1898), Rousseau (1899, 1920), Froebel (Bruce et al, 1995; Froebel, 1826, 2001a, b, c, d; Lilley, 1967), Isaacs (1930, 1945) and others being child- or learner-centred, foregrounds this belief in children's creative capacities in meaning-making and generativity. Within the arts, Eliot Eisner (2004) has developed a powerful perspective on children as creative meaning-makers particularly in and through the arts.

This encompassing view of children's creativity prevalent in educational literature is recognized by Banaji et al (2010a) as a 'democratic' approach, a term used earlier by others including, in England, the influential National Advisory Committee on Creative and Cultural Education (NACCCE, 1999). Banaji et al (ibid), analysing how creativity in education has been applied in practice, identify nine different discourses of creativity in education, which aside from the first, which focuses on extraordinary creativity, foreground capability in all children. The discourses they name as Creative Genius, Democratic and Political Creativity, Ubiquitous Creativity, Creativity as a Social Good, Creativity as Economic Imperative, Play and Creativity, Creativity and Cognition, the Creative Affordances of Technology and The Creative Classroom.

Creative pedagogies in upper primary and early secondary teaching

A key distinction made in creative teaching is that between a focus on the pedagogy ('creative teaching') and a focus on the learning ('teaching for creativity'). This is explored in the section below.

There has been a great deal of research into creative pedagogies in upper primary and early secondary teaching. These are briefly explored in this section in relation to standard



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

classroom practice, which may involve some partnership with colleagues from beyond school but is mainly facilitated by teachers; the next section explores specific creative pedagogies seen in classrooms where teachers and artists collaborate in an arts partnership.

Key elements in creative pedagogy were highlighted by Woods (1996, 2002) drawing on his ethnographic work in primary schools in England. Where teachers taught in a creative way, they engaged children in learning that they felt was relevant to them, over which they had some ownership and control and through which they could be innovative. As shown in a later study by Craft (1998) including secondary teachers as well as those in primary schools, very similar elements were present in their experience of creative teaching, including:

- A commitment to engaging in relationship with their pupils, others with whom they work in nurturing pupils, and nourishing their own emotional, intellectual and spiritual identity as teachers (reflects Woods' *relevance* for pupils)
- Importance of professional judgment (reflect Woods' *ownership* for pupils)
- Critical reflection on their teaching and adaptability of practice as appropriate (reflects Woods' *control* for pupils)
- Willingness to take risks to generate something novel (reflects Woods' *innovation* for pupils)

Creative teaching and teaching for creativity

The distinction between teaching in a creative way (creative teaching) and teaching for creativity (fostering creativity in students within particular disciplinary areas) was made by Jeffrey and Craft in 2004. This important distinction will frame the CREAT-IT project, which seeks both to foster creativity in science and also to foster this in a creative way. A discussion of the distinction between creative teaching and teaching for creativity was made in a landmark national policy report on creativity in 1999 (NACCCE, 1999), but Jeffrey and Craft warn against the dangers of simplistic polarization recognizing that, as the NACCCE Report (ibid) acknowledged, 'young people's creative abilities are most likely to be developed in an atmosphere where the teacher's creativity abilities are properly engaged' (ibid, p90). Indeed the NACCCE Report states the view that 'teaching for creativity involves teaching creatively' (ibid p90). In their article, Jeffrey and Craft highlight that creative teaching involves making the curriculum relevant, offering children control and ownership and ensuring they can innovate, and that at the heart of this is 'passing back control to the learner' (Jeffrey and Craft, 2004: 81). They recognize that this involves possibility thinking (Craft, 2002 and discussed in Part 2 of this review) at the heart of which is listening to children's questions, encouraging them to investigate and to identify problems to solve. They also recognize the role of co-participative approaches in which teachers and learners are engaged dynamically and collaboratively, and where children's



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

perspectives help to guide the learning – what Jeffrey and Craft call a learner inclusive stance (2004).

Lin (2011) working in Taiwan with older primary pupils through drama, uses the term 'creative pedagogy' to encompass both creative teaching and teaching for creativity. Whilst the distinction between creative teaching (teaching in an imaginative way) and teaching for creativity (fostering children's creativity in particular ways) is a very important one for CREAT-IT, perhaps even more important is how they come together dynamically in a learner inclusive perspective blending the learner's voice with disciplinary understanding relevant to the context.

A recent study in primary level performing arts (Chappell, 2007) considered creative pedagogies as a balancing act working towards blending children's own voice and their disciplinary knowledge and understanding (in this study in the form of arts-based compositional knowledge). The findings showed that creative pedagogies involved using tasks and strategies from three core pedagogical spectra. The three dimensions were intricately intertwined within the teachers' practice and were:

1. Prioritisation of ***creative source—'inside out' or 'outside in'*** (whether the task source was prioritised in the children's ideas or the teachers' ideas/dance knowledge). This meant responsive shifting between inside or outside as sources of theme, movement and opinion, and, in so doing, at least to some extent, ensuring that the children experienced the creative impulse as their own in order that they authentically gave voice to ideas which were meaningful to them in dance
2. Degrees of ***proximity and intervention*** (supporting and challenging creative ideas using *distanced reactivity* or *close-up proactivity*). Proximity was indicative of the amount of freedom the teachers allowed the children per se for creativity
3. ***Spectrum of task structures—purposeful play to tight apprenticeship*** (shifting between employing play-based task structures characterised by '*risk-taking*', '*acceptance of failure*', '*fun, silliness and mess*' and apprenticeship structures characterised by *tight parameters*, '*safety*' and '*structured stages*', *progression contingent on 'step-by-step success'* and '*hard work*'). Appropriate to the situation, this meant:
 - Sharing responsibility for the creative idea gradually, immediately or passing it backwards and forwards to varying degrees
 - Allowing differing amounts of keeping control and freedom from having control, which allowed for
 - Providing differing amounts of space within tasks for 'bursts of creativity' or more sustained creative explorations



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

The study's articulation of this complexity suggests both that it cannot be assumed that creativity automatically occurs when teaching the performing arts, and that there is a subtlety, and wisdom of experience within teachers which contributes to teaching for creativity of which is vitally important to remain aware.

A further recent ethnographic study by Craft et al (2013) at two primary schools in England discovered that there were three key characteristic features of creative pedagogies shared across the schools.

1. Co- construction. In each of the two schools, shared reflections were valued and inclusive teaching approaches that involved the pupil and teacher were actively embraced. Rojas-Drummond et al (2006) characterise co-construction as the 'joint efforts of coordination, negotiation and collaboration in various group work activities' (92). The researchers noted that the 'important feature of co-construction in each school was emphasis on real life contexts and relevance' (Craft et al, 2013: 11). The study reports how researchers recorded teachers co-constructing the curriculum, while at one school the children had been designing their own pathways for many years.

2. Children's control / agency / ownership. Each school provided 'a trusting, agentive environment' that encouraged 'children's decision making, offering them ownership and control over their learning' (Craft et al, 2013: 12). At one school the study reports how the children's **control, agency and ownership were fostered through creative and reflective practice that supported and enabled their ideas.** The teachers felt empowered as they had the freedom to plan what the children were interested in and the children became more engaged as they had agency over the curriculum. The **children were also involved in developing spaces that documented their work, thus they were motivated, and more confident as their self-expression was allowed.**

3. High expectations in skills of creative engagement. The final characteristic of the creative pedagogies identified by Craft et al (2013) was that teachers in each school set 'high expectations in skills of creative engagement'. The teachers observed during the ethnographic study held 'high expectations in relation to the development of children's skills in learning' (Craft et al, 2013: 14). Staff were encouraged to have high expectations as they were supported through professional development opportunities and on going shared reflection and learning.

Of relevance to CREAT-IT, is that in both schools, pedagogy for everyday creativity was integrated with the arts and that the value of the arts was harnessed as 'inherently



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

motivational' (Craft et al, 2013: 16).

As part of the CREAT-IT survey the participants were asked to rank a series of statements in the order of most to least important of the following initiatives for fostering creativity in science through education, they were:

- To enrich the understanding and interaction with phenomena in nature and technology
- To develop more innovative thinkers
- To develop positive attitudes to science
- To develop socially and environmentally aware and responsible citizens
- To provide a foundational education for future scientists and engineers
- To develop important attitudes and dispositions as a foundation for future learning

The most important initiatives to foster creativity in science education as ranked by 130 participants of the CREAT-IT survey are:

- To enrich the understanding and interaction with phenomena in nature and technology
- To develop more innovative thinkers
- To develop positive attitudes to science.

This question was asked as a way to find out what the participants thought of as the *most likely* to contribute to the development of children's creativity in science. **Encouraging children to try out their own ideas in investigations** was selected by more than half of the respondents to the survey. Teaching approaches that related **science to everyday life** was selected by just under half of participants. Here there is a further connection to the CREAT-IT definition of creativity in science education, in that teachers responding to the survey see relating science to everyday life as a positive way to foster creativity in the science classroom. Intriguingly however, fostering and encouraging student agency was ranked as the least important strategy to foster creativity. The CREAT-IT team therefore must consider if teachers understand the meaning and benefits of children's agency in their classrooms, or if it is consistently ranked low in the survey because teachers do not see it as a means to foster creativity, or because they do not understand the terminology.

The members of the CREAT-IT Partnership consortium believe that the arts can offer a special space for fostering creativity in partnership between teachers and practitioners from beyond the classroom. In the next section we consider pedagogies that can be opened up through such collaboration.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Partnership and Arts Creativity

From the turn of the 21st century, following the NACCCE Report (1999) in the UK there was an increased emphasis in English education on creative partnership as a means to encourage creativity and creative learning.

Creative Partnerships is a programme that ran from 2002 to 2011 in the UK, for schools and young people, managed by the Arts Council England and funded by the Department for Culture, Media and Sport. The aim of the programme was to nurture the creativity of young people alongside developing the skills of the teachers by working with creative practitioners.

As part of this wave of activity, although creative partnership principally manifested itself as a partnership between the school, the teacher and an external artist, it also, occasionally, involved non-arts partners like scientists. Various models of practice were developed as framing devices for theorising and practicing creative partnership and the intended ensuing creative outcomes. These models include that proposed by Griffiths and Woolf (2004) who situated partnership engagement as a version of 'apprenticeship learning'.

Many studies have looked at the role of the artist in partnership with the classroom teacher (see; Jeffery, 2005, Jeffery and Ledgard, 2009, Rolfe, 2011). Thomson, Hall, Jones, & Sefton-Green (2012), recent study investigated the dynamics of the pedagogies within creative partnerships and how they nurture creativity. They frame their Creative Signature Pedagogies (CSP) by adopting the UNESCO framework referred to as the 'four pillars of learning for the 21st Century: learning to know, learning to do, learning to be, learning to live together' (UNESCO, 2008: 8) They challenged the English default pedagogy of lesson structure, based on outcomes and assessment objectives, by suggesting their own pedagogic platform that 'creative signature pedagogies challenge school as a non-place by building sociality and the capacities of young people to become somebody' (Thomson, Hall, Jones, & Sefton-Green, 2012: 16).

Chappell (2008) also offers detail of more interdisciplinary, three-way creative partnerships between artists, scientists and educationalists. She emphasizes that in these circumstances the arts bring the capacity to create 'embodied narratives' within and around scientific knowledge which help to foster creativity in both disciplines. Based on a small study of a number of Wellcome Trust funded science/arts/education initiatives, Chappell (2008)



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

argues that some of the most innovative practices involve science and art collaborations structured in mutually influential relationships, and favour strong discipline knowledge and experience within experts from each discipline. These science-art-learning interactions are characterised by learning gains for parties within different disciplines, which result from the symbiosis between the science and art disciplines. Chappell (2008) emphasizes that at the heart of these kinds of partnerships, creativity within disciplines is different because of different fundamental epistemologies, but the processes at play feature many similarities even if they are structured in different ways.

The way in which the arts has contributed to creativity in education per se has been written about at length by eminent arts education philosophers such as Abbs (1996, 2003) and Eisner (e.g. 2004). In 1996 Abbs, based in England, wrote about the shifting paradigms in education and identified a new paradigm in British arts education. He suggested that, from the early 19th century until the 1980s, the arts were taught under the titles of Progressivism and Modernism, but this shifted in the 1980's to a new emerging paradigm 'based on a different set of premises, practices, and expectations' (Abbs, 1996: 63). The old paradigm considered the teacher in the role that releases the child's 'innate creativity through acts of self expressions and self discovery' (Abbs, 1996: 66).

However, Abbs argued that the contemporary education of that time, ignored aesthetic education in response to the growing economic imperative focus of the education system i.e. creativity was being ignored as education focused on the quantitative measuring of results (see: Ball, 2000, 2003, Sternberg, 2003, Maisuria, 2005, Beghetto, 2006). He outlined the paradigm shift by identifying the following three elements:

- The intrinsic value of art
- The place of tradition reconceived as the aesthetic field
- The idea of the arts as a generic community

Abbs (1996) suggested that in this new paradigm the arts were not seen predominantly as an act of self-expression. The new paradigm considered the arts to be a 'vehicle of human understanding' (Abbs, 1996: 70). If the child's ability to be aesthetic is considered innate then Abbs (1996) concluded that we could develop this by introducing the child 'into the living tradition of the art form' (Abbs, 1996: 70). He wanted teachers to not just instruct students about Dickens, Shakespeare and Beethoven but introduce them and educate them within the aesthetic field as a whole, rather than the separate fields of Art, Music, Dance and Drama as was prescribed by the current British education system at that time. This divide in the aesthetic subjects remains in the UK, and can be seen across the European curriculum documents. What effect would a more holistic approach have?

Craft et al (2011) argue that children will only be able to develop their creative capacity



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

through a 'rounded curriculum, which encompasses both the arts and a specific commitment to creative teaching and learning.' (Craft et al, 2011: 1). They highlight evidence from Scripp et al (2007) that when students participate in multiple arts education events they will also experience 'increased achievement motivation and engagement, creativity, enhanced school climate and community engagement' (Craft et al, 2011: 3). Drawing on data from the USA, De Moss and Morris (2008) are cited as identifying three characteristics of an arts integrated classroom, which would go some way to achieving a more holistic aesthetic vision.

They recommend that schools need to improve their **learning environment** so that children can nurture and develop a deeper understanding of education in contrasts to their perception that children are being taught by rote. The content of the curriculum needs to be **engaging** so that students are challenged to achieve academic excellence, and finally that the **community of learning needs to be broadened** so that the boundaries of learning are extended beyond what is considered the traditional classroom.

Similar to De Moss and Morros, Eisner (2004) also argues for a strong shift in the US education system. He describes six artistically founded qualitative forms of thinking.

- The ability to compose purposeful qualitative relationships
- The formulation of aims
- That form and content are inextricable
- That not everything knowable can be articulated in propositional form
- There is a relationship between thinking and the material
- Motives for engagement

By proposing the question what minds we want our children to have, Eisner considers that a child is not born with his or her mind that it is shaped by experience and culture. He cites that the arts promote a different kind of thinking and that education can learn from this, but to achieve this would require schools, staff and students to change their perception of learning. Eisner suggests that the arts play a motivational role and can encourage students and teachers to be 'flexibly purposive' to encourage children to learn via their curiosity and to prepare teachers to allow for the unexpected.

How can we begin to make this vision a reality?

Craft et al (2011) cite the Arts Education initiative that has been running in England from 2002 until 2011, as a potential answer to achieving this integrated artistic and aesthetic education. The Creative Partnerships initiative was the New Labour Governments flagship programme that promoted creative learning and aimed to develop the skills of young people across England by raising their aspirations and achievements potentially resulting in



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

more opportunities for young people in the workplace and wider society. Schools commented that Creative Partnerships also provided an opportunity for students to solve problems and that they saw an improvement in pupil behaviour and school performance (see Fleming, 2008, Kendall et al 2008)

Part way through the period of delivery the British Market Research Bureau assessed the programme and the wider impact it had upon the schools, teachers and students (2006). They found that 70% of head teachers reported that there was an improvement in pupil behaviour.

The evidence indicated that by working in partnership with arts organisations, creative professionals and artists across all phases of education schools began to see an improvement in their students' attitudes and abilities. The National Foundation for Education Research (NFER, 2008) tracked 13,000 students across the period of delivery and noticed that children who attended a Creative Partnership activity out-performed their classmates, who did not attend, in English, Mathematics and science. Their 2008 report concluded that the same students' improvements in academic attainment were being maintained and on average were scoring 2.5 grades higher than students who did not engage with the Creative Partnerships.

One way of understanding how learners and adults connect creatively is to consider this through McWilliam's improvisational concept (2008) of the teacher as 'meddler in the middle'.

Meddling in the middle: Teaching creatively and teaching for creativity

In teaching creatively and teaching for creativity (particularly the latter) there are assumptions about the active involvement of learners and their own meaning-making, which drive pedagogy and shift the relationship between learner and teacher into a particular kind of dynamic.

McWilliam (2008) describes a transition over the last two decades of education in many parts of the world from teachers behaving as 'sage on the stage' (expert, passing on knowledge and expertise in a one-way process from teacher to learner), to 'guide on the side' (supporting learners by close engagement alongside them) to 'meddler in the middle' (engaging in the dynamic of learning with learners); more of an improvisational approach (such as that documented by Sawyer, 2007, 2011, 2012)



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

The role of guide has been particularly prevalent since the 1980s, in which teachers attend closely to learners and seek to value their creative potential by close observation of their engagement in activities, stepping forward to support them as appropriate. From their qualitative work in English primary schools, Cremin et al (2006) describe pedagogical strategies of teachers who guide children engaged in creative endeavours as:

- Actively standing back
- Offering time and space
- Valuing pupil agency

As indicated earlier, additional pedagogical features of teachers who guide are described by Woods (1995, 2002) who, drawing on his ethnographic work in primary schools in England, emphasised the role taken by fostering

- **Relevance** (i.e. learning being meaningful to children's interests and needs)
- **Ownership** (i.e. children learning for themselves and not because teachers or others say so)
- **Control** (i.e. children being self-motivated, with extrinsic motivation playing little part)
- **Innovation** (i.e. encouraging the creation of something new; this might include an insight, a new skill, a new understanding – and is often a radical shift, not a cumulative change)

Building on Woods' work, Jeffrey's (2006) Creative Learning and Student Perspectives (CLASP) project, was a two-year European Commission funded report that involved nine countries including: Austria, Denmark, England, Ireland, Poland, Portugal, Scotland, Spain and Sweden over 22 months (2003-2005). The report explored creative teaching and learning in primary and secondary contexts across Europe and identified the following pedagogical strategies as vital to what might be understood as 'guide on the side' approaches to fostering creativity in children's learning in a range of domains of knowledge:

- **The establishment of real and critical events and strategic external co-operations.** Such critical events frequently developed over time and revealed all four of Woods' process of relevance, ownership, control and innovation in action. Critical events were often encapsulated within a special period of time – sometimes integrated with parts or the entire curriculum and sometimes operated as separate though there was usually an indirect or direct engagement with particular domains of knowledge. Critical events usually also involved a great deal of collaboration with others beyond the school (artists, specialist funders, advisors, visits, project specialists, workshop providers). Despite the pressures on assessment and testing across Europe within much narrower elements of the curriculum (Ball, 2000), each



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

of the sites researched drew strength from its critical events and strategic partnerships to resist these. Two particular aspects of critical events were highlighted by the research team.

- **Creative Use of Space.** This pedagogical strategy was often linked with critical events, which frequently involved changing the nature of learning spaces, and indeed often involved moving the whole teaching group into unusual actual and virtual learning spaces. The re-design and re-use of space though was not always, the project reported, successful. Not all students found it easy to engage in new learning contexts and the research team interpreted this in relation to the 'cultural capital' which children brought to the learning context (Bourdieu and Passeron, 1977).
- **Creative Use of Time.** Time was often stretched, lessons lasted longer and continued as long as interest was sustained giving time for depth of engagement, and, being linked to the critical events, signalled the importance of the critical event in fostering interest and commitment.
- **Modelling Creativity.** Alongside critical events, Jeffrey (2006) reported that teachers across Europe modelled creativity, being aware of their capacity to influence their pupils. They therefore took a real interest in children's ideas, celebrating these, put significant time into discussion and critique, worked alongside and in collaboration with partners such as artists and workshop leaders and acted spontaneously, engaging in learning and demonstrating pleasure at innovations generated (something previously noted by Jeffrey and Woods, 1997 in an earlier ethnographic study and indeed later, Woods and Jeffrey, 2006). Spontaneous activity also included making changes in plans to classroom activity.

These classroom strategies documented by Jeffrey (2006) for fostering creativity in late primary and early secondary education are also found in creative partnership between artists and teachers that focus on the fostering of creativity in specific curriculum areas.

All of these well developed and well documented strategies involved teachers guiding, and operating alongside, children. But McWilliam (2008) discusses an evolving edge of creative practice, which she names 'meddling in the middle'. For McWilliam, teachers who meddle in the middle:

- Value uncertainty
- Encourage risk-taking
- Design, assemble, edit alongside pupils



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

- Actively co-evaluate

Such improvisational-oriented practices were documented by Chappell et al (2011) in a study of creativity in dance among lower secondary pupils developed through creative partnership between dance practitioners, teachers and pupils. Craft (2011) discusses the ways in which these partnerships generated meddling in the middle activity.

Craft (2011) considers how the enquiry can develop McWilliam's 'meddling in the middle' to open up 'possibility spaces'. The Dance Partners for Creativity project funded by the Arts and Humanities Research Council, found examples of meddling in the middle that were unique and transformative. Comments from the partners suggest that 'meddling' appeared to permeate the classroom practice and the student's creativity and create spaces of possibility to stretch and challenge the partners and students.

1.1.5 Creative teaching and teaching for creativity in science education

Within Europe there are a number of drivers identified by Craft et al (2012) behind an increased focus on research and practice in science education. Whilst Craft et al were considering early years classrooms in this report, these imperatives can be argued to be just as relevant in upper primary and lower secondary education and indeed had been expressed some years previously in respect of the European Union (Rochard, 2007).

- The economic imperative which demands knowledgeable, skilful and creative scientists in an increasingly knowledge-based globalised economy (which in turn involves fostering particular capabilities in the classroom, including reasoning skills, innovative thinking and positive attitudes);
- The view that creative scientific literacy is a vital dimension to 21st century society because of the pervasive role in global society played by science and creativity
- Rapidly changing and developing affordances offered by digital platforms in shaping learning and offering new opportunities and spaces for expression, communication and assessment of learning;
- Growing recognition how capable children are and the importance of building on children's experiences and promoting positive dispositions and skills.

Effective scientific development involves an understanding of the nature of science and involves the inter-linking of procedural skills, often grouped into phases linked to the inquiry process, and conceptual understanding leading to scientific 'literacy' combined with affective aspects, such as motivation and attitudes. Effective science teaching harnesses positive, confident and enquiry focused attitudes in children building on their inherent



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

desire to make sense of the world around them, and combines these with increasing depth of understanding. Like creativity, then, science involves both process and the foregrounding of curiosity. And fostering science creatively involves, therefore, both nurturing creativity within the discipline and teaching it in a creative way.

Key initiatives in creativity in science education in Europe

Perhaps the most significant initiative in Europe and internationally in recent years in fostering creativity in science education has been the development of Inquiry Based Science Education (IBSE).

Inquiry Based Science Education (IBSE)

A widespread movement across Europe and Internationally is the Inquiry Based Science approach (IBSE), which, it could be argued, is inherently creative with its focus on investigation driven often by learners' curiosity and questions, (see Rocard et al, 2007). There is no agreed common definition of IBSE. A definition given by Linn, Davis and Bell (2004) is frequently referenced; they define inquiry to mean:

'The intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers and forming coherent arguments' (Linn, Davis and Bell, 2004: 4)

A recent report by The Wellcome Trust has developed the definition further by explicitly referring to science:

'Inquiry-based science learning sees students learning through inquiry, using skills employed by scientists such as raising questions, collecting data, reasoning, reviewing evidence, drawing conclusions and discussing results. When students learn through inquiry they can develop scientific knowledge and they can also learn about inquiry, including the processes of science and how to construct reliable, valid and accurate investigations' (Yeomans, 2011: 2)

IBSE contrasts with the more traditional method used in schools, referred to as the 'Deductive Approach' by Rocard et al (2007). This approach involves the teacher presenting the scientific concepts and examples of the application of these concepts. This method can also be referred to as top down transmissions. In contrast IBSE is seen as an 'Inductive Approach' or 'bottom-up' approach as the pupil is given space to observe and experiment with their knowledge as the teacher guides their learning.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Work undertaken by Glauert et al (2012) indicates those teachers' conceptualisations and their values and stances towards science and mathematics education and creativity frame and shape classroom practice. Teachers' perceptions of themselves, their values, their understanding and adoption of views of learning and understandings of inquiry-based approaches are influential in guiding pedagogical views and practice.

Harlen (2008) suggests three pedagogical strategies, underpinned by the IBSE philosophy, for fostering learning in the primary classroom. These are: Social constructivist approaches to learning, Inquiry based pedagogy and formative assessment of children's science learning.

Social constructivist approaches to learning

This view ascertains that children are trying to make sense of the world around them, and that the child's individual needs, need to be taken into account as a starting point for planning, thus impacting on the teachers assumption of how children learn.

Inquiry based pedagogy

This is the view of learning that children will only develop their understanding 'through gathering and using evidence from first- or second-hand sources and through argument, dialogue and discussion' (Harlen, 2008: 14).

Formative assessment of children's science learning

This final pedagogical strategy focuses on ensuring that there is progress in learning and that children are achieving particular goals set.

This reflects the IBSE pedagogy where the student inquiry is brought to the fore and 'all learning tasks, assessments, resources, environments and teaching strategies designed to support learning through an emergent process of exploration and discovery' (Levey et al, 2011: 4).

Harlen (2008)	IBSE Levy et al (2011)
Children's needs are taken into account by the teacher when planning	Student inquiry and research drives the learning experience and teachers planning learning around the students needs



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Children's learning will develop through investigation	Students construct knowledge through investigations
Formative assessment to ensure the child is progressing	Students are empowered, knowledge is reflected upon via self and peer assessment

(Table 1) Difference between Harlen (2008) and Levy et al (2011)

1.1.6 Science curriculum in Europe

The next section presents a brief break down of how science is taught at the late primary stage and early secondary stage in the European countries represented by the CREAT-IT team.

United Kingdom

The four home nations of the United Kingdom reflect a strong vision of the 'science for all' perspective, though it could be argued that the economic imperative perspective of each country drives this. Science is taught in Wales, Northern Ireland and England from age 5 – 14, Scottish student's study science up to the age of 18. Across the curricular creativity is referred to as a facet of children developing their creative thinking skills as scientists.

Creativity is recognized by the Welsh, Scottish and Northern Irish curriculums and given high prominence in the separate statutory curriculums. The English national curriculum does not mention creativity or creative thinking as part of its statutory requirements. Any mention of creativity is in the non statutory suggestions for lesson content where creativity is considered as a way to engage with children i.e. teaching creatively rather than teaching for creativity.

Greece

The National Curriculum in Greece does not define creativity in science and math's education. There are no recognised definitions of creative pedagogy in Greece. However, creativity in science and math's is fostered by means of the "flexible zone" which is a fixed cross-curricular hour once a week.

In Greece there is a general approach for creativity upon the so-called "New School". This "New School for Creative Learning" introduced by the Ministry of Education in 2011 seeks to develop a common ground between five crucial factors affecting the educational process: New Curriculum, New Structures and strategies, New teaching approaches,



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Evaluation, Teacher's Training. One of the proposed approaches, among others², was the "cross-curriculum (Interdisciplinary) approach" that will inspire students to discover knowledge. Two existing structures were enhanced in order to support these reforms and they were the whole day school (08:20 – 17:00) and the so-called "Flexible Zone" (FZ) for kindergarten, primary and early secondary education.

The FZ is an innovative method that allows the teacher to define the content of lessons enhancing interdisciplinary subjects and activities. Duration is depending from 4 hours per week (for early primary) to 2 hours per week (for late primary). In early secondary education flexible zone is implemented for 2 hours per week and it is also supported by the so-called "Student's Research Projects". FZ was significantly enhanced by the "Interdisciplinary Integrated Curriculum Framework" which addresses the cross – thematic approach applied into the national pedagogical system through the flexible zone.

Norway

The Utdanningsdirektoratet (translates as Educating Directorate) does not have a specific definition for creative science teaching, but it does recognize that creativity is an important element in education. Creativity must be integrated into teachers' official planning documents.

Italy

There is no definition for creativity in science education. The curriculum for primary and secondary make reference to creativity only in relation to Italian, music, art and physical education. The curriculum for science education emphasise the content of scientific theory, rather than the acquisition of a creative method of thinking. However, the verb "to imagine" appears in relation to the discipline of science.

The curriculum guidelines for both Technical and Vocational Schools, suggest that there is an opportunity to be creative when developing scientific thinking by observing phenomena, proposing hypotheses and when experimenting.

Belgium

In Belgium, there are three different educational systems with distinct characteristics: the French Community, the Flemish Community and the German-speaking Community. Across

² These aspects of the New School are: Open & Flexible, Focused, Unified and coherent, Concise, Pedagogically diverse, Interdisciplinary, Promoting experiential learning, Fostering student's agency, Relating curriculum to everyday life.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

the different systems there is a focus on supporting children in the development of their personal life and preparing them for critical and creative functioning in society.

Strategic and operational objectives of the current Flemish minister of education are to give opportunities to each talent, to maximize the participation in pre-primary education, to prepare students for a successful start on the labour market, and to stimulate careers in science and technology. This objective is linked to the new action plan for the stimulation of careers in mathematics, science and technology (2012 – 2020).

Belgian education policies value creativity in their science educational programmes. Yet, even though many schools promote cross-curricular methods as well as “differentiated instruction”, there is no definition of “creativity in science education” as such. Teachers encourage creativity, but do not necessarily use a creative pedagogy in their approach to achieve this.

1.1.7 What good practice is already happening with regard to creativity and science teaching?

As indicated earlier, a significant approach in good practice in creativity in science education is IBSE, or Inquiry Based Science Education. In addition, with the EU concern to foreground creativity in science as well as creative science teaching creativity is highlighted as a valuable aspect of learning that should be encouraged across the curriculum in schools as discussed above.

Below are some example of existing good practice that shows investigation driven by the learner’s curiosity and questions.

Estonia– the open-air classroom: Banaji et al (2010) analysed existing examples of excellent creative educational practices in compulsory education across Europe. Ten examples were chosen that reflected fairly a distribution of countries, age groups and domains. The examples selected below encapsulate two different ways to approach a scientific topic. The Estonia project discussed how science lesson were taken outdoors to investigate meteorological conditions. The pupils were asked to collect materials from their surroundings to create an instrument to measure the speed of the wind. Working collaboratively in teams they constructed a variety of instruments, which they then used to test their theories. The instruments were then evaluated in terms of how imaginative their ideas were and if it had scientific potential in a real environment. The creative potential of an open-air



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

classroom means that children can investigate the issues much easier than sitting in a classroom learning and discussing meteorological conditions from the board. Children maybe more motivated to learn as it 'engenders in them a more curious and hands-on attitude to the world in which they live' (Banaji et al, 2010: 23). Open-air classrooms are not a new idea and already happening in many countries, but the aim of this specific project was to reconnect the children and teachers with the world in which they live in thus fostering their inquiry.

Greece - 'Can we see sound?' The project example from Greece called 'Can we see sound?' combined physics and mathematics with music. The children were provided with a range of instruments and computer equipment to capture, process and visualize sounds. The children were then asked to work collaboratively to develop their own oscillographs from "trashy items". This innovative project, although small, was included by Banaji et al (2010) as it 'explicitly tried to foster creativity using a clear pedagogical vision, drawing on a variety of inspirations like the Montessori Method' (Banaji et al, 2010: 30). The project showed children actively engaging in activities that explored the conceptual structures shared by physics and music. The project provided hands on activities for the children to develop their own instruments and encouraged them to identify patterns, find commonalities and question why and how this is happening. Thus, Banaji et al (2010) recognized this approach as one in which it is 'essential to unlock the natural disposition that every child has towards discovery, in what is essentially a democratic and emancipatory (creativity as a liberating force) view of creativity' (Banaji et al, 2010: 33).

Below are some examples of current CPD projects that teachers can engage with:

England - Dramatic Science: A teacher-training pilot programme, teachers aimed to scaffold scientific ideas for children to enact and explore.

International - Performing Arts Labs: Creative Science Teaching: CPD initiative supported by NESTA (National Endowment for Science Technology and the Arts). The aim of the Laboratories is to foster creative pedagogy, by exploring arts activities in a unique immersive residential partnership with specialists from the arts, science and technology

Belgium - Experimentarium of l'Université Libre de Bruxelles: Based at the University Libre de Bruxelles. This organization aims to raise awareness and



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

educate students about physics through interactive workshops. They also provided teacher CPD courses.

In addition, a particularly relevant research project is Creative Little Scientists:

Europe - Creative Little Scientists: Creative Little Scientists is a European study referred to earlier, which began in 2011 and completes in March 2014, exploring creativity and science and mathematics in preschool and first years of primary education. Funded by the European Union (Seventh Framework Programme, FP7/2007-2013, Project no. 289081) the project has researched policy and practice in 9 countries and as a consequence has proposed guidelines, curricula and exemplary materials for initial teacher training and CPD in various European contexts.

With respect to science, other key examples of innovative approaches to fostering creativity in science in European schools include the three approaches being adopted within CREAT-IT:

Title of Project	Core Focus of Work
Write a Science Opera (WASO)	Creative professional development programme, which supports teachers, opera artists and scientists to develop an inquiry based music and science project
Science Café	Typically a monthly event where a discussion is held between scientists in an informal setting.
Science Theatre	The drama method can be used as an innovative way of helping students to learn scientific concepts and topics in primary science education.

(Table 2) The CREAT-IT three key case studies

To support the literature and examples discussed above the CREAT-IT survey also wanted to find out how the participants defined 'good practice' in terms of creativity in science education? They were presented with a list of 8 items that had been identified from across the literature as example of good practice in creative science teaching.

- Connected to the real world



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

- Cross-curricular learning
- Individual/collaborative/communal learning
- Inquiry based learning
- Offering children empowerment and agency
- Risk, immersion, play
- Storytelling
- Using the Arts to shed new light

Inquiry based learning (Rocard et al, 2007) was ranked the most popular example of good practice by 66% of teachers, **learning that is connected to the real world** and **using the Arts to shed new light** (Chappell, 2008) were joint second with 63% of teachers ranking these methods as the best examples of 'good practice' in creative science teaching.

With the data ranked in order of preference, teacher practice that provided opportunities of **story-telling**; opportunities to engage in **risk, immersion and play** and offered children **empowerment and agency** were ranked as the bottom three examples of 'good practice'. One comment from a Norwegian Scientist summarised though the importance of pedagogic process, in that 'it is not so much what you do, as **how you do it**... good practice doesn't pertain to **WHAT** you do but **HOW you do** whatever you do'.

The CREAT-IT survey also asked participants which other examples of good practice were *most likely* to contribute to the development of creativity in science. The results reflect the strong drive of IBSE in Europe. The participants consider that for their students to **work in small groups/work collaboratively** would be the most likely to contribute to the development of creativity in science. Followed by problem-based learning and cross-curricular teaching so that teachers began **integrating science with other curricular areas**. Yet, the participants also contradicted themselves as they were asked if the use of history, geography, role-play or drama would contribute to the development of creativity in science and these topics were ranked as the least likely. This contradiction may offer a rich seam of investigation for CREAT-IT in relation to those involved in developing creative science education through the project.

1.1.8 Emerging Tensions / Dilemmas in fostering creativity in science education

Across the literature teachers, schools and students face a number of tensions and dilemmas in the implementation of a creative approach to their science teaching. These are



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

explored below in relation to teachers, students, purpose and the integration of science and art.

Challenges facing teachers

There are a number of challenges that face teachers and students in the science classroom. Schmidt (2011) suggests that the 'traditional models of teaching and learning have done much to cultivate perceptions of science as a non-creative endeavor' (Schmidt, 2011: 441). She goes on to assert that creativity 'occupies a unique place in the scientific arena as both a requirement for future innovation and progress... and a personal characteristic/trait that can be developed and extended through quality education' (Schmidt, 2011: 435). Yet, Bore (2006) suggests that science teacher creativity is 'unlikely to be liberated without some pedagogical and curriculum maneuverability, despite the evident eagerness of these teachers to work in this manner in the classroom' (Bore, 2006: 420). Key barriers faced by teachers are:

- Teacher expertise (especially in the primary classroom)
- The traditional cultural expectation of what is science teaching
- Teacher perception of their student ability
- Students ability to work collaboratively
- Whether it is creative science or teaching science creatively that is being foregrounded

Each of these is now explored in turn.

Teacher expertise especially in primary education.

Murphy (2006) raises the concern that primary teachers are generally not science specialists, so attention needs to be paid to the training of teachers to ensure they are confident about the teaching of creative science, especially at primary level as science has the biggest and most impressionable impact on students at this age. Murphy (2006) found in their study that primary teachers felt confident teaching creatively in other subjects, but not science. Strong professional development is needed to develop the current workforce of primary teachers.

The evolution of IBSE has spawned a number of studies about how teachers engage with fostering creativity in science through this approach. For example, a survey undertaken by Levy et al (2011) revealed a number of barriers teachers face preventing them from engaging with IBSE. Teachers indicated that they had a lack of time, lack of confidence and lack of expertise. They also raised the issue that they were uncertain if IBSE would deliver the required learning outcomes, a sentiment echoed by Marshall et al (2009) who



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

suggest that teachers are unable to 'meld content and inquiry effectively and consistently in classroom instructions and learning' (Marshall et al, 2009: 502). Yet, teachers that did engage and promote inquiry based learning when interviewed by Wallace and Kang (2004) noticed that a benefit gained by their students was their improved positive attitudes towards scientific enquiry. Such enquiry based learning as discussed earlier in this document, has the potential to educate for creativity within science. Nevertheless, Marshall et al (2009) highlight that teachers appear to struggle to implement recommendations of praxis by researchers into their classrooms and appear to adhere rather to the traditional teacher led method of teaching science rather than fostering student-led enquiry.

The traditional cultural expectation of what constitutes science teaching.

A further challenge that teachers are affected by emerges from the possible conflict between aspirations, perhaps articulated beyond their school, for creative science education and their own lived experience. The cultural beliefs of the school, teachers, parents and students, needs to be considered; with respect to how science could be taught and studied. Anderson (2002) refers to this tension as the 'Political Dimension' as teachers are faced with the dilemma to resolve potential conflict between the different parties. Wallace and Kang (2004) found that the examination culture of schools was compartmentalizing the nature of science. Thus, teachers were adopting this culture of what Ball (2000, 2003) refers to as 'Performativity' and allowing it to dictate their practice, which then discouraged them from implementing a different, potentially more innovative practice.

The notion of performativity, as critiqued by Ball (2000, 2003), reflects how teachers regard their value 'within the metrics of accountability and, ... that these metrics will distort their practice' (Ball, 2003: 223). The accountability culture of schools has been questioned over the past ten years by a number of writers in the field of creativity and education (see Sternberg, 2003, Maisuria, 2005, Beghetto, 2006). Schmidt (2011) raises the issue that if the national curricula and policies are drawn from only one single discourse then this will be counterproductive to the teachers and students, as creativity will be constrained. She recommends that if science education is to encourage creativity then the discourses of creativity need to be incorporated into the national curricula so that students can:

- '1) Acquire a high level of domain specific knowledge;
- 2) Practice the application of that knowledge in developing solutions to problems across a gradient of difficulty and;
- 3) Be challenged to link their knowledge of science to their knowledge of other fields as required to pursue and solve problems of relevance/interest to them'



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

(Schmidt, 2011: 442)

Teacher perceptions

A further obstacle to inquiry-based teaching as stated by Wallace and Kang (2004), is regarding 'teacher beliefs about students and student learning, the nature of science, epistemology, and the role of the teacher' (Wallace & Kang, 2004: 940). This is echoed by Dias et al (2011) and in Levy's study: one interviewee suggested that IBSE might be effective for less able students as it requires the student to take control of their learning and as a method demands them to be motivated to see the inquiry through, suggesting that less able students might consider the only correct answer will come from the teacher rather than their investigation. This reflects a more general study of teachers' perspectives on the fostering of creativity in primary and secondary schools, which highlighted the stance of the teacher as pivotal in blocking or enabling opportunities for creative teaching, and teaching for creativity (Craft et al, 2007).

Crawford (2000) found that outstanding examples of inquiry-based teaching demonstrated the teacher in the role of 'motivator, diagnostician, guide, innovator, experimenter, and researcher' (Crawford, 2000: 931); rather similar to 'meddling in the middle'. However, for a teacher to fit all these "roles" they would need support and training. A study by Spronken-Smith et al (2011) focusing on undergraduates' learning via inquiry based teaching found that the teachers teaching on the course required 'mentoring by more experienced colleagues, support group meetings for teachers new to inquiry, learning triads as described above, or, if team teaching is involved, through the development of a community of practice' (Spronken-Smith et al, 2011: 23). So not only do teachers in primary and secondary schools need support but also at tertiary level if we are to produce teachers of undergraduate students confident with using this method.

A challenge for students: students' abilities to work collaboratively

IBSE promotes collaborative learning, however knowledge and skill differences may lead to tensions in-group work situations. Harlen (2004) suggests that one of the barriers teachers face when changing from a more traditional method of teaching to inquiry-based science teaching will require not only the teachers understanding of how children learn and the nature of science but must challenge their perception that scientific inquiry is not a solo action and will require students to work in collaboration if they wish to be innovative.

Challenges of purpose: is creative science or teaching science creatively foregrounded

In their paper on creativity in science education Kind and Kind (2007) conducted a



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

literature review of creative science education. A common theme across their review was the perception that art represented creativity more than science. Therefore, art was considered a vehicle for making science more creative. They discovered that a significant proportion of the literature referred to creativity simply as a descriptive label in science. They developed a list of the separate dichotomies, which reflected what the literature deemed as examples of creative teaching. This implied that teachers who employed these methods were considered good, and thus those that did not were considered traditional or bad teachers.

'Good' creative teaching v 'Bad' traditional teaching

Student orientated v. Teacher orientated

Group / Team work v. Individual work

Cooperative learning v. Individual learning

Explorative tasks v. close-end tasks

Open-ended problems v. Closed problems

Open investigations v. 'Recipe' work

Hands on teaching v. Lectures

Outdoor activities v. Classroom activities

Project work v. Lectures

Issue-orientated v. concept oriented

Teachers taking risks v. Teachers playing safe

(Kind and Kind, 2007: 4)

Schmidt (2011) claims that there is a 'lack of awareness/appreciation of science as a creative endeavor' (Schmidt, 2011: 442). Dias et al (2011) interviews with teachers suggested that there is a confusion regarding creative science teaching; is it about creative expression or creative innovation? They suggest that 'teachers must seek creative and varied ways for their students to learn science via relevant experiences that connect to student interests, utilizing more open forms of inquiry where appropriate' (Dias et al, 2011: 74).

Shanahan and Nieswandt (2009) note that if teachers and schools ignore the creative qualities of science then students will be left with a misunderstanding of the nature of the subject therefore limiting them and potentially alienating them from further study. Across the literature (see Kind and Kind, 2007, Shanahan and Nieswandt, 2009, Schmidt 2011) there is a suggestion that inquiry-based learning can help students become more creative



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

but their appears to be a lack of analysis regarding how the arts and science can work together rather than using the arts in service of science.

Challenges regarding the integration of arts and science: Lack of analysis of how arts and science can co-support each other (rather than the arts being used in service of science)

With a tighter focus on the integration of arts and sciences, Chappell and Craft (2009) report on their study of an immersive continuing professional development programme for science teachers in primary and secondary education in England which sought to use the arts as a vehicle for deepening student engagement and understanding in science, and to foster their creativity within it suggesting that the arts have a great deal to offer. The study highlighted many ways in which the arts opened up pedagogical approaches to be more what we might recognize as ‘meddling’ among the science teachers. Aside from the significance of inclusive ethos, multi-modality, and breaking boundaries taking processes from one discipline to another, time was stretched and from the arts came a depth of engagement by teachers in the discipline and in their teaching relationships, in terms of humanity and spirituality. Equality of status between scientists and artists was a core component as was working alongside one another and standing back and being comfortable with both success and failure. Knowledge was co-constructed by specialists who actively relied on their partnership to generate classroom activity that allowed permeable boundaries between the arts and the sciences. Learning was seen as joyful and as occurring within a valued learning community driven by possibility thinking, the capacity to imagine what might be. The study found that back in school, students and teachers developed much more co-participative approaches to learning with teaching interventions much more tailored to where learners’ own thinking and understandings were located. But the study also highlighted the need for clarity in purpose – whether this is to foster creativity in science or in the arts or both for example. And it also raised the question of whether creativity is really the same in the arts and the sciences.

Other suggestions for challenges a teacher might face raised by the CREAT-IT survey

Participants who completed the CREAT-IT survey were also asked for their opinion regarding barriers teachers might face when teaching science creatively in the classroom. 64.2% of the participants from across all the countries that participated said lack of creative **teacher training approaches** was the biggest barrier. **Resources, teacher motivation** and **time** also featured highly in the rankings. **Pupil motivation** was selected by less than 20% of the 130 participants surveyed.

Other barriers suggested by the survey participants, which the CREAT-IT team might want to consider, included the increased emphasis on **assessment/testing** currently in schools as earlier in this review (see Ball, 2000, 2003). Teachers in the UK also cited the **fear of**



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

inspection as a barrier from them utilising creative teaching approaches in their science lessons.

1.1.9 Summary from Part 1

This part of the literature reviewed has presented a concise history of the arts and creativity in education in Europe. Then presented how the arts have provided support to the various disciplinary areas in Education, including science. There is a proven history in Europe of teachers engaging positively with the IBSE pedagogy, in Science, which foregrounds enquiry and thus creativity in the classroom. IBSE appears to support the different genders and abilities in the classroom, yet teachers feel unconfident to rely upon this method across their lessons. When it comes to testing and exams teachers appear to default to a more traditional pedagogy of learning by rote. Teachers are often unable to draw a link between their students passing exams and engaging in IBSE learning.

However, there is a growing movement across the science community recognizing the potential that fostering a creative approach to the teaching of science may engage more interest in the subject, thus promote the idea that science is open to all. This could then have positive repercussions for economic reasons. The Case studies integrated within this deliverable offer examples of existing good practice that is framed by creativity in the arts, that positively positions teaching science creatively and teaching for creativity in science.

Having established the current status of the field in Europe and defined what is creative science teaching, what follows from this section of the literature review is a discussion regarding how the University of Exeter team will frame creativity and the arts in partnership with CREAT-IT to develop and produce the proposed pedagogical framework for creative science teaching.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

2. Literature review of University of Exeter theory and survey outcomes

This section of the deliverable is a literature review, and analysis of the main creativity theory, which is being drawn on within the CREAT-IT project. In section 2.1 the ideas behind wise humanising creativity (WHC), living dialogic space (LDS), possibility thinking (PT) and the 4Ps are articulated. Section 2.2 integrates appropriate information from the survey, full details of which will be published in D2.2.

2.1 Analysis of University of Exeter theory

As stated in the CREAT-IT description of work, CREAT-IT will build upon the existing state of the art in science education integrating more deeply the element of creativity in learning. In order to achieve the latter it will house the project within the framework of WHC, dialogue and difference, LDS and the four Ps. In summary, WHC positions itself in tension with purely marketised notions of creativity and argues that creators need to think about the ethical consequences of their creations as well as acknowledge their own embodied identity development as part of the creative process. In developing or making any new idea, creators are intrinsically developing themselves and their collaborators as part of that process, and this needs to be acknowledged in both science and arts education contexts. This ethical dimension is vital to responsible creativity in a world characterised by radical uncertainty. The Exeter team would also argue that the accompanying notion of 'trusteeship' is vital in the educative process. CREAT-IT will thus seek to nurture WHC through journeys of becoming which are developed through new forms of creative partnership between the sciences and the arts.

Integrated with the idea of WHC is the participatory approach of creating and working in LDSs. These involve participants (teachers, students, researchers) in creative learning conversations - which have flatter hierarchies than more traditional student-teacher relationships - in order to engage all participants as much as possible in the process and bring ideas and knowledge forward from them where appropriate as evidence. The team's theoretical work also recognises that digital environments are inherently creative and can involve PT and the 4 P's (pluralities, playfulness, participation and possibilities). The PT approach can be used to attend to how teachers might enquire into its enactment through the integration of science and the arts. The Exeter team also however acknowledges critical discourses regarding digital environments in that they may deny more embodied ways of engaging with the world, they can lack domain knowledge and focus too strongly on communication per se, competitive elements of digital environments may stifle creativity; and there may be questionable ethical practices in unmonitored areas of online digital networks. The team therefore acknowledges across this review that there is a fine



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

balance to be negotiated between digital and real-world interaction within teaching and learning.

The literature review begins with the concept of LDS as this is fundamental to how the Exeter team both aim to conceptualise their own ideas and work methodologically with others.

2.1.1 Living Dialogic Space

The idea of LDS developed theoretically alongside WHC (Chappell & Craft, 2011; Craft with Chappell, Rolfe and Jobbins, 2012). Living dialogic spaces are research spaces, which are characterised by debate and difference, openness to action, working 'bottom up' and different modes of idea exchange. Much of the explanation that follows draws on Chappell and Craft (2011).

LDS was conceptualised as part of trying to understand what was happening in the methodologies of two research projects (Aspire³ and Dance Partners for Creativity - DPC⁴) in which Chappell and Craft had developed a new working approach. The projects entailed engaging researchers, teachers, artists and students in investigating creativity and its relationship with educational futures by flattening out more traditional research hierarchies. This opened up spaces that promoted a sense of equality and allowed practitioners, students and others to become researchers oriented toward action. It is these kinds of spaces and what they promote that can be applied to the CREAT-IT pedagogical framework.

One of the key mechanisms for producing LDS was what Chappell and Craft (2011) and Craft et al (2012) referred to as creative learning conversations. The process and characteristics of these creative learning conversations had been allowed to emerge organically over time within the two research projects: Aspire and Dance Partners for Creativity. By 2011, following a re-analysis of the two projects' data and methodologies, it became apparent that creative learning conversations had a number of defining characteristics. They are: partial, emancipatory, 'bottom up', participatory; and feature debate and difference, openness to action and embodied as well as verbalized exchanges of ideas.

³ <http://elac.ex.ac.uk/aspire/index.php>

⁴ <http://education.exeter.ac.uk/projects.php?id=339>



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Creative learning conversations take place between and amongst students, teachers, other educational professionals and parents and can be led by any of these. For example, in the DPC project creative learning conversations occurred between dance artists and school teachers in the role of partner researchers in order to understand how creativity was nurtured within partnership practice; in Aspire schools, with support of University staff, students engaged in creative learning conversations with their teachers to critique and offer suggested developments to teaching and learning practice.

In their most simplified form creative learning conversations involve two key activities (Chappell and Craft with Jonsdottir and Clack, 2009): re-positioning and listening-actioning. These are the activities through which the conversations' characteristics occur. Re-positioning involves subtle shifts in relationship (e.g. by creating spaces in workshops in which students and staff could hold their Aspiring discussions in a more equal environment than usual without teacher dominance), where school staff and students physically and metaphorically reposition themselves in their discussions. Once re-positioning has been achieved, listening and actioning in tandem is vital. In the Aspire project students felt staff seriously considered students' ideas and where appropriate took time to work with students toward action.

There are a number of tools, which can aid this re-positioning, and listening-actioning. These include: conceptual mapping, creative journey mapping (e.g. Snakes and Ladders boards – see Figure 1), phrase completion exercises (e.g. 'Teacher is...Artist is...Partnership is...'), and drawing on Teacher Artist Partnership techniques (2009). Mechanisms that can be used for analysing and representing ideas within learning conversations include: shape-based sorting and prioritising exercises, photographic montage, conversation-style conference presentations using interrupted voices (drawing on a practice developed by the RESCEN team at Middlesex University, Bannerman, 2004), and filmed conversations. It is impossible to offer detail of all techniques here, but a few examples are given below, with more available in Chappell & Craft (2011). Because of the way in which creative learning conversations work it is expected that once participants become experienced in working in Living Dialogic Spaces they will generate their own tools for carrying out creative learning conversations. This would certainly be the expectation within the CREAT-IT pedagogical framework.

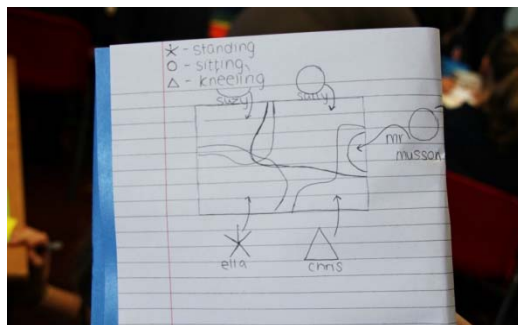
In the meantime, the first example is drawn from an Aspire secondary school. A provocation was used with around 40 students and six teachers (including senior staff) involved in a one-term intensive intervention at Hilltop Secondary School⁵. The provocation began by asking staff and students to construct collective Snakes and Ladders

⁵ Name of all schools – and students - anonymised

boards, representing barriers to and opportunities for outstanding learning in classes. Each group involved students and one member of staff. The construction of the boards involved sharing perceptions of the opportunities and challenges experienced in lessons. As half of the group worked on the board, the other half documented what they saw as going on, acting as qualitative researchers (Figure 2).



(Figure 2) Aspire students and teachers construct Snakes and Ladders whilst other students document



(Figure 3) Example of student documentation

The Snakes and Ladders exercise invited representation of multiple ideas in one space, with some evaluative discussion; observations of the group's work offered opportunities for multiple representations and interpretations of activity. Half-way through the board construction, the two sides of the group swapped roles so that those documenting were now involved in the action, and vice-versa. At the end of the activity, participants shared perspectives on what they had noticed or discovered, about learning in their school and about how the group itself worked. Observing these conversations were the university research team.



(Figure 4) Inviting multiple perspectives

As a mechanism within the wider creative learning conversations occurring in the project the Snakes and Ladders exercise and ensuing conversation re-position staff and students as equals (see Figures 2 and 4 where staff work around tables with students) and in so doing emancipate students to speak more freely, and teachers to offer a different kind of opinion to that normally expected. This game board exercise promotes participation but encourages debate and difference. Perspectives emerge 'ground-up' based on experience and evidence from that particular school, where exchanges are often frank. A key element is a commitment to recognising that whilst multiple perspectives may be represented, the interpretation of these involves humility in acknowledging the partiality and inhabited nature of representations and recognition that meaning is neither self-evident nor 'knowable' beyond subjective experience.

In creative learning conversations the intention is that engaging with difference leads to change. Examples of change stemming from openness to action were strongly evident in the DPC project. For example, one of the DPC research initiatives documented how the partner researchers' process had focused on analysing their roles and relationships and changing their practice (Malcomson *et al*, 2011), which in turn changed how the young people created. The partner researchers concluded that:

"DPC provided space to allow for exploration of the partnership, and the roles and relationships which evolved. It meant letting go of her ego for Bim and giving space for the teacher's and young people's voices. This allowed Bim to use her creativity in a different way, to work more creatively with Caroline, exploring roles and models of practice. Both partners focussed on themselves not only on the pupils learning, which empowered the young people to collaborate and become intrigued by an exploration of their relationship."

These brief examples from DPC and from Aspire, demonstrate how re-positioning and listening-actioning can lead to partiality, emancipation, working from the 'bottom up',



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

participation, debate and difference, openness to action, and embodied and verbalised exchanges of ideas. The CREAT-IT project is seeking to engage students and staff in these kinds of creative learning conversations in order to integrate arts-derived and other creative approaches to generate creative science teaching and learning.

Stepping back from the practicalities of creative learning conversations, the Exeter team argue that what was developed in these examples can be conceptualized as Living Dialogic Space (Chappell & Craft, 2011).

In considering the nature of these spaces Lefebvre's (1991) spatialisation of thinking is helpful. Lefebvre delineates perceived, conceived and lived space. Perceived space is equated with spatial practice; that is the observable reality of performing everyday routines, for example in the CREAT-IT project this would be the observable spatial interaction between teachers and their students. Conceived space is about representations of space and often functions in terms of verbal signs, for example in the CREAT-IT project the conceived roles and relationships of teachers, students and researchers. For Lefebvre this conceived space could dominate and control how we think about, explain, experience and act upon our spatial interactions. He argues that articulating spatial practice and representations of space in this way confines the imagination and does not capture the experiential complexity of actual *lived* space. Lefebvre argues that we need to also acknowledge the representational spaces of bodily experience directly lived through symbols and images. He discusses these in terms of the space of some artists, tending "towards more or less coherent systems of non-verbal symbols and signs" (p39). For Lefebvre they are "alive" with an "affective kernel...It embraces the loci of passion, of action and of lived situations...it is essentially qualitative, fluid and dynamic"..."the only products of representational spaces are symbolic works" (p42). In CREAT-IT these lived spaces would exist, for example, through the theatre and opera processes and practices, which will aim to encourage the spatial embodiment of integrated artistic and scientific ways of knowing. This is a challenging proposition but not an impossible goal.

Creative learning conversations aim to allow space for these kinds of, often arts-based, representations of space. These spaces are also defined by openness as part of collaborative activity. The Exeter team refer to them as 'living' spaces in order to acknowledge the embodiment, lack of closure and capacity for change inherent in the practices that occur within the spaces. In bringing arts practices into science education the CREAT-IT team needs to find ways to create spaces that integrate with science the 'living' space of arts practice and the fluid dynamics and complexities that these bring with them.

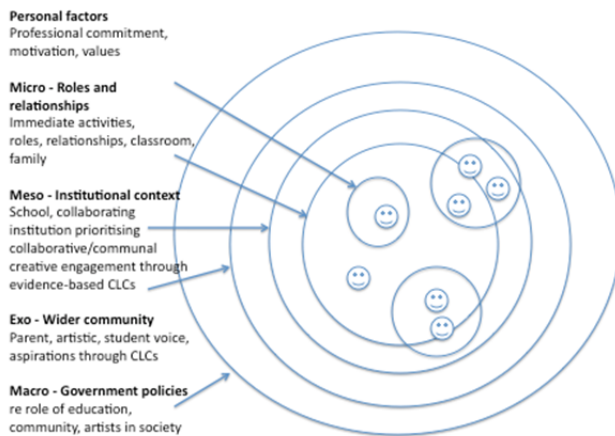


D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

These living spaces are also dialogic and here the Exeter team (Chappell & Craft, 2011) drew on Bakhtin's idea that "the single adequate form for verbally expressing authentic life is the open-ended dialogue...To live means to participate in dialogue...every thought and every life merges in the open-ended dialogue" (1984, p.293). Creative learning conversations encourage debate, participation and social change in a way that strongly resonates with this idea of dialogue. Wegerif (2010) reminds us that in Bakhtin's work dialogue is "shared enquiry in which answers give rise to further questions forming a continuous chain of questions and answers" (p25). In the creative learning conversations exemplified above it can be seen how the use of snakes and ladders boards, and classroom observation encourage dialogues which answer questions around teaching and learning, and also raise new questions which continue to move on thinking. The process is one of on-going change as shown in the teaching and learning prioritisations emerging from the snakes and ladders boards in *Aspire*. The tools of creative learning conversations contribute to this dialogic interaction of question and answer and question.

In applying LDS to the CREAT-IT pedagogical framework it is vital therefore that the right kinds of spaces and dialogues are created to not only raise pertinent questions and answer them but to allow for openness to continue generating new questions, even answer a question with a question. In so doing the framework will be able to take advantage of the best the arts has to offer, to create space for partiality, potentially contradictory representations and to create 'living' dialogic spaces.

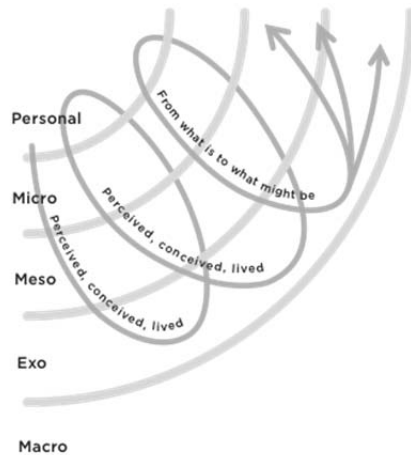
One final element from previous theorising around LDS which is also useful to the articulation of the CREAT-IT pedagogical framework is LDS' housing within Bronfenbrenner's ecological model (Chappell & Craft, 2011). An ecological placing facilitates understanding the layers within which creative learning conversations function. Bronfenbrenner's (1979) bio-ecological theory provides a model in which local phenomena are nested within their larger ecological (i.e. social, cultural) environment (see Figure 5)



(Figure 5) Ecological model of CLCs

At the heart of the Exeter team’s version of the model, is the *personal* – or the individual, whose dispositions influence development. This is nested in what Bronfenbrenner refers to as the *microsystem*, where individuals interact. In the case of CREAT-IT the microsystem might include students and teachers and their relationships; families/home life, close friendships, fellow students and colleagues. Microsystems interact with one another in what Bronfenbrenner called the *mesosystem*, i.e. the inter-relationship between two or more microsystems. Mesosystem factors in CREAT-IT may include classroom and departmental culture, priority placed on arts and sciences in the school as a whole. The *exosystem*, refers to one or more settings or contexts that do not necessarily demand active involvement or engagement yet which affect an individual’s life. In the context of CREAT-IT the exosystem might include a funding body’s prioritisation of arts or science education. The exosystem thus may reflect wider values enabled through funding, so is vulnerable to priority changes at policy level in the macrosystem. The *macrosystem* is the wider complex set of inter-connected systems, which reflect social institutions’ patterns of practice, belief and organisation. Macrosystem factors relevant to CREAT-IT would include government policy on science teaching organisation, cross-curricular practice, curriculum, pedagogy, learning, together with approaches to engagement and inclusion.

This ecological model enables recognition of multi-layered contexts in which creative learning conversations within CREAT-IT might occur. Figure 6 shows how creative learning conversations creating living dialogic spaces have been strongly located in the *mesosystem* in previous Exeter team’s work.



(Figure 6) Creative learning conversations create Living Dialogic Spaces

Because of the very real emergence of values and politics within microsystems and the creative learning conversations within them, Chappell and Craft (p382, 2011) are clear that when these creative learning conversations take place, in the context of the ecological model, they can understand how they:

do not always produce living dialogic spaces as 'perfectly' defined as the descriptions above. The process is delicate. The multiple influences of meso-, exo- and macro-system can act against each other to stifle potential research-driven change (and, we are sure, at times will continue to do so), as well as also leading to productive engagement and educational transformation.

This highlights some of the challenges the CREAT-IT team will face in applying the ideas of Living Dialogic Spaces within the dynamics of different ecological systems within different cultural contexts in the project. Each school or site will need on-going dialogue in order to allow for flexibility towards school's distance needs as well as acknowledging the on-going challenges of this kind of practice.

The LDS framework has been applied most recently in a major research project in C2Learn⁶ where it is part of a more complicated framework fed by a team at the Open University, which overlaps with the University of Exeter team as well as a different team of cognitive scientists from the University of Edinburgh (see Appendix 1 for framework image). There

⁶ The C2Learn project is supported by the European Commission through the Seventh Framework Programme (FP7), under grant agreement no. 318480 (November 2012 – October 2015). Website: <http://www.c2learn.eu/>



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

the LDS theory application is still in development but it is being used as a principle to underpin the development of *C²Learn* game-world spaces (Chappell et al 2013, Scaltsas et al 2013). The intention is to use the theory to inspire the design of a digital game and environment which flatten hierarchies, reposition game 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. It may be useful as the CREAT-IT pedagogical framework develops to feed in learning's from the application of LDS in this project as they become apparent.

2.1.2 Wise Humanising Creativity

Wise Creativity

As Part 1 of this deliverable demonstrates, and (Craft, 2012) discusses, the arguments for developing creative approaches to education and enabling student creativity within education have become widespread across the world. This has been driven by economic, social and technological change which all demand greater imagination to engage appropriately and thus to respond both wisely and creatively to the impact of these changes through education (Claxton, Craft, and Gardner 2008). In response to this, the notion of wise creativity was developed by Craft, 2008). It draws in the notion of trusteeship (that creators need to take care of what matters to them and their community) and is positioned against marketized, individualized and culture-blind creativity. Wise creativity embraces creative stewardship toward the collective good (Craft in press). In her 2008 work, Craft draws on Sternberg's (p152, 2003) commentary on wisdom, highlighting the following:

Wisdom is not just about maximising one's own or someone else's self-interest, but about balancing various self-interests (intrapersonal) with the interests of others (interpersonal) and of other aspects of the context in which one lives (extrapersonal), such as one's city or country or environment or even God.

As Craft (2008) points out, policy and thinking about creativity in education can often appear value-neutral. She argues that the challenge is to acknowledge the ethical dilemmas beneath the surface and understand how we engage children and young people in creativity within education that both involves trusteeship and is wise.

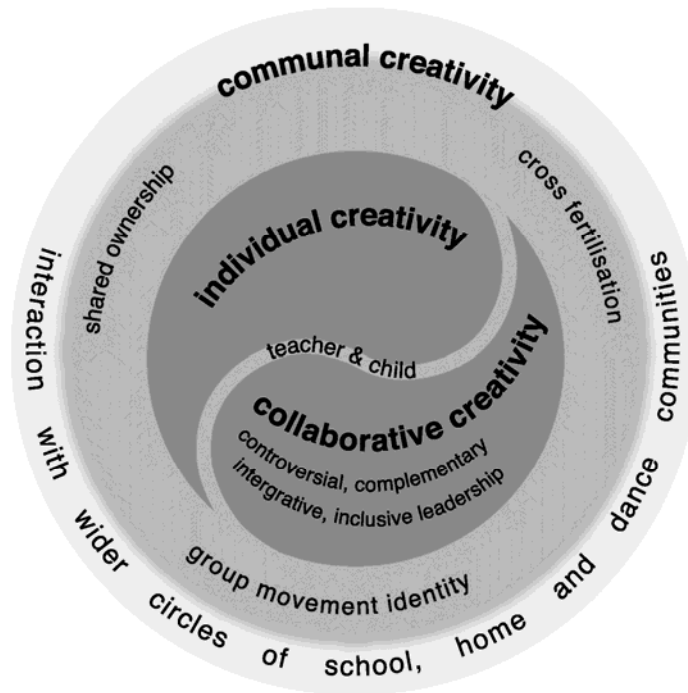
Humanising Creativity

The notion of humanising creativity has been developed by Chappell (2008) and Chappell, Craft, Rolfe, and Jobbins (2012) and draws on earlier work in the arts (Chappell, 2006). Humanising creativity emphasises the blend of individual, collaborative and communal



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

engagement in creativity (see Figure 7) and highlights the importance of communal creativity to the humanising process through its strong focus on shared ownership, group identity and empathy.



(Figure 7) Creativity as Individual, collaborative and communal as originally represented in Chappell (2006)

Humanising creativity is an active process of change guided by compassion and reference to shared values. Change comes from people engaging in collaborative thinking and shared action to imaginatively develop new ideas, which are valuable to them and their community. Shared action means that humanising creativity is embodied; it is grounded in the very place of being human, the body. This is not always a smooth or 'fun' process as it involves conflict and difference. Humanising creativity often requires creators to engage with others' differing values (Chappell, 2008).

Chappell et al (2012) argue that at the heart of humanising creativity is the embodied dialogic generation of ideas. When engaging creatively empirical research (Chappell et al, 2011) has shown that young people cross each other's personal boundaries and enter into embodied dialogues in order to generate new collaborative ideas. Wegerif (2010) suggests that dialogic relationships are at the heart of creativity and notes how they function *within education*. He argues that the inside/outside dialogues allow for education that is "about understanding ideas, not just learning how to repeat them" (p. 27). Importantly, moments of collaborative generation should not be characterized as an anything-goes approach; the empirical research showed an emphasis on rigour, discipline and high expectations from



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

artists working with young people as part of the dialogue.

This conceptualisation of humanising creativity draws on Briginshaw (2001) who emphasises the importance of a more ambiguous space of interaction, which contains the potential for opening up new possibilities rather than closing them down. The “potency of the inside/outside interface” (p.18), that is articulated in her writing suggests that interrelating different views from inside and outside the body provides transformative “potential for new world views” (Bahktin, as cited in Briginshaw; p.18). Merleau-Ponty (as cited in Wegerif, 2010) suggests that to be creative, we need to not only listen to our voice-which is expressing ourselves-but to listen to the artistic ideas being expressed. The gap, between the individual and the world that we inhabit when being creative “opens up into the space of possibilities in which the creative artist can re-imagine the world differently” (Wegerif, 2010; p.63).

Chappell et al (2012) argue that these inside-outside conversations are strongly connected to young people’s identity development. By taking part in these conversations and by taking on different identities in order to do so (for example choreographer, dancer, performer, learner), they are going through a process of making and being made. Through the creative process the young people are 'becoming'. They are growing their identities in a socially responsible, empathetic and communally informed way. This is embedded in their shared creative activity of which they are the embodied substance. The 'embodied process of becoming' is pertinent to young people creating in a humane way as well as the creative process having a humanising influence back upon them.



(Figure 8) the interrelationship of creativity and identity

There is support for the embodied nature of this humanising dialogue in Dewey's (1981-1990) work. He reaches the heart of these physical inter-relations, when he says we



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

“live...as much in processes across and ‘through’ skins as in processes ‘within’ skins” (p.119). Drawing on Dewey’s work Shusterman (2008) has argued for a kind of humanising that understands that

in our bodily actions we are not self-sufficient agents but stewards and impresarios of larger powers...the relational self acquires and deploys its powers only through its enabling relations...and we are...charged with caring for and harmonising the environmental affordances of our embodied selves (p. 214).

This argument applies to humanising creativity where there is a strong embodied reciprocal connection between the creative ideas, the developing identities and their collaborative, communal and ethical essence. It seems from early project discussions that this notion of humanising creativity is a fundamental key to the CREAT-IT project as it places the emphasis on embodied action through arts-based processes. It is this conception of humanising creativity, which Chappell and Craft have blended with wise creativity in order to develop *wise humanising creativity*, which has been proposed as a useful way of thinking about creativity within the CREAT-IT Pedagogical Framework.

WHC

Concept

Wise humanising creativity first began to emerge as a unified concept within the University of Exeter team’s work in 2011. It emerged in parallel in Chappell & Craft (2011) and Chappell et al (2011). Across these two publications WHC was articulated as an expectation of both the Aspire and the DPC project, and in both WHC was described as being central to understanding and navigating the practical, theoretical and policy tensions between creativity and performativity. Chappell et al (2011) specifically argued that WHC could be productively developed in education through the arts as it is grounded in the reciprocal relationship between the collaborative generation of new ideas and identities fuelled by dialogues between the participants and the world outside. They also argue that as it is mindful of its consequences and is rigorous, risky and empowering, it can offer far greater shared hope for the future than the competitive sink or swim mentality, which currently pervades our education system. In relation to the CREAT-IT pedagogical framework it is these qualities derived from WHC manifested in the arts that will be key.

Craft (2012) has also written since about WHC in relation to childhood in the digital age. She has argued that WHC stands in tension with a universalised version of creativity (Jeffrey and Craft 2001) harnessed to the global capitalist marketplace and that it broadens perspectives on the purposes of education by problematising the marketisation of childhood and youth which can be intensified in digital environments. She reiterates Chappell et al’s argument that ‘education needs to be imbued with greater creativity,



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

communality, humanity, empowerment and negotiation' suggesting that 'uncritical belief in [economic] growth and progress is mistaken' (2011, 158). Craft states that WHC that challenges the status quo through and within the educational system demands everyday, or little c creativity (Craft 2001; Craft 2005; Beghetto and Kaufman 2007), as distinct from world-changing big C creativity. This point is key to how WHC is applied within the CREAT-IT pedagogical framework. As is Craft (2012)'s main argument in this paper in relation to the digital elements of the CREAT-IT framework. She reminds us that childhood and youth are changing with

connectivity around the clock, with a parallel existence in virtual space...seamlessly integrated with actual lives. Young people are skilful collaborators, navigating digital gaming and social networking with ease, capably generating and manipulating content, experimenting virtually with versions of their 'social face'. They are implicit, inherent and immersed consumers (p173).

She argues here and in a further paper on changing childhoods and educational futures (Craft, 2013) that the adults also engaged in these digital changes alongside children and young people need to find ways to navigate the tensions. Her suggested route to this is for all involved to use creative potential and wisdom by coupling WHC with 'possibility thinking' and the 4Ps to generate quiet revolutions (see sections below), and to raise questions about the assumed satisfactory nature of the marketisation of experience rather than to raise questions about children and young people's right to assert their creative potential and capabilities. These suggestions for navigating a way forward for both teachers and students within the digital age should be useful to developing the digital elements of the CREAT-IT pedagogical framework.

Further to this, Craft's (2012, 2013) arguments regarding WHC in digital environments also resonate with the on-going application of the WHC theoretical concept within digital gaming (Walsh, Chappell and Craft, in development). As briefly discussed above, the C2Learn project integrates WHC within a more complicated framework (see Appendix 1 for framework image) alongside Creative Emotional Reasoning (CER), possibility thinking, the 4Ps and LDS in order to understand how digital gaming and social networking environments can foster co-creativity in learning processes across formal and informal educational contexts. Walsh, Chappell and Craft (in development) detail the qualitative piloting of four core features which have emerged at the heart of WHC in this digital context and wider theoretical framework. These are: attending to ethics and impact; engaging in dialogue; being in control; and engaging in action. It must be remembered that these four features have been generated via application within a dominantly digital setting, which can include but does not forefront the arts or understandings of embodiment, and that here WHC is integrated with CER. The C2Learn model therefore represents one way in which WHC might manifest in a particular disciplinary and theoretical context. As such, although it provides a strong example of the manifestation of WHC



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

within a particular context, it is not a directly transferable 'model' for the CREAT-IT pedagogical framework.

As a balance to this digitally focused work and for potential incorporation alongside thinking developed around WHC on C2Learn, WHC also continues to be researched and developed as a concept within the arts. Chappell, Cartwright, Dawson, Ford, Pender and Swinford, (in development) are currently researching together via The Devon Carousel Project (<http://www.thecarouselproject.org.uk>) to investigate how WHC is manifested within early years interdisciplinary arts education. This project is in progress between August 2013 and July 2014.

Its early findings are likely to be particularly pertinent to developing the CREAT-IT pedagogical framework because it is exploring WHC in an interdisciplinary context. Although all disciplines are arts-based the overall research to date (<http://www.thecarouselproject.org.uk/playing-with-circles/>) shows a number of principles are key to enabling WHC in an interdisciplinary environment. These are: communication around a shared interdisciplinary thread (or key issue/developing idea) to enable dialogue and integration between disciplines; equality and cohesion between disciplines, staff and children; space for riskiness; and the acknowledgement of the need for an atmosphere and environment that facilitates each discipline including immersion in process as well as a focus on product. Learning from these principles of arts interdisciplinarity to understand how science/arts integrated WHC can be nurtured will also be central to the CREAT-IT pedagogical framework. Early findings regarding the manifestation of WHC within this arts context indicate that WHC's communality resonates particularly with arts practices focused on child-family-artist relationships, and that this practice also provides space for embodied inside-out/outside-in creative dialogues that contribute to children's journeys of becoming. As further findings from this project emerge there will be ongoing useful insights for incorporation within the CREAT-IT pedagogical framework.

Pedagogies

The final section of this WHC part of the literature review briefly considers what has been written about the pedagogies associated with the concept. It is fair to say that the focus of the Exeter team's work in the 2008 – 2013 period has been the articulation of the WHC concept in a variety of settings as detailed above. The exact pedagogies, which accompany the concept, have been studied alongside the concept in some but not all of the empirical projects framed by the project. There are two main current sources of information regarding pedagogies directly associated with WHC. These are Chappell and Jobbins (in press), which details WHC associated pedagogies within secondary level dance education and the beginnings of empirical work on pedagogies within the C2Learn project.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Deriving from the earlier work within the DPC project on pedagogies (Rolfe, 2011), Chappell and Jobbins have drawn together a number of key practices, which facilitated WHC in a partnership context within dance education. Although these are dance specific, in certain research sites partners (one from within the school, one from the environment external to it) were from mixed arts backgrounds thus lending some interdisciplinary to the partnerships. This interdisciplinary together with the fact that pedagogies were developed between two or more individuals teaching together are particularly useful for the CREAT-IT pedagogical framework as they demonstrate pedagogies developed and practiced by more than one teacher as may be the case in integrated science/arts teaching within CREAT-IT.

Firstly, Chappell and Jobbins (in press) articulate four partnership characteristics as fundamental to nurturing WHC. Firstly students were viewed as partners in their own right and were given an active voice alongside adults. Secondly, young people and adults engaged in identity shifting, e.g. teacher, choreographer, manager which meant that students especially took on identities which empowered them to create new dance ideas. Thirdly, all partners engaged in different leadership roles (e.g. co-leader and inclusive leader), which similarly shifted how adults and students were positioned and took them in new and unexpected directions. Lastly, all of these partnership characteristics took place within a temporary shared creative group identity. This was much like a dance company and provided a safe, empathetic place to create. Together, these partnership characteristics contributed to flattening hierarchies in dance classrooms and formed the bedrock of the partnership pedagogies that ensued.

Chappell and Jobbins (in press) then go on to articulate the key features of partnership pedagogies which were important in terms of nurturing WHC: understanding that practice was a joint journey of discovery; partnerships creating new emergent possibilities through giving and sharing knowledge; partners co-constructing choreography; partners complementing each others teaching; partners exploiting their shared repertoire of choreographic practice to go in new directions; partners engaging in shared physical demonstration and partners openly collaboratively learning from each other.

These partnership characteristics and pedagogies can offer a framework within CREAT-IT where partnership working between one or more artists/teachers/scientists is possible, or can be adapted for solo teaching of interdisciplinary arts/science. In contrast to these insights from face to face arts-focused WHC nurturing, the C2Learn project offers some early insight into pedagogies and structures which might be necessary within mainly digital environments and which might equally be carried out by a facilitating teacher or a 'creativity assistant' within the C2Learn game. It is early days for the practical applications of C2Learn but thinking here has borrowed understandings of creative pedagogy from the



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

PT work (see below). C2Learn deliverables to date (Chappell et al 2013, Scaltsas et al 2013) suggest that the following pedagogies are likely to support co-creativity within which WHC is integrated: 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. More specific WHC focused pedagogies are likely to emerge from the project analysis, which will also be useful to the CREAT-IT pedagogical framework in the future.

2.1.3 WHC and Quiet revolutions

The idea of quiet revolutions emerged as a partner concept to WHC in Chappell & Craft (2011) and Chappell et al (2011). It derives from the same vein of thinking, which generated WHC as a response to overly marketised, individualised and globalised conceptualisations of creativity, which were not adequately acknowledging social, economic and environmental crises regarding sustainability and the performatisation of education. The idea of 'quiet revolutions' builds on the work of alternative education specialists Fielding and Moss (2010), and arts education philosopher Elliot Eisner (2004). They all argue that grand revolutions are not the best way to establish common ground between personally-held and societally-useful values (Inayatullah, 2008) and that a more effective approach is to determine what education is for and then take a bottom up approach to instigating change, an "incremental, cumulative and reactive process" (Fielding and Moss, 2010, p2). Eisner suggests that within the arts we need:

...to generate other visions of education, other values to guide its realisation, other assumptions on which a more generous conception of the practice of schooling can be built. That is, although I do not think revolution is an option, ideas that inspire new visions, values, and especially new practices are...the arts can serve as a model for education (p4, 2004)

Chappell et al (2011) therefore aimed to question what they felt education was for and, following in the footsteps of Eisner (2004), Fielding and Moss (2010), Whole Education (www.wholeeducation.org) and The Coalition for Education in the 21st century (www.c4e21.org) stated that

21st century education has a responsibility to develop individuals who can make an ethically-grounded, humane and sustainable contribution to their societies and environments. Education is therefore about thoughtfully, diligently and creatively developing and empowering individuals so that they and their communities thrive socially and spiritually, and perhaps economically, but without a dominating emphasis on the latter. This can be achieved through paying attention to the



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

emotional, physical, aesthetic, rigorous and critical, through attention to intrinsic as well as extrinsic values, through individual, collaborative and communal endeavour, and by working to navigate beyond 'what is'.

Once they had done this, the Exeter team combined Fielding and Moss' and Eisner's core perspectives to conceptualise the idea of Quiet Revolutions via which change towards different educational futures could be made to happen in small but potent ways. The team's project work is driven by the notion that research into WHC, carried out via creative learning conversations leading to LDSs is a way of conceiving of and fuelling alternative educational futures. And these educational futures are grounded in the kinds of theoretical ideas that counter notions of marketisation, the crisis of sustainability and other areas of concern and encourage teaching and learning which builds shared solutions from the 'bottom up'. In developing the CREAT-IT pedagogical framework informed by WHC and LDS there is therefore an in built assumption that Quiet Revolutions of one form or another will ensue.

2.1.4 Possibility Thinking

Concept

Cremin, Craft, Clack, Scheersoi and Megalakaki (2012) draw together a summary of work on possibility thinking to 2012 which provides a useful backdrop for PT within CREAT-IT. They detail the key work which first theorized and then empirically established the concept as undertaken by researchers in England (Burnard, Craft, Cremin, Duffy, Hanson, Keene, Haynes and Burns 2006; Chappell, Craft, Burnard, Cremin, 2008; Clack, 2011; Craft, 1999, 2001, 2002; Craft, McConnon and Matthews 2012a; Craft, Cremin, Burnard, Dragovic and Chappell 2012b; Cremin, Burnard and Craft, 2006), in Cyprus (Aristidou, 2013) and in Taiwan (Lin, 2010, 2011; Ting, 2013). The core research team led by Craft has explored the concept of 'possibility thinking', which at its simplest is about posing 'as if' and 'what if?' questions involving both solving and also finding problems (Jeffrey, 2006; Jeffrey and Craft, 2006). From their qualitative work undertaken in the interpretive paradigm the research team has highlighted PT occurring in learning contexts encouraging immersion and play. The theoretical work argues that PT involves children engaging in curiosity-driven exploration generating and investigating questions which generates novelty (Burnard et al., 2006; Craft et al., 2012a; Craft et al., 2012b). Cremin et al (2012) also detail that doctoral studies are under way which focus on PT in the early years, primary and secondary contexts spanning Cyprus (Gregoriou⁷), England (McConnon⁸) and Wales (Alderson⁹) and

⁷ Gregoriou, PhD thesis in process to be submitted Sept 2014



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

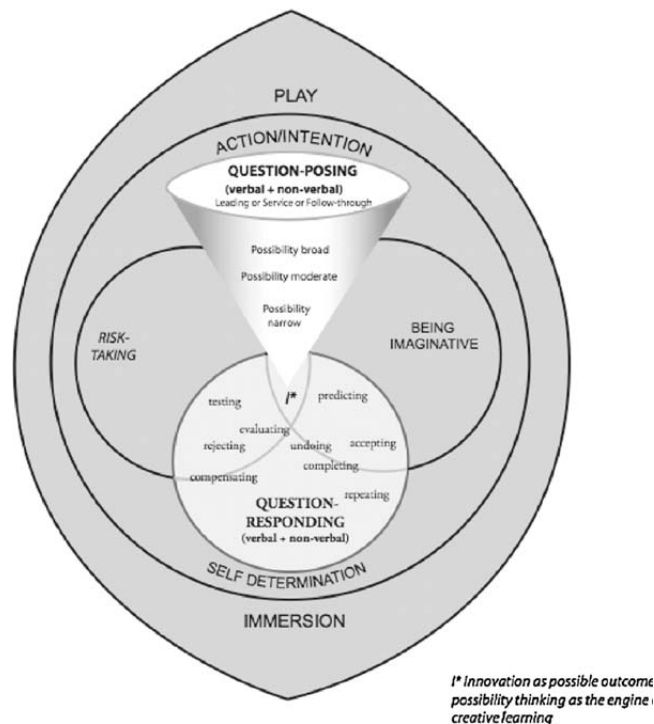
studies have been completed on possibility thinking in the upper primary years in mathematics (Clack, 2011), dance (Craft and Chappell, 2009), and drama (Lin, 2010, 2011) and in secondary schools in integrated arts (Ting, 2013).

Cremin, Chappell and Craft (2013) offer an even more recent summary of work in which they clearly document the key PT features. They articulate how Burnard et al (2006) researched the key features of PT with 4–7 year olds as: question-posing, play, immersion, innovation, risk-taking, being imaginative, self-determination and intentionality. They document how, in the next substantive phase of the work, the team sought to interrogate the framework established in the first phase.

They detail how three studies were undertaken, the first focused on the potency of children's questions, yielding taxonomy of questioning in PT episodes (Chappell et al., 2008). As shown in Figure 8, question posing and question-responding were seen occurring in a context of play and immersion in which children engaged in self-determined activity enabling and generating intentional action. This study highlighted the importance of the inherent breadth of possibility in any classroom activity, as well as delineating different kinds of questioning from leading questions framing creative endeavour to service questions enabling enquiries to proceed, and follow-through questions often used at a practical level. Questions were expressed verbally and more frequently non-verbally through enacted expression.

⁸ McConnon, L. (2014). *Communicating Possibilities: A study of English Nursery Children's Emergent Creativity, Exploring the Three to Four-Year-Old Child as an Artistic Communicator and Possibility Thinker*. PhD thesis examined Dec 2013, Pass with Minor Amendments

⁹ Alderson, D. (2014). *Creativity and arts-education partnerships in the primary school involving pupils aged 10-11 years old. A Case Study undertaken in South Wales, UK* EdD thesis examined Jan 2014. Pass with Major Amendments.



(Figure 9) Question-posing and responding and context

Cremin et al (2013) also document two other second phase studies which explored the activity of children aged 9–11 in two primary schools (Craft et al., 2012) and explored the activity of a group of 4 year olds in an early years setting (Craft, McConnon, et al., 2012). They tell how the first study further confirmed most features of PT, but found risk-taking to be absent and noted a lack of non-verbal questioning in the mathematics activity. Cremin et al note the significance of identifying peer collaboration as an emergent PT feature and the documented overlap between imaginative and playful behaviour. The second study explored PT manifest in child-initiated play and adults' roles in this. It revealed blending of individual, collaborative and communal creativity and an imaginative dynamic between practitioner and child. This study also noted the role of provocations and the presence of children's imaginative storying in PT.

Cremin et al (2013) went on to make the connection between storying and the emergence of a narrative theme, which led the team to undertake a full systematic reanalysis of the role of narrative within PT activity. The new analysis revealed that narrative plays a foundational role in PT. It tracked two main narrative characteristics: whether narrative was child or teacher-initiated; and whether narrative was fantasy, historical or everyday. It was also apparent that construction of narratives within PT was a combination of individual, collaborative and communal endeavour and that the narratives had five main features. These were: the involvement of characters, the evolution of a plot, a sequence of events, significance to the participants, and emotional investment of the participants. In particular the reanalysis also demonstrated reciprocal relationships between questioning,



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

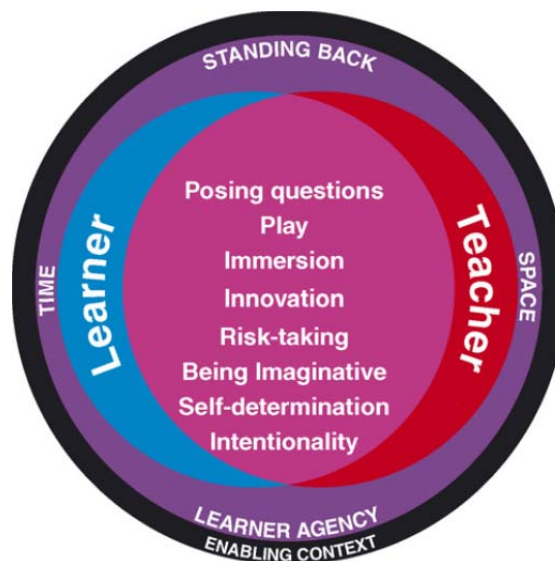
imagination and narrative, layered between children and adults.

This body of work on the concept and features of PT is offered as another conceptual strand for integration within the CREAT-IT pedagogical framework.

Pedagogies

The main study, which forms the bedrock of understanding into PT pedagogies, is Cremin, Burnard and Craft (2006). This study involved qualitative analysis of young children's classroom activity derived from observations, interviews and video analysis. It illustrated that nurturing children's PT involves adults placing a high value on enabling children's agency, offering children both space and time to develop their ideas and perhaps most importantly, standing back from the children in an acutely sensitive way, with close scrutiny of the children's engagement so as to choose wisely when to step in to provoke, clarify, support, extend and challenge.

The findings of the study are summarised in Figure 10.



(Figure 10) Pedagogy nurturing possibility thinking

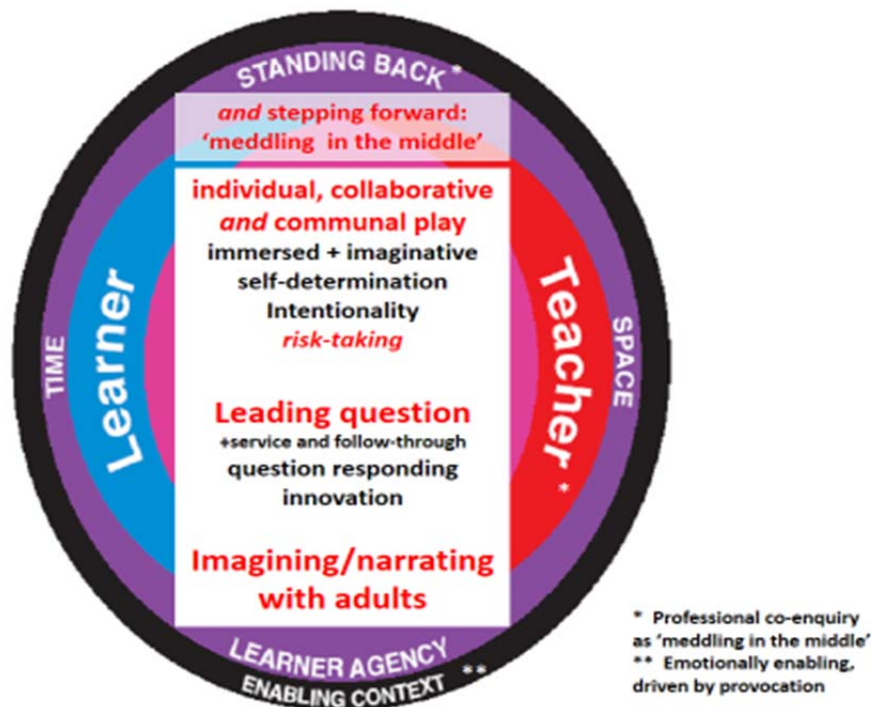
Craft et al. (2012) developed the nuance of this four-fold pedagogy in their further early years study. Their analysis revealed five ways in which practitioners supported children's creativity in child-initiated play: by provoking possibilities, allowing time and space, being in the moment, making interventions and mentoring in partnership. These findings reinforced the key aspects of pedagogy for PT already documented in earlier work, above (Cremin et al., 2006). Craft et al (2012) report how adults were seen 'standing back' at times and offering children space and time to develop their ideas, valuing children's agency. They



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

demonstrated sensitivity to the emotional environment forming part of the enabling context for children, co-reflecting critically after each episode to consider the extent to which they had got the balance of emotional comfort right.

The analysis extends previous work in a number of ways, but particularly important is its construction of how professional co-investigations involved 'meddling in the middle'. Craft, (2011) describes this as co-constructing alongside and with children. Coined by McWilliam the concept of 'teacher as meddler' (2008, p. 265) represents a distinct approach to pedagogy, beyond the 'sage on the stage' and the 'guide on the side'. 'Meddling in the middle' involves humility, care, collaboration, giving and receiving, working alongside with intense sensitivity as to appropriate interventions. The study generated this new PT feature in relation to pedagogy, which helped to develop a new representation given in Figure 11, offering further insight into the dynamic between children and between children and adults.



(Figure 11) Professional co-enquiry as meddling in the middle

Again this work, which articulates features of PT pedagogy, is offered as another conceptual strand for integration within the CREAT-IT pedagogical framework. How it might contribute to framing pedagogy alongside details of the similarly empirically



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

researched WHC pedagogies detailed above is particularly pertinent.

2.1.5 WHC, Quiet Revolutions, PT and the 4Ps

Sections 2.1.1 to 2.1.4 above review the generation of the main Exeter team's ideas and their current conceptual form which are on offer to the CREAT-IT project's pedagogical framework: LDS, WHC, Quiet Revolutions and PT.

As can be seen from this analysis in some of the Exeter team's current studies WHC and PT remain as separately conceptualized and studied ideas. However in some of the current work, WHC has been placed in different relationships with PT and Craft's (2011) notion of the 4Ps to inform theory development and practice in different ways appropriate to different contexts. Brief details of the 4Ps will be offered first here in order to provide the final piece of background to the theoretical interactions that follow.

The 4Ps were first proposed in Craft (2011) as a response to questions about what the future of education is when the possibilities that exist for children change and advance so rapidly and are so uncertain. As part of Craft's exploration of the changing nature of childhood she asks how education might need to change to respond to these questions. Her answer is to suggest that we need to construct imaginative educational futures, which hear all voices and those we might do this via the '4Ps' of changing childhood and youth. She argues that we need to acknowledge and encourage "the plurality of identities (of people, places, activities and literacies), possibility-awareness (of what might be invented, of access options, of learning by doing and of active engagement), playfulness of engagement (the exploratory drive), and participation (all welcome through democratic, dialogic voice) (Craft, 2011, p33).

These 4Ps have been integrated in slightly different ways in different projects and writings alongside WHC, PT and LDS as detailed below. These are each described briefly below as the main weight of the theory within each scenario has been laid out in the analysis above.

In the C2Learn project (Walsh et al, in development; see also Appendix 1 and section 2.1.2 above) the core PT idea that creativity involves a transition from what is to what might be through 'what if' thinking (enquiry) and 'as if' thinking (imagining) is positioned as the process through which *C²Learn* co-creativity emerges novelty. Alongside CER, the four component features of WHC (see above) are then seen as the manifestation of co-creativity within the gaming environment. In the C2Learn framework the 4Ps are embedded within the gaming environment, the idea being that that gaming environment and the pedagogies that integrate with it are structured to support pluralities, possibilities, playfulness and participation. One way of achieving this is via the LDS' also embedded in the game and present in the environment outside the game. The aim is to offer players



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

high participation and shared control, individually, in collaboration and/or as part of a communal endeavours. Within and outside of the *C²Learn* game-world, the manifestation of WHC in this context aims to fuel the potential for quiet revolutions, which is the ultimate intention of the *C²Learn* process. 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, would also be grounded in excellence and engaged involvement from children and adults in the learning space.

The C2Learn framework therefore provides a useful example to the CREAT-IT team of one way that the Exeter team's theories might be interrelated. It might be particularly useful as an indicator of how the theories can be integrated to support the digital element of the CREAT-IT project because of its dominantly digital context.

Alongside the team's collaborative work, Craft (2012, 2013, in press) has also connected or integrated PT, WHC and the 4Ps in slightly different ways to make arguments for ways forward for children and young people in the digital age, which have much thinking in common with the C2Learn project. In the process of considering the challenges children and young people face in a digital age, in her 2012 paper she positions children and young people as digital possibility thinkers posing 'what if?' questions and engaging in 'as if' activity. Continuing the debate begun in Craft (2008) and also picked up in Chappell et al (2011), this paper seeks to understand two competing discourses: young people as vulnerable and at risk; or alternatively as capable and potent. Craft (2012) states that the former perspective imbues anxiety about the digital revolution; the latter embraces it as exciting and enabling. She argues that neither is sufficient. Whilst thinking of children and young people as digital possibility thinkers, Craft suggests that we need to think carefully about our assumptions about what creativity is and what it is for by acknowledging the educational tensions between creativity and performativity. In her 2013 paper she argues that it is the marketization of children's practices, rather than children's PT that is problematic.

In all the papers she turns to WHC to make the argument for considering the ethics and consequences of the creativity that is generated by PT, alongside which she argues for co-creating students' educational futures with them through dialogue to nurture the 4 Ps: plurality, playfulness, participation and possibilities. She goes on to argue that rather than making do with possible or probable educational futures educators should challenge their imaginations and those of the children with whom they work to create their preferred educational futures in the face of marketisation and on-going global uncertainty. As part of this quiet revolution children are encouraged to have the ideas and see them through in a high trust environment, which empowers them.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Finally, in Craft (in press), she develops her 2012 and 2013 thinking within the context of inclusive education and argues that with radical uncertainty surrounding them, educators need to consider what sort of preferred educational approach they might adopt in the inclusive classroom and what capabilities are important. The need for creativity which attends to the impact of actions and which is informed by empathy and collective need is explored. Here in the context of inclusive education, Craft goes so far as to combine WHC and PT into wise, humanising possibility thinking. Again, the integration of digital media characterised by the 4P's of pluralities, playfulness, possibilities and participation within 21st century learning approaches is a key dimension in classroom practice which encourages the generation of 'quiet revolutions'.

This line of theory integration developed by Craft alongside and connected to the team's collaborative work therefore provides a very useful example to the CREAT-IT team of how the Exeter team's theories might be interrelated in a global way. This integration of the theories is very useful as an indicator of how the ideas can be blended to support the digital element of the CREAT-IT project. Hand in hand with this it also seems important to acknowledge current understandings of WHC and PT detailed above which have focused on more face-to-face and arts-based contexts. The CREAT-IT pedagogical framework will have an emphasis on the arts and sciences with some digital elements embedded within them but with an accompanying onus on functioning in real-world, embodied ways. The challenge for the CREAT-IT team is now to understand the essence of the Exeter team's ideas both within and outside of the particular disciplinary and virtual/real world contexts in which they have been generated and applied, and to develop a conceptual framework which makes the most appropriate use of the essence of these ideas in the new context of arts/science teaching and learning within science education.

2.1.6 Summary

Section 2.1 therefore presents a review of the Exeter team's work around the concepts of LDS, WHC, PT, the 4Ps and Quiet Revolutions. The review aims to demonstrate the generation of these ideas over time and their current conceptual form. It also details the different ways that they have been conceptualised together in different contexts by members of the team in solo and collaborative endeavours. As stated at the beginning of the review the team fundamentally works to the principle of Living Dialogic Spaces, which leads to an open and flexible approach to the team's collaboration, and development of ideas. Within the ethos of LDS, this idea development is also influenced by the cultural context within which the team is working as well as new colleagues with whom the team collaborates. There is not one way that LDS, WHC, PT and the 4Ps 'fit' together apart from perhaps to say that in combination they do aim to generate one kind of Quiet Revolution or another.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

From here how the concepts are integrated together to form the backbone of the CREAT-IT pedagogical framework is a unique process of negotiation for this project via which there is an expectation that the different elements of the Exeter team's theories will also develop as 'living ideas'. They each have a core but they are not static, so it is anticipated that this will happen as part of their application and practice within integrated science/arts teaching and learning in science education. It is hoped that one of the strengths of the Exeter team's work to date is that it has developed and been studied in a mixture of arts, digital and generic contexts. Understandings of how to integrate and apply the theories in all these situations can now be applied within the science education context of CREAT-IT to develop an appropriate and unique new pedagogical framework for the new context for all involved.

2.2 What we know from the survey

The outcomes from the survey have been integrated above across Part 1 to demonstrate where they interrelate with the wider literature detailed there. This section considers the outcomes from the survey in relation to the Exeter team theory detailed in Part 2 of this document. This paves the way for the overall theory integration and the CREAT-IT Pedagogical Principles detailed in Section 2.3. to offer the essential features of CREAT-IT pedagogy.

The survey included the following in its characteristics of the creative science teacher: constantly developing, pupil focused and led, emotionally connected, motivated through prioritising creative teaching, collaborative, seeking experience and positive/encouraging.

Considered in relation to the theories articulated in Section 2.1, there are a number of connection points. One of the strongest is between the survey outcome that a creative science teacher is constantly developing, pupil focused, positive and encouraging, and the Journeys of Becoming that flow from Wise Humanising Creativity. A teacher who is nurturing this kind of ethically-focused creativity, who is therefore open to the creative process contributing to who his/her students are as people (i.e. their identity) would seem to be very likely to acknowledge this process of becoming in themselves too. It is important that the survey has demonstrated that a creative science teacher is constantly developing alongside their pupils as this also resonates with the notion of collective journeys of becoming being able to contribute to quiet revolutions in terms of the way things are done. In this case, potentially contributing to changes in how science is taught.

Creative science teachers who are pupil-focused connect to the theoretical strand of agency, which is strong both within WHC and Possibility Thinking. Agency is at the heart of the 'making and being made' dialogue within WHC, as well as being evident within the



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

self-determination and intention of PT. The survey also shows that creative science teachers are emotionally connected. Acknowledging the emotional ups and downs of creativity is a feature of WHC, especially understanding that creativity is not always 'fun'; being emotionally-connected is also important to PT pedagogy. If creative science teachers can experience and encourage the emotional dynamics of creativity in science it seems they are much more likely to foster creativity than if they approach it in a more disconnected manner.

The survey also suggests that creative science teachers are motivated through prioritising and facilitating creative teaching as a pedagogical approach; that they are willing to take risks. Both parts of the literature review above demonstrate that the combination of creative teaching and teaching for creativity is vital in nurturing creativity in science learning. The survey lends further support to this. It is also interesting that the survey outcomes connect creative teaching as a pedagogical approach to risk. Risk is key to both the creativity theories of WHC and PT, with WHC pinpointing it as core to the embodied dialogue generating new ideas and PT detailing risk as one of its core features. It might be argued that creativity is to a certain extent meaningless without the inclusion of risk somewhere in the process. So its presence in the survey themes is appropriate.

Collaboration is inherent in WHC, integrated with the idea of individual and communal creativity, as well as being intrinsic to the dialogue within Living Dialogic Spaces and the notion of participation within the 4Ps. More recently, collaboration has also emerged as a feature of PT too. The survey highlights this as an important characteristic of the creative science teacher both in terms of idea generation, support and high level outcomes. The resonance between collaboration in the theory and the survey outcomes is perhaps not surprising but is reassuring in terms of the developing framework and principles.

Another reassuring area of resonance between the survey outcomes and the theoretical framework for this project, and indeed the wider premise of this project, is that the survey showed that seeking experience, often in the arts was another characteristic of a curious creative science teacher. This perhaps connects most strongly to the 4Ps notion of plurality, a willingness perhaps to take on multiple identities and to delve into pluralities of meaning through different subjects e.g. the arts, in order to move science learning on. This is perhaps one of the less obvious characteristics of a creative science teacher, and it is useful that the survey has highlighted this.

The survey also included the following in its strategies of the creative science teacher to teach creatively: inquiry based learning; learning which is connected to the real world; individual, collaborative and communal learning; cross-curricular learning; using the arts to shed new light; and trying new approaches from experience. Cross-curricular learning and using the arts to shed new light are reassuring emergent themes in that they support the fundamental premise of the integration of the arts and sciences within the project. The



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

emergence of inquiry based learning as a strategy for teaching creatively reinforces the emergence of this as a strong strand in Part 1 of the literature review. The notion of learning which is connected to the real world, trying new approaches from experience and individual, collaborative and communal learning resonate strongly with the point made in WHC that ethically-guided creativity needs to both generate ideas which are of relevance to the community to which they contribute. Creators also need to consider the impact of new ideas on the community within which they are creating (i.e. the real world!), and not just to generate new ideas for their own sake. Acknowledging the interaction of individual, collaborative and communal processes is at the heart of this.

Finally the survey offers a range of strategies, which were considered as important for science teachers to teach for creativity. For ease of analysis with key pedagogies drawn from the Part 2 literature, a comparative table (Table 3) has been drawn up so that the reader can view LDS features, alongside WHC pedagogies and PT pedagogies, and the key survey outcomes for teaching for creativity (teaching creatively has also been included in the table to further highlight the connections made in the previous paragraph). If connecting lines were to be drawn across the table to demonstrate links between the survey outcomes and previously analysed pedagogies, the table would be a mesh of lines where language and implied action resonates from theory across into survey outcomes regarding teaching for creativity.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

LDS features	WHC pedagogies	PT pedagogies	Survey outcomes re teaching creatively and teaching for creativity
<ul style="list-style-type: none"> - Partiality - Emancipation - Participation - Debate and difference - Openness to action - Working 'bottom up' - Different modes of idea exchange - Simply expressed as: - Re-positioning - Listening-actioning 	<ul style="list-style-type: none"> - Understanding that practice is a joint journey of discovery - Creating new emergent possibilities through giving and sharing knowledge - All partners co-constructing practice/content - Where appropriate, partners complementing each others teaching - Exploiting their shared repertoire of practice to go in new directions; - Openly collaboratively learning from each other; sharing responsibility - Balancing freedom and control; - Balancing who owns the creative source - Balancing proximity and intervention between adult and student; - Balancing tight and open task structures (e.g. Apprenticeship and purposeful play). 	<ul style="list-style-type: none"> - High value on enabling children's agency - Offering children both space and time to develop their ideas - Standing back from the children in an acutely sensitive way - Close scrutiny of the children's engagement so as to choose wisely when to step in to provoke, clarify, support, extend and challenge - Provoking possibilities, - Being in the moment - Making interventions - Mentoring in partnership 	<ul style="list-style-type: none"> - Teaching creatively - Inquiry based learning - Learning which is connected to the real world - Individual, collaborative and communal learning - Cross-curricular learning - Using the arts to shed new light - Trying new approaches from experience, pupil feedback and theory - Enjoying the process - Teaching for creativity - Working in small groups/working collaboratively/discussion - Problem-based learning - Integrating science with other curricular areas - Physical exploration of materials - Teaching science from or through stories - Taking pupils on field trips - Encouraging children to try out (and critique) their own ideas in investigations - Relating science to everyday life - Encouraging different ways of recording and expressing ideas - Encouraging problem finding - Rewarding/praising creative behaviours; ensuring that assessment procedures reflect and reward creativity, enterprise and innovation - Using failure or setbacks as opportunities to learn - Facilitating open discussion of the problems pupils are facing - Offering no prior correct solution or answer - Developing pupils' new, uncommon, or unique ideas

(Table 3) Pedagogical comparison between Part 2 literature review and survey outcomes



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Alongside the connections that are apparent in the above table, one main difference is worthy of note. Where WHC and PT, perhaps because of their strong connection to Living Dialogic Space place a very strong emphasis on pupil ownership and agency, and the teacher working more 'alongside' the students, this is perhaps not so strongly foregrounded in the pedagogies that have emerged from the survey. This perhaps highlights a key place where the CREAT-IT framework might start to shift practice and perceptions regarding creative science teaching into new territory.

2.3 Summary of Part 2

Part 2 has therefore offered a literature review of the key relevant Exeter theories for application within CREAT-IT. It has also drawn out the key findings from the survey which resonate with those theories. Part 3 of this deliverable will now integrate all of these ideas into the main CREAT-IT framework and pedagogical principles for application to the three case studies.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

3. The essential features of the CREAT-IT Pedagogical Framework and their application

3.1 Integrating the above to offer a description of the essential features of CREAT-IT Pedagogical Framework Principles

This section describes the first draft of the CREAT-IT Pedagogical Framework based upon the above understanding of ideas, theory and concepts.

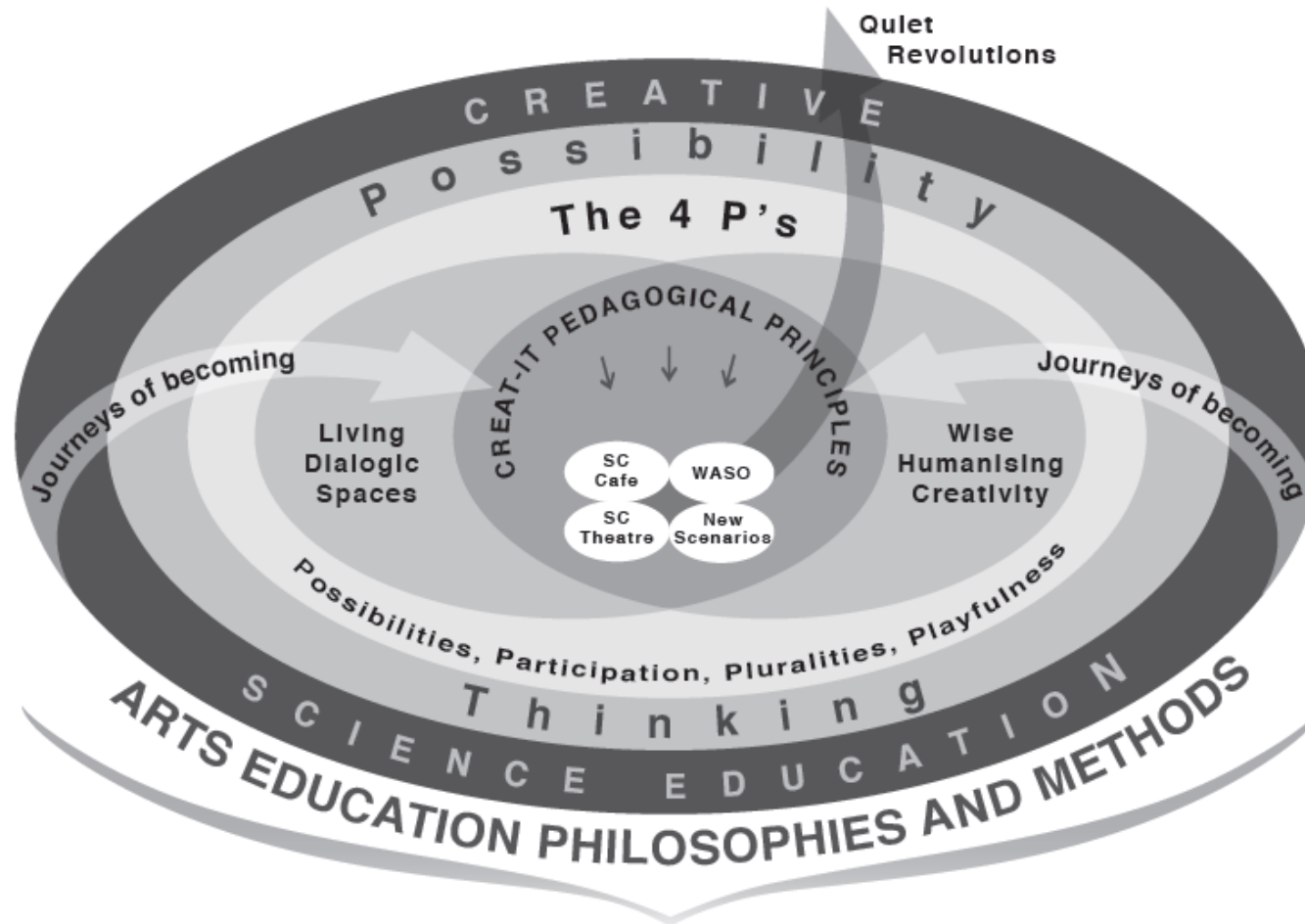
In order to propose a methodology for designing, expressing and representing individual, collaborative and communal educational practices built upon the strengths of creativity in science education in primary and secondary school environments synthesised with the other ideas and theories detailed above, the Exeter team have worked through a number of stages. They have

1. Integrated their theoretical framework with notions of creative science teaching and arts education teaching into a brief narrative and visualization to demonstrate how these come together (3.1.1).
2. Generated a set of key principles (3.1.2) from this to inform the development of the interaction between Exeter theory and CREAT-IT case studies (3.2)

From here, the Exeter team have worked with the appropriate consortium partners to analyse the three case studies in relation to the theoretical narrative and principles in order to generate collaboratively develop the case study analysis (across 3.2.1 – 3.2.3).

In doing this, the consortium aims to promote a school science teaching pedagogy that will utilize creativity and empowers students to actively engage themselves in the learning process and improve their conceptual understanding in various scientific topics (physics, biology, maths). It is therefore intended that the educational practices and strategies presented will allow science educators and specifically late primary and early secondary school teachers to identify creative activities for teaching science. Furthermore, the proposed pedagogy will aim to enable teachers to either create new creative activities or to properly assemble parts of different educational activities that are identified as creative (science cafes, science theatres, science operas) into interdisciplinary learning scenarios.

3.1.1 Narrative and visualisation of ideas and practices synthesised within the CREAT-IT pedagogical framework



(Figure 12) Integrated CREAT-IT theories and practices



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

At the very centre of the CREAT-IT figure are the **case study scenarios** and the accompanying **pedagogic principles**. Our ultimate aim as a consortium is to be able to describe and inform these case studies via the above theories in order to generate creative practice and creativity in science classrooms across Europe. The above figure therefore represents our understanding of how the theories and ideas can be synthesised together conceptually, uniquely for CREAT-IT in order to achieve this.

The figure positions **creative science education** as the main context within which CREAT-IT is working. At the bottom of the page **arts education philosophy and methods** is positioned as a 'holder' (or perhaps a petri dish!) within which creative science education (as opposed to all science education) is being nurtured, grown or 'encultured' via arts practice. As we move in towards the centre of the figure we can see that one of the main drivers for CREAT-IT creativity is **possibility thinking** for all involved. This means being able to ask 'what if' and 'as if' questions:

- what if I/we choose to explore this scientific question rather than that one...?;
- what if I/we use this arts approach to help me explore my question...?
- how can I/we imagine this as if I were...?;
- what happens if I as the teacher collaborate with that artist as if I...?.

This will be strongly encouraged in the way the CREAT-IT pedagogic principles are ultimately employed in order to help learners and adult professionals imagine new ideas in science education; to shift from 'what is' to new possibilities of 'what might be'.

As we move in another layer towards the centre of the figure, we can see four key defining features of CREAT-IT classroom environments. These are the **4Ps** of engagement in creative science education:

- *pluralities*: opportunities for learners and adult professionals to experiment with many different places, activities, personal identities, and people
- *possibilities*: opportunities for possibility thinking, transitioning from what is to what might be, in open possibility spaces
- *participation*: opportunities for learners and adult professionals to take action, make themselves visible on their own terms, and act as agents of change
- *playfulness*: opportunities for learners and adult professionals to learn, create and self-create in emotionally rich, learning environments.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

We then come closer to the heart of the CREAT-IT figure and find **WHC (wise humanising creativity)** and **LDS (living dialogic space)**. The WHC that is being sought in CREAT-IT is not only an individual activity, but also happens in collaboration with fellow learners, teachers and other adult professionals. These individual and collaborative creative activities form part of a wider web of ethically-guided communal interaction geared towards both helping children and young people become more creative scientists and assisting teachers in becoming more creative in how they teach science. For this reason WHC is positioned very close to the heart of the CREAT-IT figure as it is one of the core aims of the CREAT-IT pedagogic principles. Alongside and integrated with WHC, is LDS, always a partner to WHC in terms of conceptualising ideas and developing practice. Again LDS is at the heart of the CREAT-IT figure because its methods (participation, emancipation, working bottom up, debate and difference, openness to action, partiality, and acknowledging embodied and verbal modes of knowing) are fundamental to allowing WHC to happen.

As detailed above all of these layers of conceptual ideas have been synthesised together not only to develop this CREAT-IT figure and accompanying narrative but also to generate CREAT-IT's own set of unique working **pedagogical principles** (see 3.1.2). Hence the connector in the image between WHC and LDS, and the CREAT-IT case studies is these principles. The principles represent the unique way that the Exeter team's ideas come together in order to underpin the **case studies' pedagogies**.

So, via these processes we aim to contribute to developing creative young scientists and creative science teaching pedagogies. Embedded within this, similarly to the *C²Learn Project* and *Devon Carousel Project* described above is the vitally important notion that learners and adult professionals are creating wisely and humanely, and that cyclical developments occur between their creativity and their identity. As they generate new ideas; this in turn generates change in them as 'makers'; they are also developing or 'becoming' themselves. Slowly, small changes accumulate to contribute to **'journeys of becoming'** (shown developing across the layers in the figure). These individual journeys accumulate together, embedded within an ethical awareness of the impact of creative actions on the group. Through this process small-scale creative changes or **'quiet revolutions'** can take place for the group as a whole (shown as emerging from the heart of the CREAT-IT activity).

3.1.2 The 12 Key CREAT-IT Pedagogical Framework Principles

So, the connector in the above figure between WHC and LDS, and the CREAT-IT case studies and pedagogies is the CREAT-IT principles. The principles represent the unique way that the Exeter team's ideas come together in order to underpin the case studies and



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

generate actual CREAT-IT pedagogies. These principles are described as simply as possible below, bearing in mind that the reader has engaged with Part 1 of the literature review and the key theory in section 2.1 above, as well as the survey outcomes in 2.2.

The 12 Key CREAT-IT principles are (in no particular order, although the consortium may wish to prioritise them as the project develops):

1. **Professional wisdom:** it is vital that CREAT-IT has at its heart the wealth of teaching and discipline knowledge and expertise that practitioners bring to the project. This is a deeply contextualized knowledge often informed by intuition, which needs to be in constant conversation with CREAT-IT ideas and theories. This principle connects to the survey finding that a creative science teacher is constantly developing and pupil focused: it can be argued that this interrelated development and pupil focus are based in a process informed by professional wisdom.
2. **Individual, collaborative and communal activities for change:** practice within CREAT-IT can allow for all three ways of engaging in activities, and particularly in relation to communal engagement can take advantage of the shared identities within which participants will work, allowing for difference but with a shared creative process and purpose. The survey showed collaboration to be a key characteristic of creative science teaching as well as individual, collaborative and communal learning as a key strategy, thus reinforcing this principle.
3. **Risk, immersion and play:** allowing for these three processes to filter across CREAT-IT learning and recognize how pedagogy can assist in creating literal space as well as 'thinking' space for these to occur. This principle is also reinforced by the survey findings, which show risk as being perceived as important to the creative teaching process, and by inference the resulting learning.
4. **Different ways of knowing:** CREAT-IT can recognize at least three different ways of knowing as valuable – knowing that (propositional knowledge), knowing how (practical knowledge), knowing this (aesthetic or felt knowledge), as well as acknowledging the embodied alongside the verbal, in order to enable both the sciences and the arts to flourish within the project. Connected to this, the survey outcomes showed that a creative science teacher is perceived as someone who seeks experiences including the arts, which emphasizes the importance of this principle not only between arts and science professionals but also within the science teacher.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

5. **Dialogue:** practice can allow for dialogues between people, disciplines, creativity and identity, and ideas. This dialogue needs to acknowledge embodiment (i.e. dialogue is not simply a verbal activity) and difference and allow for conflict and irreconcilable difference. Facilitating open discussion of the problems pupils are facing was a key pedagogy, which emerged from the survey, which resonates with the role of dialogue between people within this principle.
6. **Relationship between 'bottom up' and 'top down':** understanding that it is important for ideas, knowledge and practices that emerge from 'bottom up' adult-learner activity to 'have a conversation' with existing ideas, knowledge and practices that are brought into adult-learner activity. And to know that at times 'bottom up' may be stronger, and at times 'top down' might be stronger but not to let one take over inappropriately.
7. **Interrelationship of different ways of thinking around a shared 'thread' or 'throughline':** CREAT-IT can allow space for multiple different ways of thinking (e.g. problem-finding, problem-solving, exploring, rationalizing, reasoning, reflecting, questioning, experimenting) focused around shared arts/science threads or throughlines.
8. **Discipline knowledge:** understanding the importance of allowing space for the rigorous discipline knowledge of both the sciences and the arts is vital, as well as understanding how creativity might interact with these disciplinary knowledge bases differently, albeit in the context of science education.
9. **Possibilities:** – CREAT-IT practice can allow for multiple possibilities both in terms of thinking and spaces, and know when it is appropriate to narrow or broaden these
10. **Ethics and trusteeship:** CREAT-IT adult professionals and learners consider the ethics of their creative science processes and products and be guided in their decision-making by what matters to them as a community, acting as 'trustees' of that decision-making and its outcomes.
11. **Importance of materials:** acknowledging the importance of the material within which ideas are shaped is extremely important. This is because the materials adult professionals and learners are working with (e.g. their bodies, with props, with paper and pencil, with sculpting materials, with Bunsen burners and test tubes, with chemicals, with equations) contribute to defining the way ideas are thought through,



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

as well as the form and content of ideas being highly intertwined. Exploration of materials was a key pedagogy emergent in the survey, which resonates with this principle.

12. **Empowerment and agency:** through empowering pedagogies, CREAT-IT can allow both learners and adult professionals to gain a greater sense of their own agency and ability to express themselves, and to then know what to do with that in order to be more creative scientists and to develop more creative science teaching techniques. Enabling pupil agency and encouraging children to try out (and critique) their own ideas in investigations were also key factors to emerge from the survey, thus emphasizing the importance of this principle.

3.2 The Case Study scenarios in relation to the CREAT-IT narrative, visualisation and principles

Following on from the narrative and visualisation of ideas and practices synthesised within the CREAT-IT framework and the 12 Key CREAT-IT Pedagogical Framework Principles (3.1.2), this section now articulates the three main case study scenarios in relation to these. The case studies are considered in turn and include introductory details of the practice of that case study followed by the analysis.

3.2.1 Case Study 1: Write a Science Opera (WASO)

Write a Science Opera (WASO) is a creative professional development approach to inquiry-based art and science education in which pupils of different ages (usually spanning ages 10 to 17), supported by teachers, opera artists and scientists create an educational performance.

WASO is first and foremost focused on science discovery in a creative framework. In addition, science communication is also a major factor by allowing a scientific theme to inspire a multi-disciplinary artistic project. In a WASO project, a scientific theme which is the learning focus in that particular setting is chosen to inspire a creative process in a school, culminating in an operatic performance by the pupils. Teachers from within a variety



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

of disciplines including both science and the arts guide the complete process. Characters, libretto, composition, stage design, costume, and well as Public Relations and budget are designed by the pupils and realized during the project.

WASO is an application of the widespread Write an Opera method, developed at the Metropolitan Opera in New York and then imported and developed by the Royal Opera House in England (Griffiths, 2012), which has been successfully implemented in many countries during the past three decades i.e. since the 1980s. WASO was developed at Stord/Haugesund University College (Norway), based on dialogues with the European Network for Opera and Dance Education (RESEO), as well as the Royal Opera House (London)'s Education department. The WASO approach integrates science education into the original method by involving scientists, science higher education students, science teachers, science museums or local industry, thus leading an inquiry-based creative process demonstrating common impulses shared by the sciences and the arts (Garoiian & Mathews, 1996).

In the example, which follows, from a Norwegian High School's WASO project, design, music and libretto symbolize, reflect and embody the scientific learning material, namely, the Northern Lights. Specifically, the design included lighting inspired by the specific colours of the northern lights, as well as a visual arts (textile) exhibition, which reflected the Northern Lights' colours. The music reflected the scientific discovery process by, for example, creating mysterious moods during the "finding out" period of the main Norwegian scientists within the field, all of whom were characters in the opera, and the robust, positive atmosphere following the discoveries of scientific knowledge, and an infusion of the Northern Lights representing of the feeling of hope in both music libretto (in the opera's finale, the libretto included calling upon the audience to allow the Northern Lights, as a symbol of hope, enter one's life, allow themselves to put their trust in the Northern Lights....the Aurora Borealis became a symbol of hope.

Example in focus: During the WASO project at Stavanger Cathedral School, Norway, in August, 2013, the science learning focus chosen by the high school's science teacher was the Northern Lights (Aurora Borealis) and the central Norwegian researchers who made discoveries in this field. This material informed the design of the performance's libretto, choice of characters (3 scientists and their dialogues formed the storyline), the choice of the main character's name (a high-school girl by the name of Aurora), and a visual arts exhibition created in the foyer at the concert hall, with the Northern Lights' colours and shapes, etc. and so the common impulses can be seen in that scientific phenomena, ideas, knowledge can create corresponding forms, pattern, figures and ideas in the field of arts, where the



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

scientific discovery and inquiry can be communicated, interpreted in a new way but one that still corresponds to the science. How that will be done depends upon the specific artist and his discipline....or the pupils and their WASO project specifics.

Policy documents (e.g. Rocard, 2007) draw a picture in which traditional methods of teaching science need to be re-examined, developed and infused with a more inquiry-based approach. Further international policies call for strengthening of creative thinking and activity in schools (e.g. The European Ambassadors' Manifesto of the European Year on Innovation and Creativity, 2009) and underline the need to integrate science education, creativity, culture and the arts. These include a wide range of key life skills for the global economy and modern science-active citizens. In most recent EU recommendations and decisions about the future of the educational system, and specifically about science education, a common element is that efforts should be dedicated to motivating the school community (teachers and students) to employ creative practices. The proposed approach is therefore in line with following priorities of the European Commission:

- According to the recent Decision of the European Parliament (No 1350/2008/EC), education and training systems should cater to development of key competences to support creativity and innovation, with a view to finding innovative and original solutions in personal, occupational and social life as well as to stimulate aesthetic sensitivity, emotional development, creative thinking and intuition in all children, including those in pre-school care.
- The EU faces science education challenges, specifically a low amount of students pursuing scientific career and fully embracing their innovation potential in these crucial fields. Teacher skills are a focal point of potential improvement requiring support (Rocard, 2007). Inquiry-based, multi-disciplinary teaching environments have a capacity to motivate and deepen science educational knowledge in science (e.g. Creative Partnerships in the UK¹⁰).

Analysed in relation to the CREAT-IT pedagogical principles, the WASO approach can be seen to open doors to *Different Ways of Knowing (4)*, *Interrelationship of Different Ways of Thinking around a Shared 'Thread' or 'Through line' (7)*, as well as arts and science *Discipline Knowledge (8)*. Through the integration of Science and Opera, WASO has the potential to encourage at least three different ways of knowing as valuable – knowing that (propositional knowledge), knowing how (practical knowledge) and knowing this (aesthetic or felt knowledge) (Reid, ref). And to a certain extent this means valuing the embodied alongside the verbal. The WASO approach can allow space for multiple different ways of thinking (e.g. problem-finding, problem-solving, exploring, rationalizing, reasoning, reflecting, questioning, experimenting), as well as rigorous discipline knowledge via shared

¹⁰ www.cceengland.org



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

arts/science questions. WASO also fundamentally engages young people and adults alike in *Individual, Collaborative and Communal activities (2) for change*, creating a shared group identity of the Opera 'company' during rehearsal and performance which provides a secure place for knowledge to develop via the shared creative process. The first WASO projects were realised in various schools with student's aged 11 to 16 in Norway (2012-2014). Projects have been inspired by local industry, biology, and the Northern Lights (the latter chosen specifically by the science teacher in the high school in which it was realised as a curriculum-based theme).

WASO presents the following qualities.

Fusing inquiry-based arts, science, and education in creative ways: WASO provides an innovative look at opportunities of transversal activity. Analysed in relation to the CREAT-IT Pedagogical Principles, the WASO approach can be seen to allow for multiple *Possibilities (9)* of thinking and spaces. These ways of working provide platforms for reaching beyond a narrow view of what may be "right" or "wrong" in favour of a more flexible and embodied process. Within this risk-taking (*Risk, Immersion and Play – 3*) is potentially more acceptable during the science learning process. Connecting science and art educational settings enables the integration of emotional and aesthetic elements of science (*Different Ways of Knowing – 4*) to be included in the learning paradigm. This provides a much-needed deeper emotional and cultural interaction with the curriculum and with others, which in many cases today is not the case. For example, as indicated above, during a WASO project held in Stavanger, Norway, in August 2013, high school pupils created an opera about the main Norwegian researchers involved in scientific discoveries concerning the Northern Lights. As mentioned above, the scientific discoveries, and indeed the scientists who discovered them, were part of the libretto and choice of characters in the opera. When rehearsed and performed, these characters became part of the social life of the class, and emotional links were created between pupils and the characters they performed on stage. There was emotional ownership towards activities performed and taken risks with. With the emotional investment involved in the characters, the science too may be imbued with an emotional dimension, deepening the cultural connection pupils may feel. The CREAT-IT project will afford opportunities to explore this potential emotional enrichment of the science.

Again, drawing back to the theories underlying the CREAT-IT Pedagogical Principles this reflects the idea within the WHC conceptualization that creativity is an active process of individual, collaborative and communal change guided by compassion and reference to shared cultural values (Chappell, 2008). Change comes from people engaging in collaborative thinking and shared action, which can be emotionally challenging, and from imaginatively developing new ideas, which are ethically valuable to them and their community. In developing or making any new idea, creators are intrinsically developing themselves and their collaborators as part of that process, in a dialogue between creativity and embodied identity (*Dialogue – 5*); and this needs to be acknowledged in both science



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

and arts education contexts. This resonates directly with the notion at the heart of WHC that creators are making and being made through the dialogic inter-relation of new ideas and identity. An important question though is how easy is this kind of dialogue within science education? WASO, as an example of a transversal approach, has the capacity to enable this type of development and helps to start to respond to this question. Involving exploration through the arts allows room for reaching into a different kind of idea-creation during the process, and “taking on” that pattern to inspire the scientific inquiry process.

Providing potential and a framework for original, creative ways of questioning and knowledge construction in the science education context: the WASO method encourages knowledge construction in both science and the arts, at the crossroads where they meet. In this way, the multidisciplinary team aims at encouraging what the Exeter team theoretically refer to as Possibility Thinking (PT) (Craft, 2013) amongst student teachers as well as pupils and their in-service teachers, inviting them to consider moving from what is to what might be and learning to think that way.

WASO relies on and facilitates a democratic process in that all participants recognise their own inputs in the final, collaborative whole, engendering respect for other participants' creative ideas, indeed, a wise, humanising approach to learning from others' creative ideas (*Ethics and Trusteeship – 10*). Through empowering pedagogies, the WASO approach can allow both learners and adult professionals to gain a greater sense of their own agency and ability to express themselves, as scientists who are open to the potentials of approaching the exploration and communication of science knowledge with the tools and knowledge exploration and communication approaches of other disciplines such as the arts and to develop more creative science teaching techniques (*Empowerment and Agency – 12*). WASO necessarily requires collective idea generation (*Individual, Collaborative and Communal activities for change – 2*) and a solution finding process, which is dialogic in nature (*Dialogue – 5*). However this is not to say that the dialogue at the heart of this democratic process is always reconciliatory. At times dialogues between people's ideas may progress through conflict and irreconcilable difference. With its opera-based artistic way of representing ideas, WASO provides a sympathetic product format that can acknowledge an array of perspectives, which is central to scientific exploration, and which can support the learner's capacity to explore scientific phenomena in various ways, making this possibility explicit and tangible.

WASO provides the opportunity of combining several schools, indeed schools from various countries, in the creation of science-inspired performances by the employment of ICT tools (e.g. simultaneous performance via communication tools such as *Skype* or *Linkcast*) or simpler approaches such as collaborative idea generation by e-mail during the early phase of a project. For example, in a recent 6th-grade collaboration in March 2013, between students in Greece and Norway, pupils from one school provided ideas for another school's opera. In this case the ideas provided were entirely musical but in iterations of WASO



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

developed for CREAT-IT, there is no reason why collaboration would not happen on the science exploration and communication too.

The opera was then developed and staged at Stord, Norway, but the Norwegian class invited Greek pupils to play small sections of the music during the actual performance, broadcast through Internet connection and creating a multi-modal real-time improvisation alongside the planned work.

Again, referring to the CREAT-IT pedagogical principles, this type of learning occurs on individual, collaborative and communal levels, and has the capacity to enable a creative process in which pupils and teachers may engage in *Risk, Immersion and Play (3)*, *Dialogue (5)*, *Possibilities (9)* and *Empowerment and Agency (12)*. Amongst other elements of the Exeter team's theory, these particular principles relate closely to the 4Ps (Craft, 2011): Playfulness (e.g. simultaneous improvisation), Participation (e.g. inclusion of pupils in the music making of those in other countries (e.g. Haugland, 2014), Pluralities (through recognition of, and literally working with, other cultures), and Possibilities. Through these pupils and their teachers may engage in imagining new ways of interpreting the specific curriculum themes at hand.

Though it must be true that there are as many ways to realize a WASO projects, as there are combinations of teachers, schools, pupils, science museums, and artists, the main elements of a project's realization are the following, both of which have a science education theme in focus:

1. Allowing a theme from the existing science curriculum to be in focus.
2. Allowing an external science authority (science museum or university department) to drive the science specific aspects of WASO project's realization.

The question of how the scientific theme is chosen and who by, is up to the local level of school, pupils, teachers and head-teacher to decide according to available preferences and opportunities.

This relates to the CREAT-IT pedagogical principle of the *Relationship between 'bottom up' and 'top down' (6)*. This means that it is important for students' ideas, and questions about science that emerge from 'bottom up' adult-learner activity to 'have a conversation' with existing science ideas, knowledge and practices that are brought in by teachers or indeed by the curriculum itself. WASO seems to have the capacity to allow that at times 'bottom up' may be stronger in an environment where often 'top down' can dominate unnecessarily. Also important is the role of the science teacher in the school. The science teacher may lead the choice of the opera's focus or leave it to other specialists such as a local science museum or the children themselves, providing them with a greater sense of *Empowerment and Agency (12)* over the outcome. This choice, necessarily relying on the teacher's intuition and the



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

wealth of expertise and discipline knowledge which he/she represents, ensures that the opera is well-fitted for each distinct educational setting as well as able to take advantage of the deeply contextualized knowledge which teachers bring with them to the project. This reflects the CREAT-IT Pedagogical Principle of *Professional Wisdom (1)*.

A typical project may take between 10 days and a year. During the shorter version a very intensive process is undergone typically with one class of up to 25 pupils. During this time little else is done besides the science opera project. Taken to the other extreme, a project spanning over the space of a whole school year may be realised through working during a two or three hour period each week with a final performance at the end of the school year. Any combination of these may be successfully realised. In our experience, the first and foremost important success factor is to cater to the needs of the specific school teacher and class (*Empowerment and Agency – 12*) with regards to time schedule, way of working, interaction with the pupils and space for realisation of the project. Including as many stakeholders within the school as possible in the planning process as possible as early does this as possible (*Individual, Collaborative and Communal Activities for Change – 2*). Another area to consider is who the teachers of the opera project will be. A high budget can make it possible to hire for example equal numbers of professional artists and science specialists during the project thus in relation to the CREAT-IT principles, honouring strong *Discipline Knowledge (8)* in both disciplines. These will typically be a drama and libretto specialist, a scenography specialist and a composer from the arts side and a scientist/science teacher/science education specialist from the science side.

In addition, a project leader is needed; this might be the teacher, or potentially another specialist from within the project team. Another approach is engaging student teachers that will see the project as part of their practice phase of education to become a teacher. Any combination of these is possible as long as it is well planned and co-ordinated with the school.

Each science opera project is unique and a source of extremely valuable documentation. Videos, transcriptions of libretto at early middle and final phases, recordings of improvisations and the subsequent discussions of analysing these in choosing sound samples for the opera's composition, sketches of costumes, etc. a real be kept as ideas for future projects and empirical data for future research.

Once the process of discovering science and creating an artwork inspired by that discovery begins so as to communicate the discovery process, many questions will arise on a daily basis. It is crucial to convey at this point that the specific product which is chosen is one of many possibilities which were originally available. It is also important to convey to teachers, student teachers and pupils that certain levels of uncertainty are to be expected as an integral part of the process. This may be done by means of a simple discussion including the



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

concept of improvisation and risk-taking during the learning process if the practitioner feels the need to do so. However achieved, much of the project's success will depend

On pupils and teachers feeling free to immerse themselves in the project's playful dialogue without fearing risk-taking with regard to idea generation and trying out those ideas. This way of working relates closely to the CREAT-IT Pedagogic Principles of *Risk, Immersion and Play (3)*, *Possibilities (9)*, *Dialogue (5)* and *Different Ways of Thinking around a shared thread (7)*.

WASO is conceptualized as an *example* of how science education (which currently is often not perceived to be an area of *creative* or *emotion-related* learning) may be inspired by and may inspire in turn, arts learning processes which are intuitively understood as having to do with, and relying on, creativity for their success (Gershon & Ben-Horin, 2014).

The integration of science with opera thus opens up exploratory and communication pathways for learners as regards the science content, and integrates emotional dimensions to science learning through a depth of understanding of a particular cultural phenomenon. This re-highlights a number of the key CREAT-IT Pedagogic Principles that of: *the Interrelationship of Different Ways of Thinking around a Shared Creative 'Thread' (7)*; the importance of *Discipline Knowledge (8)*; and of *Different Ways of Knowing (4)*. By providing learners with creative experiences within science education and allowing for an imagination-based interaction with the science curriculum, they will have the opportunity to continue questioning and the seeing possibilities available in this way (*Possibilities – 9*), indeed, continuing a multi-layered interaction with science, within the curriculum and beyond it.

WASO strives for creativity in science education which explores not only the theoretical aspects of the science learning material, but a more holistic conceptualization of what science learning can be. . A science-active pupil is one whose interest in science is actively awakened and who intuitively knows because of the sensitivity with which this is done, that the science curriculum is reachable through her own creative cultural context, be that hip-hop music, ceramics, haiku poetry or WASO. This resonates with the CREAT-IT Pedagogical Principle of the *Importance of Materials (11)* i.e. acknowledging the importance of whatever the ideas are shaped within; whether that 'material' is sounds, the body, poetic words, or clay – and allowing those materials to contribute to the development of understanding of the science knowledge in hand. Whatever the specific pupils' cultural preference, it will be the gateway to her emotional life, thereby unlocking creative output, which does not need explaining on the part of the teacher. On these grounds it is therefore also more like to hold weight for the pupil in terms of the CREAT-IT principles of *Ethics and Trusteeship (10)* and *Empowerment and Agency (10)* as the students' own creative culture is one in which they will be concerned to do well and via which they may wish to make a difference. WASO



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

exemplifies a model in which emotional connection with the science curriculum is reached through the pupils' emotions, culture, creativity, and theoretical capacities.

The following example shows how WASO can be realised in the classroom around a particular topic, namely that of light and the related physics. It can be used as an inspiration for a school project, but is also meant as encouragement for teachers and pupils to create their own WASOs, thus enriching the existing body of work.

Opera: "The Rainbow" **Subject matter:** light, prism and rainbows

Aimed at: secondary pupils aged 13-15

People involved: There should be one class of pupils, the science teacher, a science museum/university professional, a composer, scenographer and drama specialist who will create the libretto with them, in a best case scenario (yet in the UK, for example, teachers who have taken the Royal Opera House's "Write an Opera" course often realize projects with less staff available).

Opera characters: The sun; Isaac Newton; One sunray of light; water; the rainbow (group of characters representing various colours). A matter of importance will be to find ways in which the artistic process and its patterns may represent and inform what is being learned in the scientific domain.

Outline of process: In this example, we visit an imaginary classroom, which is currently studying the physics of light, prisms, and the rainbow. They have been learning about the importance of Sir Issac Newton, as well as some basic facts about his life. Focusing on the scientist in this way is intended to create a more direct connection for students as to why he is relevant for our life today, and help reduce a stereotype of what a scientist is all about, to something more tangible, accessible, relevant, reachable. In this sense it is intended that students knowledge of what it is to be a scientists is deepened. Similarly it is hoped that this knowledge of the scientist helps intensify students' knowledge of the science itself, by learning in different ways – through opera - and allowing pupils' cultural preferences and choices to be a bridge to understanding.

At the end of the project, pupils present their own versions of how the scientific and artistic educational realms can meet, support and inspire each other. Pupils and their teacher have experienced the results of their creative risk-taking, which happened as a result of their daring to imagine various scientific phenomena in a different domain, with different rules of handwork and evaluation. It is hoped that a much deeper understanding has been realized, as pupils have had to go through and realize a process in which learning has taken place in a more multi-leveled reality. Scientific ideas have inspired songs. Poems have taken pupils' imaginations by the hand and challenged them to specify their knowledge about the science at hand. And on a more profound level, they must choose the aesthetic style with which they



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

would like to interpret this knowledge. Thus the interpretation of science knowledge within an arts project, offers a merged, multi-dimensional understanding of both science and the arts.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

3.2.2 Case Study 2: Science and Theatre (S&T)

The Science & Theatre (S & T) methodology was developed by FormaScienza as a project of the Italian Ministry of Education, University and Research "Donne e Scienza, il valore della diversità di genere nella scienza" ("Women and Science, the value of gender diversity in science"). The S&T training (Entitled: "Sulle tracce delle scienziate" - "On the trail of the scientists") for students and teachers was based on an inquiry and interdisciplinary approach, which was implemented in 10 classes in different Italian social and geographic contexts in 2012-2013.

Analysed overall in relation to the CREAT-IT pedagogical principles, the S & T methodology can immediately be seen to reflect: *Professional Wisdom (1)*, *Individual, Collaborative and Communal activities for Change (2)*, *Risk, Immersion and Play (3)*, *Discipline Knowledge (8)* and the *Interrelationship of Different Way of Thinking around a Shared Thread (7)*.

With an S & T project always having two experienced facilitators, a scientist and a drama teacher working in collaboration, the approach has at its heart the wealth of teaching and discipline knowledge and expertise that those experienced practitioners bring to the project (*Professional Wisdom – 1*). Allowing space in the process for the rigour of their *Discipline Knowledge (8)* is vital to S & T; this is also a key CREAT-IT Pedagogical Principle. The relevance of the *Individual, Collaborative and Communal (2)* (ICC) layers of the CREAT-IT principles also resonates strongly within S & T projects as the notion of ICC is derived from understanding creativity in performing arts contexts (Chappell et al, 2011) where a 'group' or 'company' forms for a short time and provides a safe almost family-like space in which participants can create and learn. Again with drama at its heart, this is key to the S & T approach. There also seems to be great potential for *Risk, Immersion and Play (3)* within S & T projects because of the focus on the more playful, and at times risky, aspects of the drama process, as well as the fact that the pupils' own hypotheses are being investigated. The combination of a science question, inspired by student and teacher curiosity, and this kind of drama process then seems to allow for the *Interrelationship of Different Ways of Thinking around a Shared 'Thread' or 'Throughline' (7)*. These can include ways of thinking (problem-finding, problem-solving, exploring, rationalizing, reasoning, reflecting, questioning, experimenting) that perhaps manifest in different ways in sciences and arts processes, but combine together in an S & T interdisciplinary project in order to understand the scientific question or model in hand.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Key to the development of the S & T approach was first trying to understand and explain what the creative process is in science, whilst recognizing that this is quite a difficult matter. FormaScienza concluded that a scientist is creative when he/she *makes* science. They argue that the scientist has questions and is looking for answers. He/she needs to:

- A) invent a hypothesis
 - invent and build an experiment
 - interpret data

When this analysis of scientific creative process, put forward by FormaScienza is analysed in relation to the CREAT-IT Pedagogical Principles a number of the principles are pertinent. In particular for A (invent a hypothesis), *Possibilities (9)* relates to how scientists invent a hypothesis. Being able to do so in a way, which can allow for multiple relevant possibilities and know when it is appropriate to narrow or broaden these is vital to what the science specialist might do.

It also seems important for scientists to understand the *Importance of Materials (11)* within this approach as part of B (invent and build an experiment). Across the approach, it is argued that scientific thinking is not a technical tool, it is an achievement of 'Human Thinking'. This highlights an important connection between the approach and the CREAT-IT Pedagogical Principle of *Ethics and Trusteeship (10)*. For 'human thinking' is not isolated, but connected to what is important about being human acknowledging the importance of compassion and reference to shared cultural values derived from the background Exeter team notion of Wise Humanising Creativity (Chappell et al, 2011).

In C (interpret data), the interpretation process is then strongly fuelled by *Dialogue (5)* via a communal debate of the data. In practice, scientists work in groups in this way to communally interpret data and invent theoretical tools to find agreement and solve conflicts. The scientist does not work alone; she/he works in a community. The interpretation of data and validation/falsification of scientific theories are elaborated together, and this process often involves changes of point of view and surprises. It is important that the scientific process allows space for these kinds of real conflicts to occur; hence the strong resonance with the 5th CREAT-IT Pedagogical Principle.

How does the S & T practice work?



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

In didactics (in Italy), students usually learn the contents of science that someone else (a “scientist”) has produced, so they have much less opportunity to be creative. Thus, in Italy, it can be the case that you can have a degree in Physics or Mathematics or Biology yet you have never “made” science. This is the situation for most Italian teachers. In the S & T approach it is fundamental that students *make* scientific research. The teachers have to lead (or, better, to support) the research in their classes and so they need to know how it works, so, teachers have to go through training in order to be able to do research too. To become creative in science, the S & T approach holds that it is necessary to stimulate scientific creative thinking in the students and teachers. To help to clarify how this can happen in practice, the basic elements of S&T training, which are quite similar for students and teachers, are explained next.

Firstly, an Inquiry-based training is used. As detailed above this relates to the CREAT-IT Pedagogic Principles of: *Professional Wisdom – 1; Individual, Collaborative and Communal activities for change – 2; Risk, Immersion and Play – 3; Discipline Knowledge (8)* and the *Interrelationship of Different Way of Thinking around a Shared Thread (7)*. As we now focus on explaining S & T deepens, the principles of *Different Ways of Knowing 4; Ethics and Trusteeship – 10; and Importance of Materials (11)* are also highlighted. And, because it is rooted in proposing a question, inquiry based training also provides a special type of ‘bottom up’ teaching that can work very well in science. This means that it is important for ideas, knowledge and practices that emerge from ‘bottom up’ adult-learner activity to be given space in an environment where often ‘top down’ can dominate unnecessarily (*Relationship between Bottom Up and Top Down – 6*). The S & T approach recognizes that framing a good question is a creative task in its own right for scientists/pupils and in different ways for teachers. A question is a good one scientifically when it generates an answer that we can check (true or false) via experiments. For the teacher especially, a question is a “good” question if it is a scientific question and also produces a conflict in the class. In some cases an experiment cannot be carried out, for example because of the limits of technology (for example Galileo’s thought experiment), but the experiment may be able to be carried out later when the appropriate technologies are available. In the S & T approach, at first the adult professional proposes the question but later the pupils themselves will choose it and this can be connected to ethics and trusteeship.

Following the delineation of the creative process in science as described above in the introduction what follows is a description of S & T practice in more detail:

a) The students/teachers/scientists have to make hypotheses where *Possibilities (9)* are important. These hypotheses are in conflict (if a good question has been framed!) as part of the on going *Dialogue (5)*. Pupils have to take risks (*Risk, Immersion and Play – 3*) and



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

speak in front of the classroom and say what they think. Here many possibilities (*Possibilities – 9*) are created and many ways of thinking (*Different Ways of Thinking – 7*) are confronted.

b) If we have a good scientific question the pupils/teachers/scientists then think of an experiment to solve the conflict between the possible answers/hypotheses (*Dialogue – 5*). Pupils/teachers/scientists have to design and build experiments. Here the importance of *Risk Immersion and Play (3)* is focused on as students have to put forward their experiment ideas, as well as the need for acknowledging the *Importance of Materials (11)* such as clay, strings, water, fire as these experiments are carried out. For example, combining science and drama: how a participant's body is used to investigate or build an experiment around a scientific point under question is vital (e.g. how can you explore your body joints to understand pendulums?).

c) The students/teachers/scientists have to interpret the data and to critique the hypotheses which will create an interrelationship of *Different Ways of Thinking around a Shared 'Thread' or 'Throughline' (7)*; using *Discipline Knowledge (8)* via the *Dialogue (5)*. But, the results of the experiments are not always clearly "evident", as scientists have to interpret data. There could be different interpretations and the scientific community have to find an accord. The process could last years. In the S & T approach, the pupils act like the scientific community, but suitable scientific problems are used where the process lasts only a few hours.

Within the dialogue, the conflict between hypotheses, as in the scientific community, makes points apparent: in defending their own hypotheses, students become very able to detect the mistakes in the experimental procedure that some classmates are using to confirm their own opposite hypothesis. The conflict motivates the students to find theoretical and practical tools, like statistical tools, to avoid the errors and to force the experiments to give the right answers, and eliminate the wrong ones. The hypothesis that the group confirms becomes a Thesis and becomes part of the knowledge of the group. In the three phases there will especially be *Individual, Collaborative and Communal activity for change (2)* and *Dialogue (5)*.

As the S & T approach shifts into its second part, there is a particular acknowledgement of how the scientific process is quite similar to the dramatic arc, or progress of a narrative through a climax within a drama. Both the drama and science process are moved by a *conflict*, which drives a narrative. There is a strong theoretical connection here to the 5th CREAT-IT Pedagogical Principle, *Dialogue*, as well as to some of the background Exeter



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

theory that posits the importance of narrative as a key driver or context for the process of Possibility Thinking per se (Cremin et al, 2012).

The second part of the S & T workshop encourages students to use the conflict in the science process as a starting point for an original drama plot. Students are asked to transpose the scientific conflict into a metaphor, taking advantage of the fact that metaphor plays a role within science too. This relates to the CREAT-IT Pedagogical Principle of the *Interrelationship of Different Ways of Thinking around a Shared 'Thread' or 'Throughline' (7)*. In science many different metaphors may be used to understand a fact or principle, to make a model of the phenomenon. The metaphor is useful to understand a phenomenon; moreover, there is a relation between metaphor and scientific models. In some cases a metaphor is also the first step for a scientific model. For example in astronomy, quite different models are used to understand what can be seen in the sky: Ptolemaic, Copernican, Keplerian or perturbation models. The elementary particles can be described both as particle and as waves: these are two different models/metaphors. Scientists can imagine different models at same time and work to understand who is right. Here metaphor as a kind of poetic thinking material, connects to the CREAT-IT pedagogical principle of the *Importance of materials (11)*.

The difference between the use of metaphor in the sciences and the arts is that in the sciences metaphors are used to make predictions e.g. can an astronomic model predict the position of a planet? In science these models are presented, argued for and defended and then super ceded by a new model; they have to be validated by the community. In the arts it works in a different way; it is not necessary to build an argument in the same way. This relates back to the CREAT-IT Pedagogical Principle of honouring *Different ways of knowing (4)* and *Discipline Knowledge (8)*. Participants build on the science metaphor by developing it and producing the drama metaphor, having to link that with the scientific model. By changing or improving the drama metaphor, there is an improvement in the understanding of the phenomena and models from a scientific point of view.

Stepping back to wider University of Exeter theory, the idea that every student can come up with their own metaphor, connects to the idea of 'little c creativity' (Craft, 2001), which underpins the notion of Possibility Thinking (CREAT-IT Pedagogical Principle 9 – *Possibilities*). The creativity is needed to invent the model; it is in the science itself. This relates to the CREAT-IT Pedagogical Principle of *Empowerment and Agency (12)*. Creativity is then used again to elaborate the metaphor through drama, so there is a balancing act and a flow from creativity in the first part of the process through to the second. With the development of the drama metaphor to aid in understanding the science there is then a sense of flow from the drama back to the science.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

This second part of the process is described in more detail below:

1) Students are trained in basic drama techniques and practices, and given some basic knowledge about how to communicate and present ideas using drama conventions, as well as some of the rules of a group building game.

2) Students are then encouraged to embody the experiment with the Mimic Method. All students work on the same problem. The scientific knowledge needed is given in the first part of the practice, described above. Students work both individually and in groups. For example the students are asked to find a pendulum in their body, then they work in pairs, and then the whole class works like a single pendulum and must find a rhythm. Or they experiment with physical laws (the movement of planets or theory of evolution model e.g. they all start with the same movement and then someone changes it, why, who? Following which law? Which rule?)

3) Students are then encouraged to search for the conflicts that have come out in the experiment phase of the scientific training and to analyse them. Are those problems the same ones scientists faced in history? Students can see the life of different scientists and for example create a script from the life of that scientist, or create a metaphor of the experiment. For example, if the problem of the experiment was the measurement of time, pupils can relate it to when they have had problems with time, or weight, or mass. They can create a true story or put it in to metaphor.

This detailing above of the two parts of the S & T approach – scientific hypothesis generating and defending and then transposing this into the drama process - demonstrates one final important CREAT-IT Pedagogical Principle that of *Different Ways of Knowing (4)*. Hopefully it is clear from the explanations above that S & T has the potential to facilitate 'knowing that' (propositional knowledge or facts – e.g. the elements in the periodic table), 'knowing how' (practical knowledge or how to – e.g. how to physically carry out an experiment using a Bunsen burner) and 'knowing this' (aesthetic or felt knowledge – e.g. how to create a strong drama piece that has involved aesthetically judging how to represent ideas in a powerful way) (Reid, 1981).

It is worthy of note that this pupil-centered approach and the ensuing image of science, which highlights both the potential differences between pupils/teachers/scientists and the role of cooperation, has been assumed as a model for approaching gender issues in science.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Finally, and most worthy of note, the core to the whole S and T process described above is that everything always starts from the question that has driven the work. In the plot there must be a starting point, a conflict and a solution. This brings us back to a, b, c as detailed at the beginning. The text box contains an example of this process working around a specific scientific question and principle.

Example: Principle of Archimedes

If there is a glass of water on a measuring scale and I put my finger in the water, does the measurement change?

-Discussion (before testing)

-Scientific experiment

The aim is to find out the principle of Archimedes.

Archimedes' principle states that a body immersed in a fluid is buoyed up by a force equal to the weight of the displaced fluid. The principle applies to both floating and submerged bodies and to all fluids, i.e., liquids and gases. It explains not only the buoyancy of ships and other vessels in water but also the rise of a balloon in the air and the apparent loss of weight of objects underwater. In determining whether a given body will float in a given fluid, both weight and volume must be considered; that is, the relative density, or weight per unit of volume, of the body compared to the fluid determines the buoyant force. If the body is less dense than the fluid, it will float or, in the case of a balloon, it will rise. If the body is denser than the fluid, it will sink.

1) Working with embodiment: students are encouraged to play with fluids, weight and size. They are asked to imagine they are in different fluids and gases, air, liquids, water... or on the moon. They are then asked to imagine how they can change their weight, so they "become" very light and then very heavy. At the end they are asked to change their sizes, from large to small and vice versa.

2) Working with Dramaturgy: students are asked to create a plot in which they use the knowledge of how the principle can save your life. E.g. You are in a ship and it starts sinking, what do you throw out?

The students/pupils work in groups. The scripts of the different groups are staged and shown to each other and then the strong and weak points are discussed. Risk and immersion are



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

key here. Through theatre there is an emphasis on and discussion of the creative steps in the scientific process and the links between art and science processes.

The role of humanity and human interaction in science is highlighted. The pupils/teachers elaborate an imaginary application of science which is more bottom up than top down.



3.2.3 Case Study 3: Junior Science Cafè/'Caffè Scienza Junior' (JSC/CSJ)

In its broadest sense, a Science Cafè is a meeting between scientists and an audience of non-experts, held in a non-academic place in an informal setting. Science Cafés are a model of scientific communication that satisfy a number of requirements delineated in recent years in relation to enhancing the motivation of students to study science and to stimulate their participation in scientific debate. It was noted that a crucial requirement for a good science education is that science is not presented as knowledge true once and for all, but as a set of alternatives that may be in conflict.

There are a variety of manifestations of Science Cafe's:

- A "Science Cafe" (CS) is a public event (two hours of debate among experts and public);
- A Junior Science Cafe is generally a Science Cafe where the public are pupils;
- The Caffè Scienza Junior (CSJ: Italian practice) is a training for students, over seven meetings, where the students organize a Science Cafe for the public.

In terms of Science Cafes per se, there are many different practices. When project Scicafe started, in 2011, many different practices named "Science Cafe" existed. To say who invented the Science Cafè format is very difficult. It seems that fist science cafes appeared in France and in the United Kingdom around the 1990's.

Overall, the Science Cafè format has spread across the globe in a grassroots way, adapting to different cultures and audiences. One of the goals of the Scicafe project was to create the network of science cafes in the world. This allowed a comparison of the practices.

Despite this diversity, three shared values are reflected in every Science Cafè:

- It occurs in a meeting place creating a welcoming and comfortable atmosphere,
- It is open to everyone and particularly people who do not usually engage in discussions about sciences,
- It is run on the principles of free speech, listening to and respecting other's opinion.

Everyone in the audience who has something to say can contribute to the debate.

Specifically, in Italian practice two experts from different disciplines meet the public in an informal place, like a pub or a cafè, and discuss a common theme from different points of view. Each expert has 15 minutes for introducing the theme from his/her own point of view and then there is a debate between the experts and the public. The event's duration is 2 hours (30 minutes of introduction by experts and 1.5 hours of debate). The public



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

participates with questions but also by bringing other points of view. Everyone can participate, and there is no entrance fee. The public is very heterogeneous. Its composition depends on the place where the event occurs. There can be other researchers (in the same or different disciplines), teachers, students, but also people employed in different areas, mainly (but not only) with degree. Many other Science Cafes in the world are assuming this practice after the Scicafe project.

Usually the expression "Junior Science Café" means a Science Café dedicated to students from 11 to 18, with the older end of the age group felt to benefit the most from the process; where the audience/public are students.

Working differently to JSC's, "the innovative aspect of the 'Caffè Scienza Junior' (CSJ) project is that students are not only involved as audience of the Science Café but are the organizers of the event. This creates a series of objectives that are utterly different from the usual approach to scientific knowledge. In fact, the focus is shifted to the knowledge of the environment of the scientific research rather than on specific scientific contents." (Belmonte & Castellani, 2012). CSJ's pay great attention to developing in students the ability to search and select scientific information, which is particularly necessary in a society in which mass-media plays a leading role in the construction of the image of science of the citizen. In addition to this, the importance of direct contact of students with the scientific community has been emphasized. This case study presents the Italian practice 'Caffè Scienza Junior' (CSJ) analysed in relation to the CREAT-IT Pedagogical Principles.

The CSJ project has been developing since 2008, led by a group of researchers from the Italian association FormaScienza, with the collaboration of numerous scientific institutions and individual scientists mainly in the city of Rome. In 2009 formaScienza entered the European network SciCafe, created to foster cooperation between the European Science Cafes. The network, partially funded by EU, involves 14 partners from 9 European countries and aims:

- to develop a European network of Science Cafes
- to identify best practices for the dissemination of Science Cafes (including 'junior' version) in new geographic areas
- to increase the participation of new social groups
- to stimulate new groups of organizers of Science Cafes in other cities
- to experience the opportunities offered by today's advanced technological applications that support virtual presence and socialization.

In the framework of the SciCafe project a dissemination of CSJ methodology was implemented. Over 4 years, 11 CSJs took place, involving more than 20 classes and 1



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

teacher focus group. It culminated in guidelines being written on “How to Organize a Junior Science Café”.

A CSJ usually has the duration of 3 months, with 7 to 10 planning and preparation meetings at school and then the Science Café event. The main objectives of CSJ are:

- To bring students into dialogue with the scientific research environment, helping them to understand where and how scientific knowledge is produced;
- To develop in students the ability to seek scientific information, with particular attention to fostering criticality;
- To contribute to an image of science as part of general culture, also presenting attitudes towards science as a useful skill in everyday life.

When analysed in relation to the CREAT-IT Pedagogical Principles, six of the principles immediately stand out: *Professional Wisdom (1)*; *Empowerment and Agency (11)*; *Relationship between Bottom Up and Top Down (6)*; *Risk, Immersion and Play (3)*; *Discipline Knowledge (8)* and *Ethics and Trusteeship (10)*.

Professional wisdom (1) is fundamental to carrying out the CSJ process. During the preparation of a Science Café teachers are like students because they have to check expert information on the Internet. Skilfully evaluating what is reliable information on the Internet is an open problem for every citizen. Nobody could say that they have learned once for all, because the information available on the Internet is constantly evolving. There is a huge diversity of sources and complexity for relative non-specialists in evaluating the credibility of those sources. In navigating this knowledge teachers therefore constantly have to employ their professional wisdom and use their own knowledge and intuition to seek reliable information. Moreover if teachers want to organise a CSJ with the students, pupils will often choose the theme of the Science Café, so the teachers cannot know in advance what they might need to find on the Internet.

This also then relates to the CREAT-IT Pedagogical Principle of *Empowerment and Agency (11)* as decisions are placed in the hands of the young people giving them agency over the content and the direction it might go in. The participants (students, teachers and tutors) act in a less hierarchical and more equal environment where re-positioning and listening-actions are possible (linking further to one of the background Exeter theories of Living Dialogic Space, Chappell & Craft, 2011 which emphasizes exactly this re-positioning and listening actioning).

Related to this is the CREAT-IT Pedagogical Principle of *Relationship between Bottom Up and Top Down (6)*. The CSJ process acknowledges the importance of letting ideas,



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

knowledge and practices that emerge via the student's questions and ideas from the 'bottom up', lead science education rather than always being dominated by 'top-down' knowledge from scientists. CSJ finds a way to balance these by using student's questions as a starting point and then allowing them to bring in existing relevant scientific knowledge via their Internet research and the Science Cafe itself.

The risks (*Risk, Immersion and Play – 3*) associated with this for both teachers and students are clear; it is a real undertaking with a real scientist. A risk for teachers is that the students are often more able than them to use social networks but have insufficient knowledge and experience to discriminate between relevant and irrelevant information. This discrimination is related to *Professional Wisdom*, to the knowledge of the process of science, especially the methods of validation and the peer review system. For example teachers might work with students to develop understanding of what makes an article reliable (helping them to ask questions such as, 'Is there a description of the experiments?' 'Is the statistics base referred to?' 'Is there a bibliography? What kind of references is used [articles from specialized peer-reviewed journals or simply scientists' opinions]?).

The connection to the CREAT-IT Pedagogical Principle of *Discipline Knowledge (8)* then becomes apparent. Not only are students dealing with the discipline knowledge of scientific facts – the 'what' of science - but they are also coming to understand experimental reliability and validity criteria; something of the 'how' of science. While a connection can also be made to the CREAT-IT Pedagogical Principle of *Different Ways of Knowing (4)* here, in that the CSJ process includes both 'knowledge that' and 'knowledge how', it is less apparent that the process includes the more aesthetically focused 'knowing this' (Reid, 1981), as the arts are not so strongly fore-grounded in this case study as they are in the other two. Although it could be argued that the interaction with the scientist brings an element of the embodied notion of 'knowing this'.

The interaction with public debate and more culturally-based questions does however fully bring in the principle of *Ethics and Trusteeship (10)* as it engages adults and students alike in considering the ethics of science regarding what matters to them as a community.

The presence of other CREAT-IT Pedagogical Principles becomes apparent within CSJ as the deeper process of the CSJ Science Café is explained below:

Firstly, young people must choose a scientific topic, starting from their interests (*Empowerment and Agency – 12*). They decide what are the interesting questions and possible subtopics to be developed in particular. At this stage, they have the opportunity to study and deepen the topic chosen, calling into question their more or less naive ideas. This connects especially to the CREAT-IT Pedagogical Principle of *Possibilities (9)* which emphasizes the importance of space for multiple possibilities within science education and knowing when it is appropriate to broaden these i.e. within the main topic area or narrow



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

them within sub-topic areas (also connecting to the background Exeter theory of Possibility Thinking, REF, which emphasizes the importance of being able to shift from 'what is' to 'what might be').

Interestingly this part of the process relates strongly to the CREAT-IT Pedagogical Principle of the *Importance of Materials (11)*, perhaps viewing 'materials' here in its broadest possible sense in that one of the core 'materials' for CSJ is the virtual environment and knowledge manifestation on the web. This lends the project a very particular character in terms of its form and content, in the same way that a different 'material' for knowledge exploration (e.g. dancing bodies) would lend different nuances to that knowledge exploration. How the internet is used as part of junior science café is key. The pupils have to organize a Science Cafè, so they have to develop interesting question around the chosen theme and to find the expert to answer their question in the public event, which is the final real Science Cafè.

During the training students develop the ability to find and check technical information on the Internet. They learn to read scientific material via the web and gain the tools to discriminate material and scientific information and so they become more critical users of the Internet. They ask and respond to questions such as 'Who is an expert on this particular scientific theme? In the experience of those facilitating CSJ's, in the mind of the students, before the CSJ training, teacher, journalist, researcher often seem indistinguishable. During the CSJ they will discuss the differences and will decide that the most expert in relation to science knowledge is the researcher because he/she builds the scientific knowledge by him/her-self and so knows the results but also understands the procedures and limits of these results.

Then the students have to find an expert to invite. They have to visit University and Research Centre websites. In this way they learn where and how scientific knowledge is built. They have to discriminate who is really expert on the theme. In this way they develop the skill of discriminating that is reliable on the particular topic.

The students' selection of the expert relates to the above-detailed CREAT-IT Pedagogical Principles of *Discipline Knowledge (8)* and the *Relationship between bottom up and top down production of knowledge (6)*.

After the identification of the speakers, the students organize a meeting with them in order to discuss how the Science Cafè will proceed. Before and after the meeting, the young people deepen the topic of the Science Cafè. In order to collect and share information and materials they choose and use digital tools (Facebook group, blog, etc.). They also look for pieces of literature or film clips related to the theme to present during the final Science Cafè event. The group finalizes the organization of the Science Cafè; they choose the order of the questions and the connected materials. Then the group works on logistics and on promotion of the final Science Cafè event, they usually design and print promotional posters



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

and cards. In the final event the speakers meet the public. The public is composed mainly of the students' peers, other teachers and parents but also the general public, the debate is coordinated by a facilitator, who is also a student (*Empowerment and Agency – 12*).

In every step the difference of opinion and the debate are crucial to developing knowledge and to driving the project. This resonates strongly with the CREAT-IT Pedagogical Principle of *Dialogue (5)*. This principle emphasises the importance of allowing for dialogues between people, disciplines, creativity and identity, and ideas. This dialogue allows for conflict and irreconcilable difference as well as negotiation and agreement. These facets of dialogue are alive and well within the CSJ format which has debate at its heart and which allows conflict to take a prominent role where appropriate. The digital tools (Facebook group, blog, etc.) that support the debate are chosen by pupils to encourage and further these debates.



The screenshot shows a Facebook event page for "Caffè scienza - VIAGGI NEL TEMPO". The event is scheduled for Wednesday, June 15, from 19:00 to 22:00 at the Biblioteca Villa Mercedes, via Tiburtina 113, (San Lorenzo). It was created by Fulvio Panetta and will be attended by 18 people. The event description mentions that it will feature a discussion with Giovanni Amelino Camelia (physicist) and Matteo Morganti (philosopher). The page shows several comments from participants, including Emanuele Colabuono asking about the topics and Ilaria Tirelli asking if drinks are provided.

(Figure 13) Facebook snapshot advertising Science Cafe

The participative context of organizing a science café has some powerful advantages. It allows students to:

- Learn to share a collective project in an atmosphere of cooperation and collaboration,



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

- Be aware of where and how scientific knowledge is produced
- Learn to search for scientific information and connect different topics
- And also highlight the individuality and specific skills of everyone

Students are also invited to develop citizenship competences as they:

- Find contacts with experts
- Benefit from an interdisciplinary approach to a scientific subject
- Make information useful and expendable inside and outside school
- Contribute to an image of science as part of general culture
- Understand the scientific stakes of today and tomorrow.

These shared values and advantages relate closely to the CREAT-IT Pedagogical Principles of *Empowerment and Agency (12)*, *Ethics and Trusteeship (10)* and *Individual, collaborative and communal activities for change (2)*. The latter has not yet been discussed but it seems very apparent in the CSJ method as that approach allows for individual, collaborative and communal activities, which can feed each other, especially with a student group forming around the creation of the Science Cafe. This offers a shared identity to that group within which participants can work, allowing for difference but with a shared creative process and purpose.



3.3 Approaches to Continuing Professional Development: From across Europe

This final section of Deliverable 2.1 aims to generate concrete approaches to integrating CREAT-IT methodology into professional development. It was developed in association with partnership representatives from each country in the consortium writing this work package. Interviews were conducted with teachers currently working in schools or who had just left the profession to discuss their experience of attending Continuing Professional Development (CPD) courses or training events. These interviews were conducted in order to understand the current state of CPD in each country and to consider how best to suggest that the CREAT-IT methodology can be integrated within that. Teachers were interviewed from Belgium, Greece, Italy, Norway, Serbia and the United Kingdom. The range of teacher experience varied in years of service, the age range they taught and current position with in the school, the most senior interview was conducted with a Deputy Head Teacher from a high school in Serbia.

Belgium

The Belgian education community is split into two separate bodies, the Flemish and French; this means that the country has two ministries of education. However, the French community is split further into catholic and non catholic, so the French community is represented by a further two separate education ministries.

Interviews were conducted with two teachers, representing the two separate communities; any specific differences in the approach to teacher CPD are highlighted.

Teachers have to attend 6 days' worth of training over three years; school INSET training will also take up some of that allowance. Teachers from the French community must apply through a centrally run online programme, which is offered by the Universities in Belgium. No outside non-educational ministry organisations offer teacher CPD. When organising CPD courses for teachers, the CREAT-IT team must consider this fact and plan whether it is feasible and how to negotiate a way into this centrally run system perhaps through consortium member contacts.

Each school in the French community has a link teacher who is the bridge between the university and the school. It is their role to keep up to date with the training being offered and to promote the courses to their colleagues. These roles are subject specific and considered by the teacher interviewed as not a privilege more of a "annoyance" than a role



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

they want to engage in. Once teachers attend the course there is no monitoring of progress or follow up regarding the activity. Teachers are not required to disseminate the information with their colleagues. Teachers consider CPD in Belgium as formal and old fashioned, they are not excited by it as the programme offered by the various ministries stays the same every year.

However, museums often offer scientific and creative initiatives / days which teachers attend with their students. These are one off events that do not come with any formal training. These may be a more conducive site within which to organise the CREAT-IT CPD. Or a model around which to plan the CREAT-IT Belgian CPD on the understanding that this training programme will be available for teachers to access outside of their more closed official system.

Greece

The Greek pedagogy institute called the Life Long Learning Programme <http://www.epimorfosi.edu.gr/> is the official CPD programme for teachers in Greece. Participation in CPD is not statutory, but teacher's can gain credits for the courses they attend. Courses and workshops are offered for all subjects apart from music as teachers are expected to have a degree and masters in the musical instrument they wish to teach. There is a substantial demand for courses in ICT as the government and teachers have identified this as an area of weakness. Courses can last between 1 – 4 months, and consist of a series of workshops in which the teachers gain credits for their CV's. All teachers can apply for the courses, however not all are accepted. There are only a certain number of places and funding available and once a teacher accepts a place they are legally required to attend. When they have completed the course the teachers name is published on the central website (see link above).

Teachers in Greece are keen to attend and engage with CPD. When they graduate from university and teacher training programmes teachers then apply to the State for a job. The State allocates where the teacher will teach, this is dependant on the needs of the school, pupils, and area. In their first two years of teaching all teachers are obliged to work at a remote school in Greece or on the Islands. These areas have a shortage of teachers and decent graduates. Therefore, teachers have a slightly ulterior motive to attend CPD courses as the more credits they gain the greater chance they have of being transferred to a city. Teachers in Greece want to work in the cities, especially Athens as they are paid at least 10% more money than they would teaching in the remote villages and islands of Greece. To successfully recruit teachers to attend their CPD courses the CREAT-IT team must consider if



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

and how they can offer credits for the teachers who enrol on the course. Links will need to be developed with the Greek pedagogy institute.

Italy

In Italy teachers will train at a university to become a teacher, once they graduate a teacher then becomes “unstable”, this means that they are not paid over the holidays and have no benefits, this period in teaching can last between 10 – 15 years. By attending CPD training the teachers in Italy can collect points, points and years of experience go towards becoming a “stable” teacher. When a teacher becomes “stable” they cannot be fired as a teacher, they are paid over the holidays and can be a teacher until they retire. When a teacher applies for a job the applicant with the most points must be offered the job first by the school. This culture of collecting points to become “stable” demonstrates why teachers are keen to engage with CPD in Italy.

Training is not obligatory and teachers can decide which courses they want to attend. Courses can last for one day, but most are longer. Not all training offers points and teachers are happy to attend these CPD courses as well. In Italy there are two types of courses a teacher can attend. One course is typically taught by professors at a university, the other type of course is lead by teachers. The CPD course follows a similar structure of theory in the morning and more collaborative workshop style structure in the afternoon. However, the interviewees from Italy suggested that they found this format ‘old fashioned’. Here the CREAT-IT team might want to debate what format the structure of their CPD courses should take. Would a different format to the Italians traditional structure put off some teachers when applying or would an alternative structure be welcomed as fresh and exciting and entice more teachers to enrol onto the CREAT-IT CPD courses?

Both interviewees identified networking as an important part of attending CPD courses. Having the opportunity to meet others and interact with teachers working at a similar stage in their career was considered very useful as teachers do not really get a chance or opportunity to do this back in their schools. Therefore, the CREAT-IT team must allow for some networking to take place during the CPD event.

One of the weaknesses identified by the interviewees is that CPD training in Italy can be very traditional, there appears to be a long amount of time spent listening to professors talk rather than “doing”. The respect the teachers have for the professors leading the workshops is also considered a weakness as often they have little experience of working in schools and approach the theory with academia at the foreground rather than what the teachers consider practical knowledge. Who leads the CREAT-IT CPD courses must be considered by



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

the team, teachers in Italy will respect a workshop leader with recent experience of teaching far more than an academic with little experience of working in schools, although they do respect the knowledge that the academic represents.

CPD does not only take the form of the traditional one day course in Italy, one of the interviewees mentioned how they interned at a school following a mentoring programme, she found this exceptionally useful and beneficial to her practise as she got to see how other taught her subject and work with them in developing her own curricular. One of the emerging themes is lack of monitoring of teacher CPD across the different countries; teachers in Italy and Serbia appear to suggest that they would welcome this where as the teacher from Greece would not. This is a discussion to be had by the CREAT-IT team, whether to provide some follow up after the course with teachers. The teachers from Italy suggested that they would like to use a web platform so that they can communicate with the trainers after the course to ask further questions or share examples of their work with other teachers.

Norway

Teachers can attend CPD courses through the Central Administration Department, <http://www.udir.no/Utvikling/Etter-og-videreutdanning/> the courses are then delivered at University High Schools. Courses typically run for a term, for example September to December. During this period teachers will come together on average three times, they are set tasks to complete in between like reading, writing, filling in online material, or carrying out research in their school. Some of the tasks might be individual and some of the tasks will require teachers to collaborate with others.

Teachers in Norway must apply for the course through their school leader. The leader decides if the teacher can attend. When the teacher completes the course they are awarded credits, credits mean that their salary can be increased for example 30 credits equates to a salary increase of about 10, 000 Norwegian krone. As a result of this the school leaders prefer to promote the courses to teachers who do not come with credit and will veto applications from teachers if they do not wish to pay them the salary increase. This means that teachers in Norway do not necessarily value the courses that they do not gain credit from. If the school leader agrees that the teacher can attend the course then the teacher will have to cover the cost of attending, teachers can apply for scholarships to cover this fee and some courses are free but typically teachers will pay to attend CPD course's. The CREAT-IT team will need to consider if they will charge for courses in Norway and conduct further research to find out what is a typical cost for a course in this country. Again there is



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

further evidence here that like Greece, the CREAT-IT team will need to affiliate their course with the national institute so that teachers can gain credits for attending.

CPD courses are offered in all school subjects however the government has identified that teachers in Norway need to improve their skills in Math's and Science so these courses are generally promoted more to teachers by their school leaders. Here is a strong opportunity for the CREAT-IT team to promote their CPD courses to science teachers in Norway. The Norwegian interviewee cited an example of her wanting to take a creative CPD course in music but her school leader vetoed her requests and asked her to attend a course in special needs as the school lacked any teachers with this expertise.

With the Norwegian government wanting to improve teacher's skills in science and examples from the interview of schools not wanting to support teachers in attending creative courses, the CREAT-IT team must ensure that any course they run in this country foregrounds science in the promotional material so that school leaders are not put off by the creative content.

Some of the CPD course strengths identified by the interviewee is similar to the Italians that having the opportunity to network with other teachers from different areas. Discussing ideas and sharing advice by other teachers was seen as just as important as actually attending the CPD course. The interviewee expressed that one of the weaknesses of Norwegian CPD courses is dependant on the course leader, if the leader has only worked at university level and not been in a classroom for a considerably long period of time working with 30 children then the teachers considered then less valuable as they are not connected to the "real world". The interviewee suggested that teachers in Norway prefer to attend these courses taught by someone with current, practical experience of working in schools, this would mean that their theories or suggestions would resonate with the teachers more. Again this is similar to the Italians, the CREAT-IT team must consider who leads the course, what their experience of working in schools is and that they have the creative and scientific knowledge to gain the respect of the teachers attending.

Serbia

Teachers in Serbia are obliged to attend and engage with CPD training. CPD is statutory and teachers must complete 20 hours of external training over a year. Teachers must also attend internal CPD i.e. school INSET and complete 20 hours of training during five years of service. The obligatory programme, equates to about 40% of teachers' uptake and they can attend 60% of the optional programme. The obligatory CPD programme can be subject specific units or pedagogy units referring to methodology, behaviour management ICT, for



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

example, these units are either taught by the Ministry for Education, or are approved and recognised courses featured on the online catalogue <http://katalog.zuov.rs>. The optional programme is dedicated to topics and units that are subject specific, they are related more to the curriculum rather than practise and pedagogy. The CREAT-IT team will need to develop links with the Ministry for Education so that the course can feature on their online catalogue. If this is possible the team will then need to create a CPD course that would fit into the optional programme. If this is not possible the CREAT-IT team will need to search for alternative ways to promote their course to teachers.

Typically, teachers attend a 1-day course maximum 2 days and receive a certificate for attendance, this is then added to their portfolio. One of the strengths of CPD courses in Serbia is that teachers are able to meet other teachers from their subject and share their good practice, knowledge and ideas. They see the CPD process as a positive way to improve their practise, they get to develop more critical thinking skills, indulge in-group work with other teachers and develop their methodology by learning how to apply their knowledge in different ways. The teachers in Serbia find CPD interesting but the same topics every year offered to them so they can become bored, as there is a lack of variety offered to them. If we consider these last two statements here is a need the CREAT-IT team could fulfil, to offer a fresh and new CPD course, but the course must also provide opportunities for the teachers attending develop their knowledge and show them how they can apply this new theory to their existing practice.

Similar to the other countries interviewed the course leaders are considered as one of the weaknesses of CPD course. Typically the courses are lead by academics and researchers rather than leaders with practical experience of teaching in schools. This emerging theme is something the CREAT-IT team will have to address when planning the CPD courses in Work Package 3. The interviewee also suggested that the courses could also feel superficial as there is no follow up or monitoring of teachers development offered. Teachers in Serbia are dissatisfied that CPD is not monitored. And so like the CPD course that will be run in Italy the CREAT-IT team might want to consider the strengths of a web platform to assist the teachers and share examples of good practice after the course has concluded.

United Kingdom

Similar to Belgium the United Kingdom is split into four different countries, therefore four different governments design the working conditions for teachers in the UK.

England and Wales

In England and Wales there is no statutory obligation for teachers to attend CPD courses. Teachers are free to apply for and attend any professional development that they see fit,



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

typically schools will cover the cost of teachers attending one CPD event a year. Teachers are also expected to attend in service training (INSET) of 25 hours per year, this equates to five days, which is traditionally held by the school at the start and end of a term. This in-house training can be either led by the schools Senior Leadership Team (SLT) or outside agencies might deliver a workshop or give a talk about a specific subject that the school might want to deal with. Here is an opportunity for the CREAT-IT team to consider offering INSET to a school, this would result in more teachers attending the training and could develop cross curricular links within the school's departments.

Teachers can attend CPD courses in either subject specific training or pedagogy and methodology courses for example topics may relate to policy initiatives, assessment, leadership, or behaviour management. The team will need to decide if the CPD course will be associated specifically with science, or pedagogy, methodology or assessment or if the course can be designed to reflect all of the different areas, this has the potential to interest more teachers.

Subject associations run courses and conferences nationally and regionally and there are many private independent providers. Universities tend to focus on award bearing CPD (masters or post graduate certificates and diplomas).

The CREAT-IT team when planning courses to be delivered in England and Wales has many opportunities to either develop courses affiliated with subject associations or approach private independent companies. It is unlikely that the CREAT-IT course could offer credits towards a Masters award or offer post graduate certificates and diplomas as this would be beyond the scope of the project, but it is something the team might want to consider as a goal for teachers to attend in England and Wales.

Schools can also be organised in clusters called learning communities or schools can be funded to act as leaders in their area i.e. Teaching School Alliances, here the school will provide support and advice within their group of schools and beyond. This could be in form of running courses, projects or conferences or offering resources and planning material online. Here is another opportunity for the CREAT-IT team to deliver their work, by embedding within a Teaching School Alliance cluster and work with teachers in a more long term and formal setting.

Scotland



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Teacher CPD is statutory for teachers in Scotland. Teachers are entitled to an annual Professional Review and Development interview every year of their service. This interview will focus on identifying the teachers' strengths and suggests areas for development. This then becomes the basis for the teachers' CPD plan and is agreed in collaboration with the senior leadership team and the teacher. It would be interesting for the CREAT-IT team to uncover if creativity is considered a skill a teacher needs to develop in Scotland, unfortunately no teachers were interviewed specifically from Scotland to discover this. Teachers are required to undertake 35 hours of CPD a year; this can be a mixture of internal and external courses via which teachers develop a reflective portfolio. Scottish teachers have the most hours to complete in a year towards CPD, here the CREAT-IT team might want to consider how long their workshop might be as teachers might be more inclined to attend a full day course rather than a two hour workshop.

Northern Ireland

Teacher CPD is currently under review in Northern Ireland. CPD is provided to teachers in partnership with the Curriculum Advisory and Support Service. Similar to the Scottish reflective system, teachers in Northern Ireland follow a teacher competence framework, this framework underpins teacher education and sets out what teachers must know and understand at various stages in their career. Teacher CPD is undertaken to support teachers to engage with developing this reflective framework. With the current uncertainty in Northern Ireland about how teachers will engage in CPD, the CREAT-IT team will want to monitor the situation so that when the government makes the recommendations, the course can be designed to reflect what has been stated.

3.3.1 Emerging themes, recommendations and guidance for the CREAT-IT team to consider in relation to the 12 CREAT-IT Principles

The CREAT-IT team when planning the workshops must acknowledge the expertise and **professional wisdom (1)** of the participants attending and leading the series of workshops. A number of the interviewees discussed how the competency and experience of the course leader, the expectations of the attendees and the work set affects their respect to listen and digest what is being taught.

The structure and delivery of content in the CREAT-IT workshop needs to be considered. Teachers from Italy discussed how they found the traditional format of **'top down' (6)** CPD courses they attend as 'old fashioned'. The typical structure for an Italian workshop is theory



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

lecture in the morning followed by practical workshop in the afternoon. The CREAT-IT team should consider if an alternative structure would entice or deter teachers from Italy.

When planning this structure the CREAT-IT team must also acknowledge the **importance of materials (11)** used when shaping these new courses. Various interviewees were asked about the importance of resources and whether they used them in their future planning. Some teachers did refer back to the course notes or hand outs but most admitted that they did not and left this material on the shelf. Materials can also refer to the equipment used when working in the lab e.g. the attendees bodies, Bunsen burners, test tubes, chemicals etc. So the CREAT-IT team will need to consider how they can supply materials for attendees to their CPD workshops, what venue would be appropriate for teachers to work in and if workshop leaders are qualified and confident to use this equipment.

When planning the structure of the delivery format the CREAT-IT team must allow attendees opportunities to **collaborate (2)** and network during **communal (2)** activities. It appears that teachers get little opportunity to network with others in particular Italy and Norway, the CREAT-IT team must allow time within the workshop to facilitate and encourage this to happen. This is supported by the results from the survey that showed collaboration is considered one of the key characteristic of a creative science teacher.

The CREAT-IT team must also allow teachers attending their workshops time to explore and **play (3)** with ideas. This will require a sufficient amount of time in the activities planned so that the teachers can **immerse (3)** themselves with the ideas and embody their new knowledge, the interviewees from Italy in particular wanted to have time working in labs with other attendees from the workshop so that they could explore ideas and collaborate with them which in turn would develop their **empowerment and agency (12)**.

The findings from the survey reinforce the view that teachers value opportunities to indulge in **risk (3)** taking activities and dialogue.

From the beginning of the planning stage the CREAT-IT team must understand, plan for and allow space for the different **discipline knowledge (8)** from the sciences and the arts to communicate. The follow up interviews conducted from the survey demonstrated many examples of science teachers already working creatively in their classes and the CREAT-IT planning team must respect this when designing the CPD workshops. If the CREAT-IT team could facilitate a discussion before the planning of the workshops this would allow **dialogue (5)** to begin generating views from across the different disciplines of science and the arts,



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

this has in part already begun with the interviews conducted regarding CPD and the follow up interviews conducted from the CREAT-IT survey with science teachers. The CREAT-IT team might want to consider opening up dialogue now with specialists from the field of the arts. By allowing for **multiple ways of thinking (7)** that share a thread with science and the arts the CREAT-IT team are beginning to generate multiple **possibilities (9)** and potential content suggestions for the workshops.

3.3.2 Further recommendations not related to the 12 CREAT-IT Principles

- Credits

Teachers from specifically Greece and Italy countries would not be interested in attending a CPD course if they could not obtain credit for doing so, so CREAT-IT would need to consider if it is possible to develop a course and have it affiliated with the various education ministries or institutes so that teachers can gain credits for attending.

- Course accreditation

The CREAT-IT teams will not be able to advertise their CPD courses in Belgium as workshops here are organised from a central educational ministry, access to Museums might be a way to solve this problem.

- Universities

The CREAT-IT team will need to engage with the universities in Belgium, Norway and Italy to access teachers and promote the course.

- Web platform presence / Social Networking

The CREAT-IT team should consider the use of a web platform to provide follow on support for teachers who attend the workshops. This space could also showcase examples of teachers engaging with the methods developed during the course. The team recognises the importance social networking has in the future of teacher CPD and there are already examples of this happening. 'Meet me' is a social network where teachers sign up to deliver a presentation to other teachers on a bus that travels around London <http://teachertoolkit.me/tmlondon/>. A search on Twitter for 'Science Teacher CPD' demonstrates that there is already a growing world of teachers sharing ideas, resources and lesson plans on line for other teachers. The idea of developing a social media-networking platform will be investigated further in Work Package 3.2

3.4 Summary of Part 3

Part 3 has drawn from both Part 1 and Part 2 to offer a description of the essential features of the CREAT-IT pedagogical framework, together with the 12 CREAT-IT pedagogical



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

principles. Section 3.2 presents the analysis of the three CREAT-IT cases studies; Write a Science Opera (WASO), Science and Theatre and Junior Science Café. Finally, Section 3.3 analysed the CPD provision in Europe with details integrated from the CREAT-IT survey presented in D2.2. This section concluded by applying the 12 CREAT-IT principles to present the CREAT-IT team's recommendations for concrete approaches to continuing professional development (CPD) that will be considered when developing its CPD workshops in Work Package 3.



Reference List

Abbs, P. (1996) *The Educational Imperative*, London, Falmer Press.

Abbs, P. (2003) *Against the flow: Education, the arts and postmodern culture*. London: Routledge Falmer. Chapter 3: The rise and fall of the new arts paradigm in education

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B. & Wong, B. (2013b) 'Not girly, not sexy, not glamorous': primary school girls' and parents' constructions of science aspirations, *Pedagogy, Culture & Society*, 21:1, 171-194

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B. & Wong, B. (2013a) *ASPIRES Young people's science and career aspirations, age 10 –14*, Available from <http://www.kcl.ac.uk/sspp/departments/education/research/aspires/ASPIRES-final-report-December-2013.pdf> [Retrieved 12th January 2014]

Aristidou, V. (2013). The relationship between teacher talk and children's possibility thinking in the Drama Game method in Cypriot primary education. Open University: Unpublished Ed Thesis

ATL (2014) Your CPD Entitlement [ONLINE] Available at: <https://www.atl.org.uk/help-and-advice/performance-management/continuing-professional-development.asp> [Retrieved 27th March 2014]

Baer, J. & Kaufman, J. C. (2006). Creativity Research in English-speaking Countries. In J. C. Kaufman & R. J. Sternberg (eds.) *The International Handbook of Creativity*. New York: Cambridge University Press.

Bakhtin, M.M. (1984) *Problems of Dostoevsky's poetics*, ed. and trans. Caryl Emerson. Minneapolis: University of Michigan Press.

Ball, (2003) The teacher's soul and the terrors of performativity, *Journal of Education Policy*, 18:2, 215-228

Ball, S.J. (2000) Performativities and Fabrications in the Education Economy: Towards the Performative Society? *Australian Educational Researcher*, 27:2, 1-23.

Banaji, S., Burn, A. & Buckingham, D. (2010a) *The rhetoric's of creativity*. London: Arts Council England (2nd edition).



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Banaji, S., Perrotta, C. & Cranmer, S. (2010) *Creative and Innovative Good Practices in Compulsory Education in Europe, Collection and Descriptive Analysis of 10 Good Practices of Creativity and Innovation in Compulsory Education in the EU2*. Available from http://ftp.jrc.es/EURdoc/JRC59689_TN.pdf [Retrieved 16th January 2014]

Bannerman, C. (2004) The Artist and the Process of Creation. Paper presented at ESRC Seminar, Creativity the Arts and Achievement, Christchurch Canterbury University, July 2004. Available from http://opencreativity.open.ac.uk/recent.htm#previous_papers.

Baram-Tsabari, A. & Peleg, R. (2011). Atom Surprise: Using Theatre in Primary Science Education. *Journal of Science Education and Technology* 20:5, 508-524

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

BELB (2013) i-teach belfast, quality learning & teaching. Induction Support Programme for Beginning Teachers. A beginners Guide to the Induction Process. Available from: http://www.belb.org.uk/downloads/i_epd_bts_guide_to_the_induction_epd_process.pdf [Retrieved 28th March 2014]

Belmonte, B. & Castellani, T. (2012) 'The 'Caffè Scienza Junior' project: Students protagonists of their scientific training' paper presented at *SciCafé 2012 Conference and Events: Europe's Science Cafés Thinking Forward*. Epinioa, Athens, 2012

Belmonte, C., Castellani, T. & Parisi, A. (2010) 'Café Junior Science: Students protagonists of their scientific training' paper presented at *Eighth National Conference on Science Communication*. Trieste, Italy, 24th May 2010. ISBN: 978-88-7699-201-8

Belmonte, C., Castellani, T., Maggi, L., Pontecorvo, E. (2008) A proposal for teaching science teaching course no. 3 [ONLINE] <https://sites.google.com/site/tcastellani/articoli/didattica-della-scienza/naturalmente>

Boden, M. A. (2004). *The Creative Mind: Myths and Mechanisms*. Second edition. Routledge.

Bore, A. (2006) Bottom-up for creativity in science? a collaborative model for curriculum and professional development, *Journal of Education for Teaching: International research and pedagogy*, 32:4, 413-422

Bourdieu, P. & Passeron, J. C (1977) *Reproduction in Education, Society and Culture* London: Sage



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Briginshaw, V. (2001) *Dance, space and subjectivity*. Basingstoke & New York: Palgrave

Bronfenbrenner, U. (1979) *The ecology of human development*. Cambridge, MA: Harvard University Press.

Bruce, T., Findlay, A., Read, J. & Scarborough, M. (eds.) (1995) *Recurring Themes in Education*, London: Paul Chapman Publishing

Burnard, P., Craft, A., Cremin, T., Duffy, B., Hanson, R., Keene, J., Haynes, I. & Burns, D. (2006) Documenting 'possibility thinking': A journey of collaborative enquiry. *International Journal of Early Years Education*, 14, 243-262.

Caselli, R. J. (2009) Creativity: An organizational schema. *Cognitive and Behavioral Neurology*, 22, 143.

Chappell (2006) Creativity within Late Primary Age Dance Education: Unlocking Expert Specialist Dance Teachers' Conceptions and Approaches (PhD thesis). Available from <http://kn.open.ac.uk/public/document.cfm?docid=8627>

Chappell, K. (2007) The Dilemmas of Teaching for Creativity: Insights from Expert Specialist Dance Teachers. *Thinking Skills and Creativity*, 2, 39-56.

Chappell, K. (2008) Embodied Narratives, in Parry, S., Nicholson, H., & Levinson, R. (Ed.), *Creative Encounters*. Wellcome Trust

Chappell, K. (2008) Towards Humanising Creativity. UNESCO Observatory E-Journal Special Issue on Creativity, policy and practice discourses: productive tensions in the new millennium, 1:3, Available from <http://www.abp.unimelb.edu.au/unesco/ejournal/vol-one-issue-three.html> [Retrieved December 2008]

Chappell, K. & Craft, A. (2011) Creative learning conversations: producing living dialogic spaces, *Educational Research*, 53:3, 363-385

Chappell, K. & Craft, A. (2011). Creative learning conversations. *Educational Research*, 53:3, 363-385.

Chappell, K. & Jobbins, V. (in press) Empowering Creative Partnerships. In *Dance Education around the World: Perspectives on Dance, Young People and Change*.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Chappell, K., Cartwright, C., Dawson, S., Ford, K., Pender, T., & Swinford, E, (in development) Making and being made: investigating wise humanising creativity in interdisciplinary early years arts education. BERA 2014 Conference submission.

Chappell, K., Craft, A. with Jonsdottir, S. & Clack, J. (2009) *Aspire South West*. Report to Qualifications and Curriculum Authority.

Chappell, K., Craft, A., Burnard, P. & Cremin, T (2008) Question-posing and question-responding: the heart of 'Possibility Thinking' in the early years. *Early Years*, 28:3, 267-286.

Chappell, K., Craft, A., Rolfe, L., Jobbins, V. (2012). Humanising Creativity: valuing our journeys of becoming. *International Journal of Education and the Arts*. 13:8 1-35. Available from <http://www.ijea.org/v13n8/> [Retrieved 11th January 2013]

Chappell, K., Rolfe, L., Craft, A., & Jobbins, V. (Eds) (2011) *Close Encounters: Dance Partners for Creativity*. Stoke on Trent: Trentham Books

Chappell, K., Walsh, C., & Craft, A. (2013) C2LEarn Learning Design for CER: Deliverable No D2.2.1

Chappell, K., with Craft, A. R., Rolfe, L., & Jobbins, V. (2012). Humanizing creativity: Valuing our journeys of becoming. *International Journal of Education & the Arts*, 13:8. Available from <http://www.ijea.org/v13n8/> [Retrieved 28th November 2013]

Chekhov, M. (2002) *To the actor*. Oxon: Routledge

Clack, J. (2011) *What features of mathematics activity enable Possibility Thinking in the Key Stage 2 classroom and how do teachers enable them?* Unpublished Doctoral Thesis, University of Exeter, July 2011.

Claxton, G., Craft, A. & Gardner, H. (2008) Concluding thoughts: Good thinking – Education for Wise Creativity. In A. Craft, H. Gardner, and G. Claxton (eds.), *Creativity, wisdom and trusteeship: Exploring the role of education*. Thousand Oaks: Corwin Press

Costruire I Nuovi Licei (Building the new high schools) (2010) [ONLINE] <http://nuovilicei.indire.it>

Costruire I Nuovi Professionali (The New Professional Building) (2009) [ONLINE] <http://nuoviprofessionali.indire.it>



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Costruire I Nuovi Tecnici (The New Building Technicians) (2009) [ONLINE]

<http://nuovitecnici.indire.it>

CPD guidance (2014) Teaching Scotland CPD guidance Teaching Scotland [ONLINE]

Available at: <http://www.teachingscotland.org.uk/professional-development/cpd/27-cpd-guidance.aspx> [Retrieved 27th March 2014]

Craft, A. (1998) Holistic Postgraduate Learning: Evaluation of a UK-based Innovation. *Analytic Teaching*, 19:2, 19-30

Craft, A. (1999) Creative development in the early years: Some implications of policy for practice. *Curriculum Journal*, 10:1, 135-150.

Craft, A. (2000) *Creativity Across the Primary Curriculum*, London: Routledge.

Craft, A. (2001) 'Little c Creativity' in Craft, A., Jeffrey, B., Leibling, M., *Creativity in Education*, London: Continuum (45 – 61)

Craft, A. (2002) *Creativity and Early Years Education*, London: Continuum

Craft, A. (2005) *Creativity in schools: tensions and dilemmas*, Abingdon: Routledge

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

Craft, A. (2011) Becoming Meddlers in the Middle: stretch, challenge and leap? In Chappell, K., Rolfe, L., Craft, A., Jobbins, V. (Eds). *Close Encounters*. Trentham Books

Craft, A. (2011), *Creativity and Educational Futures*. Stoke on Trent: Trentham Books

Craft, A. (2012) Childhood in a digital age: creative challenges for educational futures, *London Review of Education*, 10:2, 173-190

Craft, A. (2013) Childhood, Possibility Thinking and Education Futures *International Journal of Educational Research*, 61, 126-134

Craft, A. (2013) Childhood, possibility thinking and wise, humanising educational futures. *International Journal of Educational Research*, 61, 126–134.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Craft, A. (2013) Craft, Childhood, possibility thinking and wise, humanising educational futures, *International Journal of Educational Research* (2013), Available from <http://dx.doi.org/10.1016/j.ijer.2013.02.005>

Craft, A. (In press) Wise, Humanising Creativity: A goal for inclusive education (in preparation) *Revista de Educación (Inclusive Education Journal)*. [Journal article formed from keynote given in Zaragoza, Spain, March 2013]

Craft, A. & Chappell, K. (2009) Fostering Possibility Through co-researching creative movement with 7-11 year olds. In S. Blenkinsop (ed.), *The imagination in education: Extending the boundaries of theory and practice*. Cambridge Scholars Publishing.

Craft, A. & Jeffrey, B. (2001), 'The Universalization of Creativity', in Craft, A., Jeffrey, B., Leibling, M., *Creativity in Education*, London: Continuum (1 – 13)

Craft, A. & Jeffrey, B. (2004) Learner inclusiveness for creative learning, *Education 3 – 13*, 32:2, 39-43

Craft, A. with Chappell, K., Rolfe, L. & Jobbins, V. (2012). Creating fruitful research spaces: methodology. In Chappell, K., Rolfe, L., Craft, A., & Jobbins, V. (2011) *Close Encounters: Dance Partners for Creativity*. Stoke on Trent: Trentham.

Craft, A., Cremin, T., Burnard, P., Chappell, K. (2007) Teacher Stance in Creative Learning: A Study of Progression. *Thinking Skills and Creativity*, 2:2, 136-147

Craft, A., Cremin, T., Burnard, P., Dragovic, T. & Chappell, K. (2012) Possibility thinking: culminative studies of an evidence-based concept driving creativity?, *Education 3-13: International Journal of Primary, Elementary and Early Years Education*, DOI:10.1080/03004279.2012.656671 Link: <http://dx.doi.org/10.1080/03004279.2012.656671>

Craft, A., Cremin, T., Clack, J., Compton, A., Jonhston, J., Riley, A., Glauert, E., Manches, A. (2012) *Conceptual Framework, Creative Little Scientists*. Available from <http://www.creative-little-scientists.eu/content/deliverables> [Retrieved 5th December 2013]

Craft, A., Cremin, T., Hay, P. & Clack, J. (2013) Creative primary schools: developing and maintaining pedagogy for creativity. *Ethnography and Education*, 9:1, 16-34

Craft, A., Gardner, H. & Claxton, G. (2008) *Creativity, Trusteeship, and Wisdom*. Thousand Oaks: Sage.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Cremin, T., Burnard, P., & Craft, A. (2006) Pedagogy and possibility thinking in the early years, *Thinking Skills and Creativity*, 1:2, 108-119

Cremin, T., Chappell, K. & Craft, A. (2013) Reciprocity between narrative, questioning and imagination in the early and primary years: Examining the role of narrative in possibility thinking, *Think Skills and Creativity*, 9, 135 - 151

Cremin, T., Craft, A., Clack, J., Scheersoi, O., Megalakaki, A. D2.2 Conceptual Framework ADDENDUM 2 of 4: Literature Review of Creativity in Education.

Available from <http://www.creative-little-scientists.eu/sites/default/files/Addendum%20%20Creativity%20in%20Ed%20FINAL.pdf> [Retrieved 28th November 2013]

Crespi, M, (2010). 'Telling science. Need for morphology' paper presented at *Eighth National Conference on Science Communication*. Trieste, Italy, 24th May 2010

Csikszentmihalyi, M. (1996). *Creativity: Flow and the psychology of discovery and invention*. New York: Harper Perennial.

Curriculum for Excellence (CfE) (2012) *Sciences, Experiences and Outcomes* Available from http://www.educationscotland.gov.uk/Images/sciences_experiences_outcomes_tcm4-539890.pdf [Retrieved 17th January 2014]

Dallas, D., Bagnoli, F. & Pacini, G. Science café [ONLINE] <https://sites.google.com/site/scicafewebbook/>

De Haan, G., Huck, J., Eds (2008) Recommendations for Policy makers, Form-it. Take part on research project, 6 European Framework Programme, Publisher: Austrian Institute of Ecology

Department for Children, Education, Lifelong Learning and Skills (DfCELLS) (2008) *Science in the National Curriculum for Wales* Available from http://wales.gov.uk/dcells/publications/curriculum_and_assessment/arevisedcurriculumforwales/nationalcurriculum/sciencenc/scienceeng.pdf?lang=en [Retrieved 9th January 2014]

Department for Education (DfE) (2013) *National Curriculum in England Framework Document*. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/260388/MASTER_final_national_curriculum_11_9_13_2.pdf [Retrieved 23rd January 2014]



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Donovan, B.M., Moreno Mateos, D., Osborne, J. F., & Bisaccio D. J. (2014) Revising the Economic Imperative for US STEM Education. *PLoS Biol*, 12:1, e1001760.
doi:10.1371/journal.pbio.1001760

Educational Career for Teachers (2014) [ONLINE <http://www.udir.no/Utvikling/Etter-og-videreutdanning/>] [Retrieved 27th March 2014]

Eisner, E.W. (2004) What Can Education Learn from the Arts about the Practice of Education? *International Journal of Education and the Arts*, 5:4, 1-12

European Commission (2004). *The teaching profession in Europe: Profile, trends and concerns. Report IV: Keeping teaching attractive for the 21st century-General lower secondary education: Key topics in education in Europe Volume 3*, Brussels: Education, Audiovisual and Culture Executive Agency.

European Commission (2006). *Science Teaching in Schools across Europe: Policies and Research*, Brussels: Education, Audiovisual and Culture Executive Agency.

European Commission (2007a). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on a European Agenda for Culture in a Globalizing World*. Brussels: Office for Official Publications of the European Communities.

European Commission (2007b). *Key competences for lifelong learning: European reference framework* Brussels: Office for Official Publications of the European Communities.

European Commission (2011). *Science education in Europe: National policies practices and research*, Education, Audiovisual and Culture Executive Agency EACEAE9 Eurydice, Brussels: Education, Audiovisual and Culture Executive Agency

European Union (2009) *Manifesto of the European Ambassadors for the European Year of Creativity and Innovation*. Available from:
http://ec.europa.eu/education/lifelonglearningpolicy/doc/year09/manifesto_en.pdf
[Retrieved 4th April 2011]

Fielding, M. & Moss, P. (2010) *Radical education and the common school: a democratic alternative*. London: Routledge

Froebel, F. (1826) *On the Education of Man (Die Menschenerziehung)*, Keilhau/Leipzig: Wienbrach.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Froebel, F. (2001a) Friedrich Froebel's education by development (J. Jarvis, Trans.). In K. J. Brehony (ed.), *The origins of nursery education: Friedrich Froebel and the English system; v. 4*. London: Routledge

Froebel, F. W. A. (2001b) Friedrich Froebel's Pedagogies of the kindergarten (W. N. Hailmann, Trans.). In K. J. Brehony (Ed.), *The origins of nursery education: Friedrich Froebel and the English system (Vol. 1)*. London: Routledge

Froebel, F. W. A. (2001c) Froebel's Letters on the kindergarten. In K. J. Brehony (Ed.), *The origins of nursery education: Friedrich Froebel and the English system (Vol. 1)*. London: Routledge

Froebel, F. W. A. (2001d) Mother's songs and selected writings (W. N. Hailmann, Trans.). In K. J. Brehony (Ed.), *The origins of nursery education: Friedrich Froebel and the English system (Vol. 1)*. London: Routledge

Gago, J. M. (2004) *Europe needs more scientists*. Report by the High Level Group on increasing human resources for science and technology in Europe. Brussels: European Commission.

Garoian, C. R. & Mathews, J. D. (1996). A common impulse in art and science. *Leonardo*, 29:3, 193-196

Garroni, E. (2010) *Creatività, introduzione di Paolo Virno*. Macerata: Quodlibet

Gershon, W. S. & Ben-Horin, O. (In press) "Deepening Inquiry: What processes of making music can teach us about creativity and ontology for inquiry-based science education." *International Journal of Education and the Arts*

Glauert, E., Manches, A., Stylianidou, F., Rossis, D., Compton, A., Scheersoi, A., Savu-Nuutinen, S., Sporea, D., Sporea, A. Costa, M.F., Varela, P., Gatt, S, Gatt, I., Megalakiki, O., Cremin, T., Craft, A., Clack, J., Van Houte, H., De Smet, M., Devlieger, K. (2012). *Literature review on science and mathematics: appendix to Conceptual Framework*. Available from <http://www.creative-little-scientists.eu/content/deliverables> [Retrieved 28th November 2013]

Green, L. (1997). *Music, Gender, Education*. Cambridge: Cambridge University Press

Griffiths, H. (2012). Write an Opera Teachers' Notes. London: Royal Opera House and Den Norske Opera & Ballett



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Griffiths, M. & Woolf, F. (2004) *Report on Creative Partnerships Nottingham Action Research*. Nottingham: Nottingham Trent University

Harlen, W. (2004) "Evaluating inquiry-based science developments." *Paper commissioned for the Meeting on the Status of Evaluation of Inquiry-Based Science at the National Research Council, Washington, DC*. Available from http://www7.nationalacademies.org/bose/WHarlen_Inquiry_Mtg_Paper.pdf [Retrieved 18th January 2014]

Harlen, W. (2008) Science as a key component of the primary curriculum: a rationale with policy implications. *Perspectives on Education, Primary Science*, 4–18.

Harlen, W. (2010) *Principles and big ideas of science education*. Available from <http://cmaste.ualberta.ca/en/Outreach/~media/cmaste/Documents/Outreach/IANASInterAmericasInquiry/PrinciplesBigIdeasInSciEd.pdf> [Retrieved 18th January 2014]

Haugland, A. (2014) OdaVar Best Sunnhordaland. [ONLINE] Available from <http://www.sunnhordaland.no/article/20140206/NYHENDE/140209837> [Retrieved February 9th 2014]

Horizon 2020 (2014) <http://ec.europa.eu/programmes/horizon2020/en/h2020-section/leadership-enabling-and-industrial-technologies>

Il Nuovo Obbligo di Istruzione (New Compulsory Education) (2010) [ONLINE] <http://www.indire.it/obbligoistruzione/>

IIE Accredited Programmes (2014)[ONLINE] <http://katalog.zuov.rs.> [Retrieved 27th March 2014]

Inayatullah, S. (2008) Mapping Educational Futures. Six Foundational Concepts and the Six Pillars Approach. In Bussey, M., Inayatullah, S. & Milojevic, I. (eds). *Alternative Educational Futures: Pedagogies for Emergent Worlds*. Rotterdam: Sense Publishers

Isaacs, S. (1945) *The Nursery Years: the mind of a child from birth to six years*. London: Taylor and Francis

Isaacs, S. with Isaacs, N. (1930). *Intellectual Growth in Young Children*. London: Routledge & Kegan Paul Ltd



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Jeffery, G. (ed) 2005 *The Creative College: Building a successful learning culture in the arts*. Stoke on Trent: *Trentham Books*

Jeffery, G. & Ledgard, A. (2009) *Teacher Artist Partnership Programme 02, Perspectives from the literature*, CapeUK

Jeffrey, B. (2006) Creative teaching and learning: towards a common discourse and practice, *Cambridge Journal of Education*, 36:3, 399-414

Jeffrey, B. (ed.). 2006. *Creative learning practices: European experiences*. London, Tufnell Press.

Jeffrey, B. & Craft, A. (2004) Teaching Creatively and Teaching for Creativity: distinctions and relationships, *Educational Studies*, 30:1, 77-87

Jeffrey, B. & Craft, A. (2006) Creative learning and possibility thinking. In B. Jeffrey (ed.), *Creative learning practices: European experiences* 73-91. London: Tufnell Press.

Jeffrey, B. & Woods. P. (1997) The relevance of creative teaching: pupils' views, in: A. Pollard, D. Thiessen and A. Filer (Eds) *Children and their Curriculum: The perspectives of primary and elementary children*, London, Falmer, 15-33.

Jorde, D. & Bungun, B. Eds (2003) *Nature didactics. Perspectives, research and development*. Gyldenal Norwegian Publisher

Kachan, M., Guilbert, S. & Bisanz, G. (2006) 'Do teachers ask students to read news in secondary science? Evidence from the Canadian context', *Science Education*, 90:3, 496-521.

Kaufman, J. C. & Beghetto, R. A. (2009). Beyond Big and Little: The Four C Model of Creativity. *Review of General Psychology*, 13:1, 1-12.

Kendall, L., Morrison, J, Sharp, C. & Yeshanew, T. (2008). *The Impact of Creative Partnerships on Pupil Behaviour*. Slough: NFER.

Kolstø, S. D. (2008). Science education for democratic citizenship through the use of the history of science. *Science & Education*, 17 (8-9), 977-997

Kozbelt, A., Beghetto, R. A. & Runco, M. A. (2010). Theories of Creativity. In James C. Kaufman & Robert J. Sternberg. *The Cambridge Handbook of Creativity*. Cambridge University Press.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Kuhn, T.S. (1962) *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press

Lefebvre, H. (1991) *The production of space*. Oxford/Cambridge, MA: Wiley-Blackwell.

Levy, P., Lameris, P., McKinney, P. & Ford, P. (2011) *The Features of Inquiry Learning: theory, research and practice* Available from <http://www.pathwayuk.org.uk/what-is-ibse.html> [Retrieved 23rd January 2014]

Lilley, I. (ed.) (1967) *Friedrich Froebel: A selection from his writings*, Cambridge: Cambridge University Press.

Lin, Y-S. (2010) Drama and possibility thinking – Taiwanese pupils' perspectives regarding creative pedagogy in drama. *Thinking Skills and Creativity*, 5:3, 108-119

Lin, Y-S. (2011) Fostering Creativity Through Education: A Conceptual Framework of Creative Pedagogy. *Creative Education*, 2:3, 149-155

Lord Sainsbury of Turville. (2007). *The race to the top: a review of government's science and innovation policies*. London: HM Treasury.

Lubart, T., Besancon, L. & Barbot, B. (2011). *Evaluation of Potential of Creativity*. Paris: Hogref.

Major Training Programme (2014) [ONLINE] <http://www.epimorfosi.edu.gr/> [Retrieved 27th March 2014]

Malcomson, B. & Watkins, C. With Rolfe, L. & Jobbins, V. (2011). The double of act of partnership, breaking the rules to explore new possibilities in dance pedagogy. In Chappell, K., Rolfe, L., Craft, A., & Jobbins, V. (2011) *Close Encounters: Dance Partners for Creativity*. Stoke on Trent: Trentham

Manifesto of the European Ambassadors for the European Year of Creativity and Innovation (2009). Available from http://ec.europa.eu/education/lifelong-learning-policy/doc/year09/manifesto_en.pdf [Retrieved April 4th 2011]

Maslow, A.H. (1943) A theory of human motivation. *Psychological Review*, 50:4, 370–96.

McWilliam, E. (2008). Unlearning how to teach. *Innovations in Education and Teaching International*, 45:3, 263-269



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Millar, R. (2011) Reviewing the National Curriculum for science: opportunities and challenges, *The Curriculum Journal*, 22:2, 167-185

Ministry of Education University Research (2009) *Guidelines for the teaching of Citizenship and Constitution*. Available from http://old.istruzione.lombardia.it/progetti/citt-costituzione/doc_indirizzo-cittcost.pdf [Retrieved June 2011]

Moje, E., Collazo, T., Carrillo, R. & Marx, R. (2001). "Maestro, what is `quality'?" Language, literacy and discourse in project-based science. *Journal of Research in Science Teaching*, 38:4, 469-498

Mumford, M. (2003) Where have we been, where are we going? Taking stock in creativity research. *Creativity Research Journal*, 15:2, 107-120

Murcia, K. (2009) 'Re-thinking the Development of Scientific Literacy Through a Rope Metaphor', *Research in Science Education*, 39:2, 215 - 229

Murphy, P. (1991) Assessment and gender. *Cambridge Journal of Education*, 21:2, 203-215

Murphy, P., Lunn, S., & Jones, H. (2006) The impact of authentic learning on students' engagement with physics, *The Curriculum Journal*, 17:3, 229-246

N.A.C.C.C.E. (1999) *All our futures: creativity, culture and education*. London: DfEE.

National Science Foundation, (1999) Inquiry, Thoughts, Views, and Strategies for the K-5 Classroom. Foundations, A monograph for professionals in science, mathematics, and technology education. Available from <http://www.nsf.gov/pubs/2000/nsf99148/pdf/nsf99148.pdf>

National Union of Teachers (2010) Teachers Working time and Duties an NUT Guide. Available from: <http://www.teachers.org.uk/files/Workload-A5-7037.pdf> [Retrieved 27th March 2014]

Osborne J., Collins S., Ratclie M., Millar R., Duschl R. (2003) 'What Ideas about Science Should Be Taught in School Science? A Delphi Study of the Expert Community', *Journal of Research in Science Teaching*, 40:7, 692 - 720

Osborne, J. (2005) 'The role of Argument in Science Education', *Research and the Quality of Science Education*, 2005, 367-380

Osborne, J. & Dillon, J. (2008) *Science Education in Europe Critical Reflections. A Report to the Nuffield Foundation*, London, UK: Nuffield Foundation



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Pacini, G., Bagnoli, F., Belmonte, C., Castellani, T. (2012) Science is ready, serve it! Dissemination of Science through Science Café In M. Buchi (Ed.) Proceedings from the 12th International Conference on Public Communication of Science and Technology: Quality, Honesty and Beauty in Science and Technology Communication, 34–38. Florence, Italy. [ONLINE] <http://www.pcst2012.org>

Pestalozzi, J.H. (1898) *How Gertrude teaches her children*. (L.E. Holland F.C. Turner, Trans.) Syracuse, New York: C.W. Bardeen (Original work published 1801).

Pievani, P., Sala, M. & Serrelli, E. (2011) *The discovery between scientists and children: The case of youth Charles Darwin's Notebooks*. Pisa: Piazza Carrara

Reid, N. & Skryabina, E. A. (2002) Attitudes towards physics, *Research in Science and Technological Education*, 20:1, 67–80

Rhodes, M. (1961) An analysis of creativity. *Phi Delta Kappan*, 42, 305-310.

Roberts, G. (2002) *SET for success: the supply of people with science, technology, engineering and mathematics skills*. London: HM Treasury

Rochard, M. (2007) *Report of the high-level group on science education*. Available from http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf [Retrieved February 5th 2014]

Rochard, M. (2007) *Report of the high-level group on science education*. Available from http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf [Retrieved April 10th 2011]

Rogers, C.R. (1954) "Towards a Theory of Creativity." *ETC: A Review of General Semantics*, 11, 249-260.

Rojas-Drummond, S., Mazón, N., Fernández, M. & Wegerif, R. (2006) Explicit reasoning, creativity and co-construction in primary school children's collaborative activities, *Thinking Skills and Creativity*, 1:2, 84-94

Rolfe, L. (2011) The development of partnership based pedagogies. In Chappell, K., Rolfe, L., Craft, A., & Jobbins, V. (2011) *Close Encounters: Dance Partners for Creativity*. Stoke on Trent: Trentham

Rousseau, J.J. (1899) *Emile, or Treatise on Education*. London: Appleton



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Rousseau, J.J. (1920) *The Social Contract*. London: JM Dent & Sons

Sala, M. (2007) *The art of (not) teaching, and the self-organization of children in games and in scientific conversations*. Torino: Change

Sawyer, R. K. (2006) *Explaining Creativity: The Science of Human Innovation*. New York: Oxford University Press

Sawyer, R. K. (2007) *Group genius: The creative power of collaboration*. New York: Basic Books.

Sawyer, R. K. (2012) *Explaining creativity: The science of human innovation (second edition)*. New York: Oxford University Press.

Sawyer, R. K. (Editor) (2011) *Structure and improvisation in creative teaching*. New York: Cambridge University Press.

Scaltsas, T., Stenning, K., Alexopoulos, C., Chappell, K., Craft, A., and Walsh, C. (2013). Co-Creativity Assessment Methodology: C2Learn Deliverable No D2.3.1.

Schmidt, A. (2010) The battle for creativity: Frontiers in science and science education, *Bioessays*, 32, 1016–1019

Schmidt, A. (2011) Creativity in Science: Tensions between Perception and Practice, *Creative Education*, 2:5, 435-445

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

Sternberg, R. J. (Ed.) (1999) *Handbook of creativity*. New York: Cambridge University press.

Sternberg, R. J. and Lubart, T. I. (1998) Creativity across time and place: Lifespan and cross – cultural perspectives. *High Ability Studies*, 9:1, 59 – 74

Sternberg, R.J. (2003). *Wisdom, Intelligence, and Creativity Synthesized*. New York: Cambridge University Press.

Tarrare, A., Savre, A., Belmonte, C. & Castellani, T. (2011) Guideline: How to organise a junior science café. Scicafe project. Available at http://www.scicafe.eu/sites/all/themes/newspro/docs/SCI_CAFE_How_To.pdf



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

Ting, M. (2013). Fostering creative pedagogy among secondary art teacher training students in Taiwan: investigating the introduction of Possibility Thinking as a core of creative pedagogy in a workshop intervention. Unpublished doctoral thesis, July 2013

Thomson, P., Hall, C., Jones, K. & Sefton-Green, J. (2012) *The signature pedagogies project Final Report*. Newcastle upon Tyne: Creativity, Culture and Education. Available from http://www.creativitycultureeducation.org/wp-content/uploads/Signature_Pedagogies_Final_Report_April_2012.pdf [Retrieved 31st January 2014]

Torrance, E. P. (1974) *The Torrance Tests of Creative Thinking – Norms, Technical Manual Research Edition*, Princeton, NJ: Personnel Press

Tytler, R. (2007). Reimagining science education: engaging students in science for Australia's Future. *Australian Education Review*. Australian Council for Educational Research.

UNESCO (2008) First Collection of Good Practices for Quality Education Available from <http://unesdoc.unesco.org/images/0016/001627/162766e.pdf> [Retrieved 24th January 2014]

Wallas, G. (1926) *The art of thought*. New York: Harcourt, Brace.

Walsh, C., Chappell, K. & Craft, A. (in development) Wise humanizing creativity in digital environments

Watermeyer, R. (2012) Confirming the legitimacy of female participation in science, technology, engineering and mathematics (STEM): evaluation of a UK STEM initiative for girls, *British Journal of Sociology of Education*, 33:5, 679-700

Watson, E. (2007) Who or what creates? A conceptual framework for social creativity. *Human Resource Development Review*, 6, 419-441.

Wegerif, R (2010) *Mind expanding: Teaching for thinking and creativity in primary education*. Maidenhead: Open University Press

Woods, P. (1995) *Creative Teachers in Primary Schools*, Buckingham, Open University Press.

Woods, P. (2002) Teaching and Learning in the New Millennium, in C. Day and C. Sugrue (Eds) *Developing Teaching and Teachers: International Research Perspectives* (London, Falmer), 73-91.



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

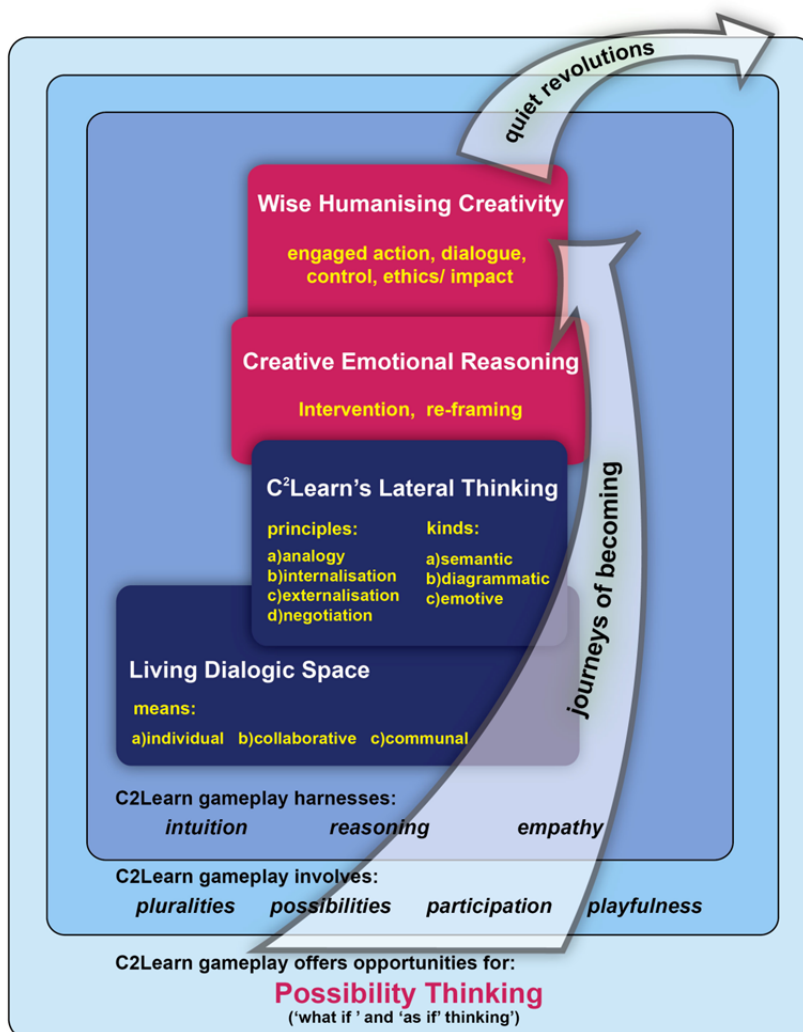
Woods, P. and Jeffrey. B. (1996) *Teachable Moments: The art of creative teaching in primary schools* (Buckingham, Open University Press).

Appendix

Appendix A: C2Learn co-creativity conceptual framework

C2Learn Co-creativity Conceptual Framework

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



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



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

ADDENDUM TO CREAT-IT PEDAGOGICAL FRAMEWORK

Project Reference:	539818-LLP-1-2013-1-NO-COMENIUS-CMP	Editing:	Chappell, K., Hennessy, S., Slade, C.
Code:	D 2.1	Approved by:	
Version & Date:	1.0 2.10.14	Process Owner:	EXETER

Short Description: CREAT-IT intends to create a workable methodology for designing, communicating and representing creative science education approaches for late primary and early secondary schools in Europe. The foundation for this project is presented within Work Package 2 in the three deliverables D2.1 (Pedagogical Framework), D2.2 (Effective Creative Science Teacher Profile) and D2.3 (CREAT-IT Training Scheme and Implementation Scenarios).

This addendum to D2.1 follows on from feedback and discussion within the CREAT-IT team, which concluded that the 12 pedagogic principles would be more manageable in planning and delivery terms if they could be reduced. The Exeter team therefore honed the 12 principles down to 8 principles, which will be used in this format in the project from this point on.

As the project has progressed the CREAT-IT team have come to recognise that the original 12 pedagogical principles presented in D2.1 could be collated further reflecting results from the CREAT-IT survey D2.2, teacher interviews and the beginnings of practical work across the consortium.

Professional wisdom was originally the first of the 12 principles. This has been pulled out of the list and is now seen as an element which is respected and encouraged across CREAT-IT (ie it is a context within which the principles function): it is vital that CREAT-IT has at its heart the wealth of teaching and discipline knowledge and expertise that practitioners bring to the project. This is a deeply contextualized knowledge often informed by intuition, which needs to be in constant conversation with CREAT-IT ideas and theories. This element connects to the survey finding that a creative science teacher is constantly developing and pupil focused: it can be argued that this interrelated development and pupil focus are based in a process informed by professional wisdom.

The main changes are as follows:

- The principle previously entitled 'Relationship between 'bottom up' and 'top down'' has now been blended within the 'Dialogue' principle. It was felt that the process of conversing between top down discipline knowledge and the bottom up curiosity driven questions of students is inherently present within the kind of dialogue which is detailed in the principles,



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

i.e. dialogue which occurs within more flattened hierarchies and allows space for both voices.

- The two principles previously entitled 'Interrelationship of different ways of thinking around a shared 'thread' or 'throughline'' and 'Different ways of knowing' have been merged into one principle 'Interrelationship of different ways of thinking and knowing'. This highlights the importance of both different thinking skills such as problem-finding, problem-solving, exploring, rationalizing, reasoning, reflecting, questioning alongside the role of different ways of knowing the world which are inherent within the sciences (dominantly 'knowing that' and 'knowing how') and the arts (dominantly 'knowing how' and 'knowing this'). The notion of the throughline is played down in the principle heading but would still be expected to be present in whatever core theme is driving any science education project/lesson.
- The principle previously entitled 'Importance of materials' has been blended into the 'Discipline knowledge' principle. It was felt that scientists and artists should understand how the materials with which they work contribute fundamentally to the ideas that they have as part of their discipline knowledge. When this principle is applied in action this is an element to highlight within the Discipline knowledge to science teachers to raise their awareness of this point.

Below are the now 8 CREAT-IT principles (as previously in no particular order):

1. **Individual, collaborative and communal activities for change:** practice within CREAT-IT can allow for all three ways of engaging in activities, and particularly in relation to communal engagement can take advantage of the shared identities within which participants will work, allowing for difference but with a shared creative process and purpose. The survey showed collaboration to be a key characteristic of creative science teaching as well as individual and communal learning as a key strategy, thus reinforcing this principle.
2. **Risk, immersion and play:** CREAT-IT practice can facilitate all three processes across learning and recognizes how pedagogy can assist in creating literal space as well as 'thinking' space for these to occur. This principle is also reinforced by the survey findings, which show risk as being perceived as important to the creative teaching process, and by inference the resulting learning.
3. **Dialogue:** practice can allow for dialogues between people, disciplines, creativity and identity, and ideas. This dialogue needs to acknowledge embodiment (i.e. dialogue is not simply a verbal activity) and difference and allow for conflict and irreconcilable difference. It is important to facilitate open discussion of the questions generated by pupils (bottom up) and bring these into dialogue with live questions from professional science and science education (top down).
4. **Interrelationship of different ways of thinking and knowing:** CREAT-IT practice can allow space for multiple different ways of thinking (e.g. problem-finding, problem-solving,



D2.1 CREAT-IT PEDAGOGICAL FRAMEWORK

exploring, rationalizing, reasoning, reflecting, questioning, experimenting) focused around shared arts/science threads or throughlines. At the arts/science interface it can also offer the space for three different ways of knowing (knowing that - propositional knowledge, knowing how - practical knowledge, knowing this - aesthetic or felt knowledge), as well as acknowledging the embodied alongside the verbal.

5. **Discipline knowledge:** CREAT-IT practice understands the importance of allowing space for the rigorous discipline knowledge of both the sciences and the arts, as well as understanding the importance of materials relevant to those disciplines (e.g. their bodies, with props, with paper and pencil, with sculpting materials, with Bunsen burners and test tubes, with chemicals, with equations). Practice also acknowledges that creativity might interact with these disciplinary knowledge bases differently, albeit in the context of science education.
6. **Possibilities:** – CREAT-IT practice can allow for multiple possibilities both in terms of thinking and spaces, and know when it is appropriate to narrow or broaden these.
7. **Ethics and trusteeship:** CREAT-IT adult professionals and learners consider the ethics of their creative science processes and products and are guided in their decision-making by what matters to them as a community, acting as ‘trustees’ of that decision-making and its outcomes.
8. **Empowerment and agency:** through empowering pedagogies, CREAT-IT can allow both learners and adult professionals to gain a greater sense of their own agency and ability to express themselves, and to then know what to do with that in order to be more creative scientists and to develop more creative science teaching techniques. Enabling pupil agency and encouraging children to try out (and critique) their own ideas in investigations were also key factors to emerge from the survey, thus emphasizing the importance of this principle.