



## Creativity in Early Years Science Education

# Curriculum development methodology report

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## INTRODUCTION

The Council of the European Union has identified one of the education and training goals for ‘Europe 2020’, as the strengthening of creativity and innovation in and through education. The need to sustain and support young children’s creative potential is aligned with acknowledgement of the need for empowering today’s students to become tomorrow’s creative citizens.

The strengthening of science education is another crucial goal in European education policy as it is widely acknowledged that inquiry based science education promotes innovation and curiosity (Osborne and Dillon, 2008). Rocard *et al.* (2007) view the adoption of inquiry-based activities in science education as the way forward to ensure that science education engages students with science and scientific phenomena, through extended investigative work and ‘hands-on’ experimentation.

The link between inquiry-based science education and creativity could be more explicit in both primary and secondary education. A move away from the pedagogy of the correct/wrong answers in science (and other subjects) teaching combined with both pupils and teachers learning ‘to let go’ would be a good foundation for more creative pedagogy. Unlocking children’s creativity through inquiry-based science education in early years would prepare them to take risks, dare to be ‘wrong’, use their curiosity and innovate even in later years. In order to achieve this shift from the ‘right/wrong answers’ pedagogy to an inquiry-based creative pedagogy, changes in educational practices are needed. These changes should encompass different approaches to the development of both new curricula and new initial teacher education (ITE) and continuing professional development (CPD) programmes that would promote the use of creativity, innovation and inquiry-based teaching and learning.

The Council of the European Union (2009), not surprisingly, connected the need for the improvement of the overall quality of the education in the EU with the need for an improvement of the education of teachers. It emphasised that continuing professional development of all teachers and school leaders needs to focus on equipping them with pedagogical and other competences necessary to take on the new roles that would foster a more creative, innovative and inquiry-based pedagogy. In spite of the explicit acknowledgement of the role of teachers there is still need for further support for teachers as change agents within the profession.

The ‘*Creativity in Early Years Science Education*’ (CEYS) project (an Erasmus+ funded partnership consisting of 5 partners from 4 European countries) aims to address the above needs by developing a professional development course that will encourage teachers to promote the use of creative approaches in teaching science in preschool and early primary education and adopt the role of agents of change in their schools and more widely. The project involves stakeholder communities, particularly early years teachers and teacher educators, in the iterative process of design and evaluation of the development course and its accompanying materials. The outcomes of the CEYS project will be immediately usable in the relevant European professional contexts of the partner countries.

The CEYS project is based on the ‘*Creative Little Scientists*’ (CLS) project (<http://www.creative-little-scientists.eu/>) that was funded by the European Union from October 2011 until March 2014. The CLS project explored science and mathematics related activities carried out in pre-school and in the first years of primary schools and their link to the development of creative dispositions among children aged three to eight. The CEYS project will work on expanding the existing state of the art in early years and early primary

inquiry-based science education and creativity, as this has been explored and described by the research project CLS.

The CEYS project intends to sensitize in-service teachers to the synergies between inquiry-based learning and creative approaches identified in CLS, and train them to foster these in their classrooms. In this way, the CEYS project will not only transform the previous outputs into actual practice and provide the means (i.e. the training for early years teachers) for their dissemination, but will also enrich and further develop them through the active involvement of teachers in the development of the curriculum and classroom materials suitable for teaching science creatively and for teacher training.

The CLS literature review of teacher education in science revealed that integrated practices in teacher education institutions concerning science, inquiry and creativity are rare. This situation is of considerable concern given the fact that teachers are the key agents in promoting and nurturing creativity and inquiry in classrooms. Teacher education has a crucial role in promoting approaches that foster creativity and inquiry and in helping teachers develop the imaginative, critical, and reflective processes that are essential in these. The CEYS project thus aims to change this situation by implementing a usable and flexible training curriculum, which easily can be incorporated in broader programmes of initial teacher education (ITE) and/or be the focus of science-specific continuing professional development (CPD) programmes.

There is on the whole consensus that any materials to be used by teachers should be designed in collaboration with them and with the involvement of all relevant stakeholders (e.g. teacher educators, school mentors, school leaders, etc.) in order to be relevant and have the maximum potential for impact. Collaboration between schools and higher education institutions not only improves ITE but also contributes to school development and teachers' CPD. Following the methodology of curriculum development outlined in this document, CEYS will involve teachers as co-designers in the iterative phases of development of its interventions, sharing their ownership and thus facilitating their adoption.

The process of curriculum development is at the core of the CEYS project and, in addition to its focus, is one of its main innovative elements. This methodology indicates that the learning and assessment classroom activities designed in the CEYS project will have an emphasis on stimulating partnerships between teachers and researchers i.e. schools and Universities (the majority of the latter group also being active teacher educators); it is believed that these partnerships will contribute significantly towards bridging the gap between theory and practice, enhancing science education with the focus of creativity, and promoting a vision of science as a creative and dynamic discipline.

This document discusses and presents the methodological approaches of the CEYS project that is the process of curriculum development (for teaching science creatively in early years) the partnership plans to employ.

# 1 OVERVIEW OF APPROACHES TO CURRICULUM DEVELOPMENT

## 1.1 The concept of curriculum

Although there are different and sometimes conflicting ways to define curriculum, it is widely accepted and agreed that the word curriculum derives from the Latin verb *currere* meaning ‘to run’ and can also be understood as a ‘course’ or ‘track’ to be followed. One of the possible implications of the etymological origin of the word might be that a curriculum could be seen as a track/course for learning to be followed. Taba (1962) defined the word ‘curriculum’ precisely like that, namely as a ‘plan for learning’. McKimm (2003:2) argues that ‘curricula usually define the learning that is expected to take place during a course or programme of study in terms of knowledge, skills and attitudes’ and is not to be confused with a syllabus that refers merely to the content of a programme and presents one part of a curriculum.

According to Philips (2008), the definitions of curriculum are also influenced by the way of approaching a curriculum. It can be approached as:

- **content:** a body of knowledge to be transmitted;
- **product:** the learning outcomes desired of learners;
- **process:** what actually happens in the classroom when the curriculum is practiced.

Phillips’ understanding of curriculum can inform the process of curriculum development by focusing on the ‘product’ i.e. final outcome of the curriculum, on the process itself i.e. a methodological approach to both development and application of curriculum in the classroom and on content i.e. syllabus and classroom materials to be used as a body of knowledge. Van den Akker (2007) suggests three different levels of curriculum referring to them as intended, implemented and attained. Each of the levels deals with a different scope of the curriculum: the first one focuses on the curriculum’s overall aims and intentions, the second on teachers’ interpretations and actual classroom teaching and learning processes and the last on the learners’ perspectives and outcomes (see Table 1).

Intended	Ideal	Vision (rationale or basic philosophy underlying a curriculum)
	Formal/written	Intentions as specified in curriculum documents and/or materials
Implemented	Perceived	Curriculum as interpreted by its users (especially teachers)
	Operational	Actual process of teaching and learning (also curriculum-in-action)
Attained	Experiential	Learning experiences as perceived by learners
	Learned	Resulting learning outcomes of learners

**Table 1.** *Different forms of curriculum (van den Akker, 2007:38)*

All three levels are described in detail in continuation. *Intended curriculum* includes two subcategories referring to a) vision or rationale of the curriculum (intended ideal curriculum) and b) intentions as specified in curriculum documents and/or materials (intended formal/written curriculum). *Implemented curriculum* encompasses a) a so-called perceived curriculum that is actually the curriculum as interpreted by teachers and b) an operational curriculum, i.e. curriculum-in-action that entails actual processes of teaching and learning. *Attained curriculum* is divided into a) experiential curriculum, which describes learning experiences as perceived by learners and b) learned curriculum, which focuses on the resulting learning outcomes of learners.

Nonetheless, McKimm (2003) warns that no curriculum is developed from scratch and hence most curricula ‘operate within organisational and societal constraints’. These will be discussed, explored and acknowledged later in the document.

In the CLS project, the international partnership consisting of 12 partners from 9 European countries adopted the definition of curriculum formulated by Taba (1962) and recommended by van den Akker (2007). Moreover, in the CLS project the word ‘curriculum’ was used at three different ISCED-levels: the curricula of preschool and primary schools and the curriculum of teacher education. Similarly in the CEYS project ‘curriculum’ will be understood as ‘plan for learning’ (Taba, 1962) and it will be used at two different levels: for early years science education and for ITE and CPD. While curriculum for teaching early year science creatively will be developed and tested directly with teachers that will be involved in the CEYS project, the curriculum for teachers’ professional development course (ITE and CPD) will be informed by the process itself and by the feedback participating teachers provide. Furthermore, the process of curriculum development will be carried out through different forms of partnerships: partnerships within schools and out-of-school partnerships with colleagues from the university sector and with organisations devoted to research.

## 1.2 Curriculum development in partnership

As mentioned in the introduction, any curriculum to be used by teachers should be designed in collaboration with teachers, teacher educators, school leaders, school mentors and others for obvious reasons of relevance, adoption, implementation, impact and ownership. Partnerships among different stakeholders (schools, teachers, universities and other educational organisations) created to collaborate in order to develop the curriculum and classroom materials for learning can enhance the quality of teacher education (initial and professional development), whole school development processes, pedagogy and learners’ progress.

Literature on curriculum development focuses on different models not all of which are suitable for a partnership approach. The so-called ‘objectives/outcomes model’ is based on the belief that all learning should be defined in terms of what learners should be able to do after participating in the programme. According to this model, the curriculum development process should follow four steps:

- reach agreement on broad aims and specific objectives for the course/programme;
- construct the course/programme to achieve these objectives;
- define the curriculum in practice;
- communicate the curriculum to teachers (McKimm, 2003).

As the last step indicates, this model excludes teachers as co-designers of curriculum and as such leaves no space for a partnership approach. The ‘process model’ for curriculum

development, on the other hand, includes creative, experiential and reflective approaches where ‘learning happens through experience and generally through the dynamics of a group process’ (Fry *et al.*, 1999). In this model a lot depends on the quality of the teacher and the interactions between the teacher and learners, among teachers and among learners themselves. Problem-based learning approaches (that include inquiry, reflection and curiosity) are usually categorised as belonging to the process model of curriculum development although in some instances they can also fit under the objectives/outcomes model. As the CEYS partnership aims to develop (together with teachers) both a curriculum for creative and inquiry-based early years science teaching and a curriculum for a teacher education programme in order to train early years teachers to develop creativity and inquiry-based science education, the process model of curriculum development seems to be the most appropriate choice.

In order to use the curriculum development process as an opportunity for collaboration and reflection on teachers’ learning through partnership experience and through the dynamics of a group process (as described by Fry *et al.*, 1999), it is useful to explore the already existing forms of collaborative and reflective culture among teachers. Hargreaves and Dawe (1990) distinguish between collaborative culture and contrived collegiality. They define the former as comprising evolutionary relationships of openness, trust and support among teachers, whereas they suggest the latter represents rather administratively guided interactions among teachers in order to implement the curricula and pedagogy developed by others. The CEYS project aims to achieve a collaborative and reflective culture (of openness, trust and support) among early years teachers and teacher educators by engaging them in co-designing and co-owning the curriculum for early years science education and for ITE and/or CPD of early years teachers.

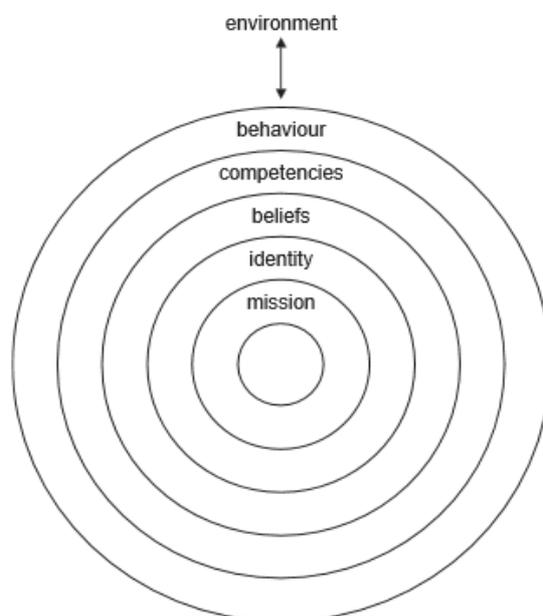
Peer coaching is widely recognised as a form of support and reflection among teachers as it involves a confidential process through which teachers reflect on their practice together, expand and refine their skills, share and build on each other’s ideas, conduct classroom research and engage in professional development. On the other hand, peer coaching of the technical kind has been seen to contribute more to the implementation of the curriculum or the pedagogy, rather than the creation of a collaborative culture in which curriculum, pedagogy or professional development are co-designed and shaped through interaction and reflection (Hargreaves and Dawe, 1990).

Peer coaching is also included in lesson study, a professional development approach that originated in Japan. Many educators around the world acknowledge lesson study as an approach that brought about the Japanese evolution of effective mathematics and science teaching (Lewis and Tsuchida 1997, Takahashi, 2000). Lesson study arguably promotes overall improvement of pedagogy in a collaborative way through partnership among teachers. The visible features of lesson study include: planning, peer observing and coaching and rethinking the lesson. Lesson study claims to encourage teachers to share their understanding of the essential science or mathematics concepts that the learners need to learn, to compare the concepts with curriculum and to identify and consider the existing knowledge of learners. Fernandez (2005) highlights the partnership nature of lesson study by defining it as a process in which teachers come together to examine their practice by planning and trying out lessons. Even though lesson study clearly demonstrates elements of partnership and can be supportive of a collaborative and reflective culture, it seems that its application is more focused on the lessons themselves rather than on the overall curriculum and professional development that could and should bring about changes on different levels

from individual (teachers and learners) to organisational (schools and universities) ones. This is the reason why it was not selected as the core methodology for the CEYS project.

It has been argued that there is no curriculum development without staff development' (Stenhouse, 1975) and that this brings changes on micro and macro levels. Korthagen (2004) is particularly vocal in emphasising the importance of change that, he perceives, teacher education could and should provoke on different levels. As the CEYS project aims not only to develop curriculum for teacher training for early years science education (micro level), but also to contribute to supporting and sustaining the creative potential of the young children to become tomorrow's creative citizens (macro level), it needs to employ a multi-layered approach to curriculum development.

Korthagen (2004) advocates that teacher education should not only focus on changing behaviour, competencies or beliefs, but also take into account teachers' professional identity and their mission as a teacher on a more profound level. Furthermore, in his 'onion model', based on Dilts' (1990), he lists six levels of change (see Figure 1): environment, behaviour, competencies, beliefs, identity and mission. For successful teacher education, he suggests changes on all, particularly, on the innermost levels (beliefs, identity and mission) are required. The two outermost levels, namely, environment (i.e. the class, the learners, the school) and behaviour seem to be the usual focus of both ITE and CPD. Korthagen (2004) invites teacher educators to develop ITE and/or CPD programmes that uncover the beliefs teachers have about their learners, subjects they teach and even about themselves, thus touching on teachers' professional identity and their interconnectedness with wider entities and communities. This is an aspect, which will be integrated into the CEYS methodology.



**Figure 1** *The onion: a model of levels of change.*

In many articles on teacher education 'communities of practice' are recognised as highly supportive and collaborative for improving the practice of teachers. According to Wenger (1998), communities of practice are groups of people who share a concern or a passion for something they do, and learn how to do it better as they interact regularly. In exploring the evidence provided by formal professional development experiences for learning about inquiry-oriented science teaching, many studies embrace the notion of community which provides the chance to learn from others through social interaction. Such communities of practice can be fostered when teachers come together intent on learning from and with one

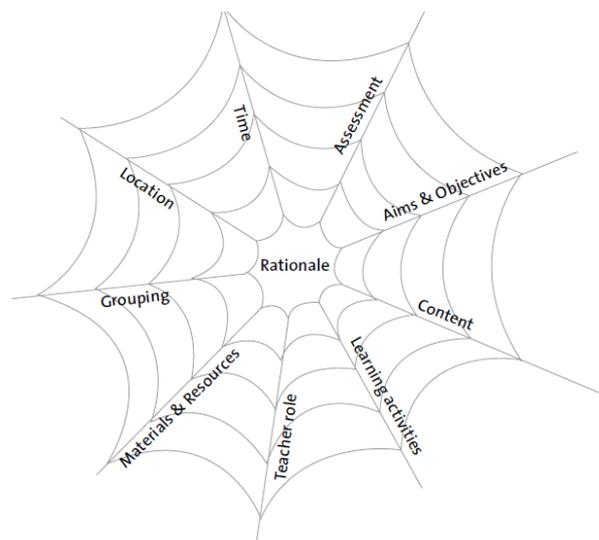
another and other colleagues in the group. This is intended in the CEYS project, which has five groups of five teachers across Europe, working together to build a wider community of practice in partnership with their CEYS co-ordinators.

Based on what has been presented above on curriculum development in partnership (e.g. aiming for collaborative and reflective culture) and on teacher education (e.g. provoking changes through both professional and school development) and based on the recommendations in the literature review on professional development in the CLS project, the CEYS partnership identified action research as its central research method. Action research has emerged in recent years as a significant methodological approach for development, intervention and change. It is a form of curriculum development undertaken in partnership (e.g. aiming for a collaborative and reflective community of practice) provoking changes through both professional and school development.

Action research is defined as an interactive inquiry process that balances problem-solving actions implemented in a collaborative context with data-driven collaborative analysis or research to understand underlying causes enabling future predictions about personal and organizational change (Reason & Bradbury, 2001). The definition of an action research approach is clearly well aligned with the intended CEYS inquiry-based and creative approach to science education, the collaborative and reflective culture of co-designing curriculum in partnership and with the different levels of change needed in teacher education. Similar to Peyton's (1998) curriculum cycle, action research is seen as a cycle with planning, acting, observing and reflecting phases (Kuhne and Quigly, 1997). If curriculum development through action research is carried out in schools among teachers as well as between teachers and teacher educators, it can contribute to partnerships within and beyond school. As such action research seems appropriate for CEYS, since the project's core aim is to develop a curriculum for teacher education in early years science education through a collaborative, reflective partnership approach. The use of action research as a tool for co-designing curriculum to foster creativity and inquiry in science education is discussed in section 1.5.

When developing curriculum in partnership McKimm (2003) points out that alongside the *process* of how curriculum is developed, key aspects of the curriculum *product* like aims, learning outcomes, content, teaching and learning methods and assessment methods also need to be considered. Van den Akker (2007) presents a slightly extended version of key aspects of the curriculum *product* in the shape of the spider web, thus metaphorically illustrating that placing additional focus on one of the key aspects of the curriculum *product* would inevitably influence the shape and the strength of the whole web. The key aspects of the curriculum (see Figure 2) van den Akker presents as the vulnerable spider web are: rationale, aims and objectives, content, learning activities, teacher role, materials and resources, grouping, location, time and assessment. The spider web model was employed in the CLS project and has proven useful and encompassing learning, teaching and assessment methods and contexts.

In discussing the process of educational design research, Plomp (2009) focuses on three phases: the analytical, the prototyping and the assessment phase. Even though they might sound similar to Peyton's (1998) curricular cycle and action research phases, Plomp's three phases could provide an overall framework for the curriculum development methodology thus encompassing phases from both the curricular cycle and action research. Particularly the middle phase, i.e. the prototyping phase with its iterative nature could be considered a perfect phase for iterative cycles of action research.



**Figure 2** *Curricular Spider Web* (van den Akker, 2007, p.41)

As mentioned earlier action research is considered a valuable methodology for development, reflection, intervention, and change and as such it can result in professional and whole school development. The importance of professional development through curriculum development is elaborated below.

### 1.3 Professional development and whole school development through curriculum development

Bolam (1986) stresses five purposes of professional development:

- whole staff, team, department or faculty performance
- an individual teacher’s practice
- an individual teacher’s role or career
- an individual teacher’s professional knowledge
- an individual teacher’s personal education or growth (cited in Craft, 2000, p.17)

The last listed purpose addresses personal education or growth, and thus introduces personal development as an important element of professional development. Many authors would certainly see personal development as being a sub-set of professional development. Craft (2000) argues, “time for such personal education is a good way for someone to recharge their batteries and it can be argued that a teacher who is excited and motivated by the experience of their own learning is likely to be in a strong position to communicate the excitement of learning to pupils” (p.19). In addition, Luera and Otto (2005) claim that professional development standards in the USA recommend a change from teacher as consumer of knowledge about teaching to teacher as producer of knowledge about teaching and learning. Guskey (2002) connects high-quality professional development to nearly every attempt at improving education. Most high-quality professional development programmes aim to “alter the professional practices, beliefs, and understanding of school staff toward an articulated end” (Griffin, 1983, p. 2). Both Guskey and Griffin believe that its essential purpose is thus to improve student learning and hence professional development programmes can be defined as systematic efforts to bring about change in the classroom practices of teachers, in their attitudes and beliefs, and in the learning outcomes of the students.

The curriculum development process, particularly if carried out through action research, could provide a platform for collaborative learning and development of the participating teachers as co-designers, pedagogy development through reflection on and in practice (Schon, 1983) and whole school staff development through peer observations, coaching and cascading approach (Guskey, 2002). Additionally, school communities will benefit from participating teachers sharing their newly acquired skills, knowledge, beliefs and attitudes towards creativity and inquiry-based science education.

Many professional development programmes make an impact due to multidimensional support delivery to teachers. For example, one of the elementary science education programmes proved to be a great success thanks to the use of three important steps/support models (Goebel *et al.*, 2009), namely that: sessions offered in-depth exploration of existing curricular materials, collaboration with scientists, and opportunities for teachers to design and implement sessions for other teachers. The CEYS approach to professional development (of both individual teachers' and whole staff practice, role, professional knowledge and personal growth and whole staff development) through curriculum development will include multidimensional support based on partnerships among teachers within schools, among participating teachers from different schools nationally and internationally, and between participating teachers and teacher educators/universities in the form of the CEYS coordinators.

Professional development for early years teachers (particularly in the field of science education) is influenced by teachers' beliefs about science in general or about their capability to teach science. Frequently early years teachers are unaware of how much they do or do not know and how this might affect their ability to provide appropriate science experiences for young children (Garbett, 2003). The same goes for teachers' beliefs about how creative or otherwise they are and whether they perceive they can foster creativity in the young (Dawson *et al.*, 1999). In order to gain increased awareness, it is planned the teachers will undertake action research as they trial CLS approaches and develop their own strategies through examining the spider web dimensions (van den Akker, 2007) and the CLS associated List of Factors. This will enable them to co-design the curriculum for early years science education. The teachers will be developing classroom materials and curriculum for early years science education and in this process issues associated with partnerships and implementation of change will be explored. Although the teachers/schools will not be developing the curriculum for teacher training itself the issues explored as well as the process, the developed classroom materials and curriculum will hopefully all inform the curriculum and design of teacher training as well as guidance and training materials for teacher training.

Gesemann (2007) advocates giving extensive time for reflection during ITE and professional development claiming that when teachers reflect on their pedagogical praxis they become reflective practitioners and develop faster both professionally and personally. The above mentioned authors emphasise that embracing the reflective phase in any professional development is beneficial for teachers as individuals and for the school settings. As action research is at its core a tool for action and reflection, it is clear it is a supportive tool for professional development. However, one of the main barriers to achieving professional and whole school development through curriculum development process might still be the teachers' own (and the schools') conceptions, attitudes and beliefs about science education and creativity and thus CEYS seeks to enable teacher to reflect upon their own perceptions and expand these.

## 1.4 Teachers' beliefs about science and creativity

It is widely reported that the term science can cause fear in many early years teachers. This can be due to their own science learning experiences, to a perceived lack of sufficient subject knowledge (Murphy et al., 2007) or simply due to a belief that having an in-depth understanding of the nature of science is a prerequisite for teaching science to young children. Research in the field of science education indicates that teachers' beliefs play a key role in the development of their teaching practices (Zacharos et al., 2007; Downing and Filer, 1999; Yilmaz-Tuzin, 2007).

Cullen *et al.* (2010), however, noticed that once teachers began to look for easy opportunities to infuse science into their classroom, their attitudes changed from negative to positive. The CEYS partnership's overall goal is to co-design teacher training programme that would help teachers use creativity and inquiry in early years science education. In order to achieve this, the teachers' beliefs about creativity and inquiry as well as the teachers' beliefs about themselves will need to be considered.

Hamachek (1999) famously claimed that “consciously, we teach what we know; unconsciously, we teach who we are” (p.209). In the light of this statement, van Houtte *et al.* (2012) stated that teachers are expected to become inquirers themselves in order to be able to promote inquiry among young children. Teaching science through inquiry-based activities and processes may assist both teachers and children in developing a science-learning atmosphere that values observation and exploration in non-threatening teaching contexts. Teachers may need to change their beliefs about science teaching and abandon any sense of the ‘right/wrong answers’ pedagogy. Roehrig *et al.* (2011) confirm that the quality of science teaching can be improved by sustained and culturally based professional development where analysis of teachers' own convictions and attitudes towards science are first explored and then slowly changed. As a result, teachers start to listen more closely to their children's interests and ideas and use curiosity to drive instruction rather than any imposed or planned schedule of work. Plomp's (1999) first phase (analysing) of educational design research provides an opportunity for teachers to uncover their existing beliefs about science and/or creativity; the second phase (prototyping) enables teachers to develop a different set of beliefs about science and/or creativity. This is planned in CEYS, through iterative cycles of action research, planning new inquiry-based activities, testing them, observing children and reflecting on the whole process.

Armga *et al.* (2002) explain that “children are continually observing, questioning, and describing the things in their world and they are identifying, comparing one thing to another, and communicating their discoveries” (p.1). Armga values asking questions as a tool for promoting scientific and inquiry-based thinking. In a not dissimilar manner the CEYS curriculum development process for early years teachers will create safe learning contexts in which teachers can experience being co-designers, reflective and curious practitioners, inquirers, asking and answering questions and using creative approaches to science teaching.

The teacher education literature exploring the connections between creativity and early years science education notes that the majority of practitioners see creativity concerned with supplying specific resources or activities, rather than processes (Worthington, 2011). Bore (2006) sees creativity in science being fostered in teachers by means of curriculum development that encompasses four stages: uncertainty, visioning, realization, and readiness. ‘Letting go’ of scheduled instructions and adopting risk-taking, play, collaboration, questioning and curiosity might be a way to promote creativity in early years science education. Most recent research suggests that technology can improve teaching and that ICT

can be used to enhance creativity. One study (OECD, 2010) showed that teachers who believe that their ICT training was helpful select interactive and social computing applications as contemporary tools for more creative pedagogy. Other research shows that for creativity to be fostered teachers need to believe that they are capable of creating a learning environment that will provide conditions for, at least, divergent thinking (Cheng, 2001) and risk-taking (Dalgarno & Colgan, 2007).

In the CLS project the following general definition of creativity was initially agreed upon: ‘creativity is a purposive imaginative activity generating outcomes that are original and valuable in relation to the learner’, drawn from the NACCCE (1999) report. The consortium defined later creativity in science and mathematics as ‘generating ideas and strategies as individual or community, reasoning critically between these and producing plausible explanations and strategies consistent with the available evidence’ (CLS, 2014). The project also identified that inquiry-based and creative approaches to learning and teaching have some features in common. These pedagogical synergies were identified as including:

- Play and exploration;
- Motivation and affect
- Dialogue and collaboration
- Questioning and curiosity
- Problem-solving and agency
- Reflection and reasoning
- Teacher scaffolding and involvement
- Assessment for learning (CLS, 2014)

Teachers’ beliefs about these synergies between creative and inquiry-based approaches to teaching and learning may hinder or enhance their professional development through the process of co-designing curriculum for early years science education and teacher training. For example, Newton & Newton (2010) argue that some practicing primary teachers may need to widen their views to see constructing a scientific explanation as a creative incident. They suggest that to foster creativity and inquiry-based approaches to teaching and learning making a ‘direct link between the word ‘creativity’ and ‘productive thoughts’ in science education could be beneficial, in order to provide a wider view of what creativity in science can offer (Newton and Newton, 2010).

It is the CEYS partnership’s task to develop the most appropriate curriculum development methodology that will encourage early years teachers to promote as many synergies between inquiry-based and creative approaches to early years science education as possible.

## 1.5 Action research and rationale for selection of action research

Even though many authors differ in how they define action research the social psychologist Lewin (1999) is quite unanimously considered the ‘inventor’ of action research. Action research can be described as a form of inductive, practical research that focuses on gaining a better understanding of a practice problem or achieving a real change or improvement in the practice context. It is essentially a systematic process of practitioner problem-posing and problem-solving. The idea of action research was taken up in the field of education in the USA during the 1950s. Its focus was on enabling teachers to apply scientific methods to solve their practical classroom problems, and thereby improve the educational process. This action research movement had become more dispersed and diverse by the end of the 1950s,

but the idea of classroom action research was revived by Stenhouse, Elliot and others, who were promoting the concept of the ‘teacher as researcher’ in Britain in the late 1960s and 1970s (Stenhouse, 1975; Elliot, 1991). When curriculum and professional development were merged into a single activity that engaged teachers as active agents in the 1960s Stenhouse strongly argued for teachers’ involvement in research (Cochran-Smith & Lytle, 1990). In the 1970s, work in the United States on practical inquiry also called for teachers to play a central role in curriculum development and to engage in reflection by paying close attention to the children and their own pedagogic practice (Elbaz-Luwisch, 2006). Since then the teacher research movement, which foregrounds the potency of action research and reflective practice, has grown internationally (McAteer, 2013).

The distinctive elements of action research are summarised by Kemmis and McTaggart (1984), who describe it as an open, on-going process based on putting new ideas to the test:

*“[It involves] trying new ideas in practice as a means of improvement and as a means of increasing knowledge about the curriculum, teaching, and learning. The result is improvement in what happens in the classroom and school, and a better articulation and justification of the educational rationale for what goes on. Action research provides a way of working which links theory and practice into the one whole: ideas-in-action” (Kemmis and McTaggart, 1984 p.5).*

On the other hand, Carr and Kemmis (1986) define it as “simply a form of self-reflective enquiry undertaken by participants in social situations in order to improve the rationality and justice of their own practices, their understanding of these practices, and the situations in which the practices are carried out.” (cited in Hammersley, 2004, p. 162). Kuhne and Quigley (1997) further describe action research as a “practical tool for professional development of educators” (p.24). Lewin (1999) portrayed action research as involving a spiral process in which a hypothetical solution to a problem is formulated and tried out, its level of success monitored, the proposed solution reformulated in light of this, the new strategy implemented and assessed and so forth.

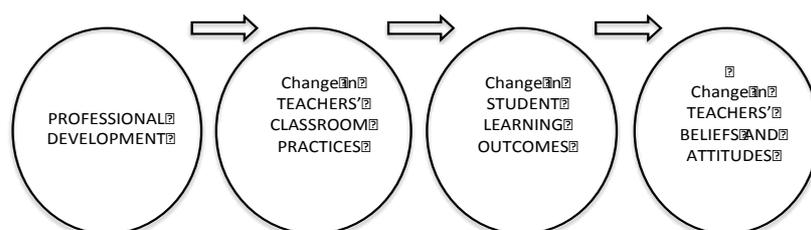
It has been argued there are four different types of action research, varying across several dimensions depending on whether it is carried out solely by practitioners or involving external agents; whether it is pursued individually or collectively; whether it is concerned with local and specific problems or with bringing about wider educational or social change; which methods it favours; what methodological or theoretical stances it draws on, for instance positivism, pragmatism, interpretivism, critical theory, or post-modernism (Hammersley, 2004, p.165). Using Hammersley’s criteria the CEYS curriculum development process might be described in the following way:

- It is carried out both by practitioners and external agents/partners (partnership of teachers and teacher educators).
- It is pursued both individually (each teacher on their own in their school settings) and collectively (all involved teachers and teacher educators),
- It is concerned with both local and specific problems (classroom material) and with bringing about wider educational or social change (introducing both co-designing process of curriculum and the use of inquiry-based and creative approaches to early years science education)
- It draws mainly on interpretivism as it is planned to use focus groups, semi-structured interviews, teachers’ reflections etc. However it is possible that the curriculum development process might draw on other methodological and theoretical stances.

The above discussion of the CEYS curriculum development process suggests that the ‘types’ of action research may sometimes overlap and that this particular process is multi-layered and all-encompassing and as such it needs a methodology matching its complex and interwoven nature. Action research with its iterative cyclical model of 4 phases (planning, acting, observing and reflecting) seems to live up to the criteria of being multi-layered, all-encompassing and interwoven.

In sum, having explored approaches to curriculum development in general and in partnership approaches as well as professional and school development and the significance of teachers’ beliefs about science and creativity, it is clear that action research could address all of these key elements:

- *curriculum development in partnership* emphasised the collaborative and reflective nature of the process and action research in its 1<sup>st</sup> and 4<sup>th</sup> phases provides conditions for collaborative planning and reflecting ;
- *collaborative curriculum development* initiates both professional development of individual teachers and whole school development, and action research through its 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> phases enables individual teachers to act, observe and reflect on their own and other teachers’ practice. Action research also enables teachers and schools to become change agents as changes in curriculum and in teacher training will be initiated by them;
- *teachers’ beliefs and attitudes toward science and creativity* might need to be changed in order to fully promote inquiry-based and creative approaches to early years science education. Guskey’s (2002) model of teacher change demonstrates that with the carefully designed professional development, changes in teacher’s classroom may be initiated which influence changes in student learning outcomes that in turn may impact upon teachers’ beliefs and attitudes (Figure 3). As the action research process assigns a central role to teachers and enables them to become agents for change Guskey’s model reinforces the CEYS choice of action research as a methodological approach to co-designing curriculum with teachers.



**Figure 3** A Model of teacher change (Guskey, 2002)

### 1.5.1 Action research in science education

Focusing on teacher research into science education, Oversby (2011) comments that this can be perceived as a ‘fuzzy discipline’ in which conclusions reached are often able to say little more than what sort of teaching worked well in a particular situation with particular group of pupils. However it is evident that that there is research going on in science education by practitioners who seek to explore topics relevant to them, design their research and subsequently act upon the findings and outcomes, shaping their curriculum in the process. Oversby (2011) argues that the benefits of such research are that the practitioner is engaging with other research in the field, which when published thus contributes to research overall.

While the literature indicates that within education there is a recognition that action research can lead to developments in classroom practice in science (Oversby, 2011) the literature searches did not uncover a wide range of published papers pertaining to action research in science education. A reason for this may be that while action research projects are commonly undertaken by practitioners (in Masters programmes for example), improvements in practice and developments in knowledge stay within the classroom and the findings are not necessarily shared with the wider community. However, there are a number of publications which looked at the experience of action research either as case studies of individual practitioners engaging in it or reflections on engagement with groups of practitioners engaging in action research in science. From these we can pull together some common themes that are significant and can inform the CEYS project.

Johnston (2011,p. 158) supports the idea of practitioners engaging in action research to develop their teaching of science. Drawing on Elliot (1991) and McNiff and Whitehead (2002) Johnston defines action research as a ‘methodology in which the professional attempts to improve or develop practice in a cyclic way’ (2011 p.196) and thus requires reflection on action (Schon, 1983). Johnston proposes that when research in science education is focused on teacher practice in this manner it consequently has the ability to act as a tool for improvement. She outlines the threefold nature of its benefits, arguing it

- Develops the personal capacity of practitioners to engage with research
- Raises the level of critical thinking about teaching and learning
- When published – shares valuable outcomes with others.

Goodnough (2003) as a facilitator of an action research group presents an engagement in critical self-reflection and through this process identifies key issues to consider in undertaking action research in science. The project, in alignment with the views of Elliot (1978) and McNiff (1996), sought to develop aspects of professional practice and a critical understanding of the teacher’s practice and themselves. It was defined as being ‘practical in nature’, with a focus on teacher development and the improvement of classroom practice’ (Goodnough, 2003, p.44). Goodnough’s (2003) reflections highlight that the teachers involved in the action research project became more confident in their ability to teach science (p.56). Of significance also, was the finding that alongside this development in self-confidence was the benefit of the collaborative nature of the project. It was evident that the more experienced science teachers were able to support the development of subject knowledge in other group members.

These findings support the proposals for conditions for quality action research explicated by Capobianco and Feldman (2006) who reflect on their participation in a number of different action research projects with groups of teachers. In doing so they explore the notion of quality action research and pose the question "what does quality in action in teacher action research look like" and “what steps can be taken to promote quality in teacher action research” A number of factors necessary to achieve quality action research are proposed. They argue that an action research group must operate not only as a community of practice (Wenger, 1998) but also as what they term an ‘epistemic community’. This is based upon their premise of quality action research as being such that classroom practice is to be improved but also knowledge and understanding is generated. This will need to be considered during the CEYS project especially how this might be supported with a specific focus on creativity and inquiry in science education. Careful thought needs to be given to what could prompt and support this *subject specific* debate. For this to occur the teacher researchers must have a solid grounding of the nature of action research and knowledge of appropriate research methods. A factor which emerged as significant was the ability and

interest on the part of teachers to stimulate open discussions with teachers' questioning and exploring ideas, and collaborating with one another with the intention of exchanging knowledge and understanding.

To summarise, Capobianco and Feldman (2006) present four assertions about the conditions necessary for action research, which is high quality and collaborative in nature.

1. The collaborative action research group must function as a community of practice (Wenger, 1998).
2. The action research group must also function as a “knowledge producing epistemic community” (Creplet et al., 2003).
3. The teachers involved in the action research need to have a thorough grounding in the very nature of action research.
4. The teachers involved need to have knowledge of appropriate research methods.

Briscoe (2002) presents a case study of one teacher's experience of action research in science and explores factors, which supported the research process. One such as factor was the collaborative environment in which to share ideas and gain support – echoing the views of Capobianco and Feldman (2006) and Goodnough (2003). The second factor was that teachers engaging in action research need a commitment to change, the determination to develop and improve practice and need to perceive a need to change in order to overcome constraints and challenges which they will inevitably encounter. Time was a constraint given particular consideration. A further assertion made by Briscoe (2002) regarding influential factors was that during the research process any teacher engaged in action research needs to examine and develop their own understanding of the nature of science and conceptualise what science is to them. The experience showed that previously taken for granted understandings of what children knew and how they learn science were challenged, as a result of this the teacher's confidence in her own teaching of science subsequently increased. The lessons from these studies have been attended to in designing the CEYS project. Ideally during and after the CEYS project some follow up activities on this would be helpful focusing in more detail on nature of science and science learning.

### **1.5.2 Action research in creativity in education**

While historically creativity has been researched through empirical work and mainly through large-scale, positivist studies (see e.g. Guilford 1950) creativity in education has recently been investigated and reflected upon through more qualitative approaches. Some such approaches have been co-participative in nature and have involved teachers not as the object of the research but as collaborative members of the research team. For example in the body of work examining possibility thinking (e.g. Burnard et al., 2006; Craft et al., 2012, 2013; Cremin et al., 2006), teachers collected data and reflected on their own practice through video stimulated review. However it should be acknowledged that despite their involvement they were working largely to the agenda set by the university based researchers. There are relatively few documented studies of action research being used to investigate creative teaching and learning. The notable exception is ‘the Creativity Action Research Awards’ (CARA, 2005), which, led by CAPE UK, and funded by Creative Partnerships, included 104 individual projects carried out in 145 schools across the UK in 2005-6. This programme not only used action research but also a partnership approach as the projects were run with around 300 teachers and creative partners, supported by a team of 52 mentors drawn mainly from Higher Education. Around 3000 young people took part.

The CARA programme was deemed to be successful and confirmed that the use of the action research cyclical approach contributed to the freedom to try things out in a genuine spirit of enquiry and exploration. The mentors' (mainly teacher educators/university partners) role was particularly crucial. They stimulated thought and ideas, helped partnerships reflect on the issues, challenged thinking through asking questions, advised on action research instruments, helped co-plan different projects, co-analysed and interpreted data and organised and collated material. They also acted as critical friends seeking to enable the teacher-artist partnerships to interrogate their practice and the impact of the changes upon the children and young people. This body of work is relevant for the CEYS project as it not only employed action research, but also a partnership approach in which teacher educators supported teachers in co-designing creative projects.

However whilst there are similarities with CEYS there are also significant differences, all studies involved the use of a creative partner, in addition to the university mentor partner-these colleagues from the creative and cultural sectors made a vital contribution to the development of teachers' action research studies and indeed were integral to them. Such work is not sustainable without significant finance. Additionally few of the CARA studies focused upon creativity in science in the early years. There was one exception however, which was a study that sought to profile questioning in the context of a creative Learning Journey on Forces, and to identify practical classroom strategies, which could foster children's curiosity (Williams and Cremin, 2007). It involved the practitioner in working with 6-7 year olds to explore the scientific concept of Forces with the long-term goal of producing a radio programme through which the children could communicate their learning to their peers. This goal gave the project a real life application, which was considered to be crucial in lending validity and relevance to the work in the eyes of the learners (Woods, 1994). Through the action research project the practitioner perceived that the young people became more aware of being active participants in their own learning, began more confidently to use scientific vocabulary and were increasingly able to talk about and reflect upon their learning. In the words of the practitioner: "Our classroom experience became dominated by a climate of inquiry. We profiled questioning, we profiled thinking, and we profiled reflection. We went where we did not expect to go!" (Williams and Cremin, 2007:13). However, the degree to which working in partnership influenced the teacher's practice in the longer term was not examined, although it was clear that the opportunity to work with others, to question and reflect upon pedagogic practice and children's learning encouraged the practitioner to take risks and let the children lead and shape their learning more than usual, a key characteristic of creative endeavour. The CEYS project seeks both to afford new spaces for teachers to shape their own enquiries in the light of insights from the CLS research, but also to document and understand the role of the partnership in supporting this process.

### 1.5.3 Action research, science and creativity in education: challenges and consequences

The literature reviewed in the previous sections has identified a number of important factors impacting on the effectiveness of action research projects, and in relation to teachers engaging in such research focused on science and/or creativity.

As McKimm (2003) notes, no curriculum is developed from scratch and hence most curricula 'operate within organisational and societal constraints'. One of the challenges for the use of action research in science and creativity in education is linked to the need for organisational support within school and communal support out-of-school (parents, carers etc.). Without the

support action research may not be as effective in bringing about change. Additionally, teacher research can be challenging as it takes time, requires trust and a sustained commitment to working collaboratively to question, observe, analyse and problem-solve in teacher groups. The importance of creating a collaborative environment and fostering a community of practice in which to share ideas and expertise and gain support and understanding is seen to be vital (Goodnough 2003, Capobianco and Feldman 2006, Briscoe and Wells 2002). The partnership approach inherent within the CEYS project is pertinent here; the CEYS partner will play a key role in facilitating these conditions, this is further emphasized by the experiences of the CARA project (2005) outlined above. Another matter of potential concern is that as Somekh (2006) has warned, there are somewhat limited forms of practitioner research where teachers are only guided to trial something new or reflect upon their pedagogy and in such cases the scope of reflection is primarily ‘technical’ in nature (Kemmis, 2006). The CEYS partnership seeks to guard against this and offer a sufficiently deep frame for reflection that for example addresses the teachers’ beliefs, values and professional identities as well as their practice.

A commitment on the part of teachers to develop and improve practice, borne from a clear perception of a need for change will also need to be developed within CEYS. There is evidence (Briscoe and Wells 2002) that when teachers engage in action research, or implement change generally, they face obstacles and constraints, a lack of time or a sense of the change not yet having the desired effect for example. There may even be a possibility of the teacher abandoning the project. In the CEYS project it might be strategic to ‘recruit’ more teachers in order to avoid endangering the project due to some teachers abandoning it. In Briscoe and Well’s (2002) study it was seen that a ‘personalised commitment to change’ acted as a motivating force for continuing. Time to allow the practitioner to identify a genuine need for change within their class or school and to formulate coherent goals will thus be written into the CEYS project in order to contribute to the effectiveness of the action research project. Strategies for change and challenges will be important to feed into the training guide and materials for teacher training as well. There is also a need for teachers to have a sound understanding of the nature of action research and appropriate methods.

A willingness to examine and develop their own understanding of the nature of science and conceptualise the ways in which science and creativity work together will be needed as well as constant support and on-going input by the CEYS partnership. It is anticipated that where such willingness is present, then the action research process will support this reconceptualization in line with Guskey’s (2002) model of teacher change (as outlined in 1.5).

#### 1.5.4 Change management

In order to support teachers through the action research cycle that brings about changes on different levels it is worth exploring the employment of the **ADKAR** Model (Hiatt, 2006) which emphasises the importance of having an **A**wareness of the need to change, then **D**esire to participate and support the change, **K**nowledge on how to change, **A**bility to implement required skills and behaviours and **R**einforcement to sustain the change (see Figure 4). The action research approach (with its on-going reflective phase) seems to be an appropriate tool for raising awareness of the need for change. The CEYS partnership plans to facilitate change already built into the initial phase of the CEYS project (induction workshops) and through two action research cycles, which the teachers will undertake. The 5 curriculum development workshops will contribute to the body of knowledge on how to change and the teachers’ action research and reflection upon it, alongside their discussions with peers at the workshops will lead to enhanced capacity to foster creativity in early years science education and

materials to feed forward into the project's outcomes. The CEYS country coordinator will provide reinforcement for the sustainability of the changed practice through visits to schools and in-between workshops Skype conferences.



**Figure 4** ADKAR Model (Hiatt, 2006)

Another approach for supporting change management to be considered is coaching. Although there are variations across different programmes, the common theme is of coaching being facilitative rather than instructional (Creasy and Patterson, 2005; Hanbury, 2009) with the process resting on the coach reflecting back to the learner what they observe or hear, in order that the learner can set goals, resolve problems and take action. This approach draws from Whitmore's (2002) GROW model (goal, reality, option, will) where reflection can lead to change in practice. (Forde et al., 2012, p.106). The International Coach Federation, the oldest professional body in the coaching field, defines coaching 'an on-going interactive relationship that helps individuals/organizations deepen their learning and initiate new patterns of thinking in order to achieve extraordinary results.' [[www.coachfederation.org](http://www.coachfederation.org)]. Coaching though has not been selected for CEYS, in part because it focuses on the skill set of another and does not afford such rich opportunities for university and school partnership as facilitated action research. In action research, the teachers, whilst guided by the CEYS coordinators in the lights of CLS insights, will be able to identify areas for development in response to school and learner needs. The teachers will each be supported in identifying school needs in the light of the CEYS spider web and earlier work in CLS focused on creativity in Early Years science. Thus this partnership has stronger collaborative potential than a somewhat asymmetrical coaching frame.

## 2 OVERVIEW OF THE CEYS METHODOLOGY

### 2.1 The ‘Creative Little Scientists’ and the CEYS methodological frameworks: similarities and differences

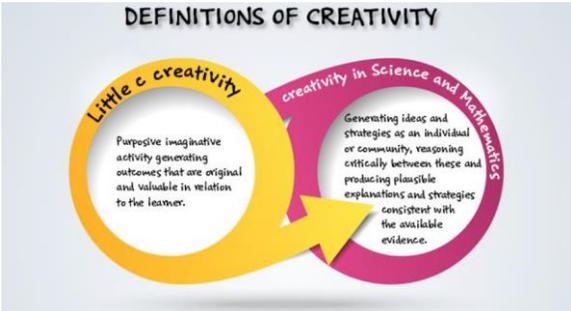
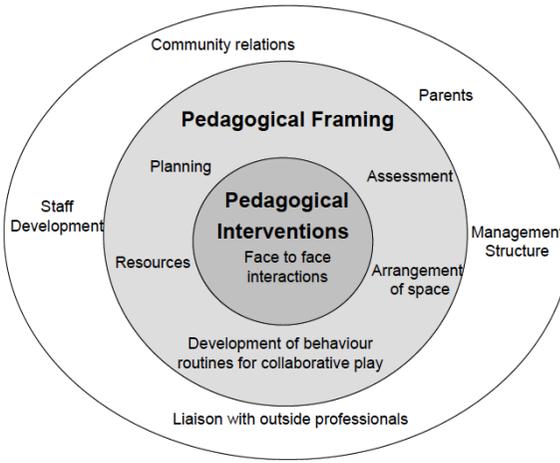
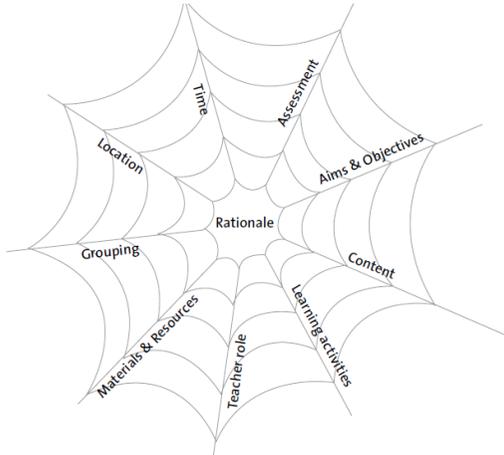
As the CEYS project builds on the CLS project it would be beneficial to review the CLS methodological framework first in order to explicate similarities and differences. The methodological framework of the CLS project was informed by the following principles/practices/priorities (see the CLS deliverable *D4.1 Methodology for in-depth fieldwork*):

*Conceptual framework – definition of creativity and synergies:* The CLS partnership agreed on the definitions of creativity in science and mathematics as well as created the list of synergies between creative and inquiry-based approaches to science and mathematics education (see Table 2).

*Curriculum strands and curriculum spider web dimensions:* Van den Akker’s (2007), curriculum spider web, offers a framework of curriculum components, comprising key aspects of learning in schools: Rationale or Vision; Aims and Objectives; Learning Activities; Pedagogy (or Teacher Role); Assessment; Materials and Resources; Location; Grouping; Time; Content. These dimensions were grouped under three broad strands: *Aims, purposes and priorities*; *Teaching, learning and assessment*; and *Contextual factors* (see Table 2).

*List of factors:* The list of factors reflects the concepts and processes identified in the CLS project’s conceptual framework as characterising creative practices in early years science and mathematics education (see Appendix 16)

*Pedagogical model:* The CLS fieldwork explored pedagogy including ‘pedagogic interventions’ in the context of the wider pedagogical framing and school context as shown below (see Table 2). The model is drawn from the work of Siraj-Blatchford et al. (2002).

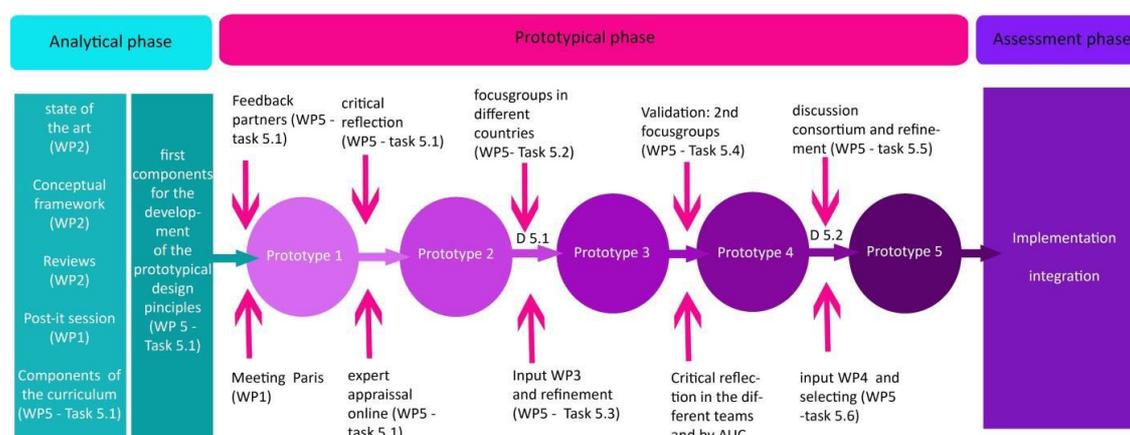
<p align="center"><b>Conceptual framework</b> (definition of creativity and synergies)</p>	<p align="center"><b>Curriculum Strands and Curriculum spider web</b> (van den Akker, 2007)</p>	<p align="center"><b>Pedagogical model</b> (Siraj-Blatchford et al., 2002)</p>
<p><b>Creativity in science and mathematics:</b> generating ideas and strategies as individual or community, reasoning critically between these and producing plausible explanations and strategies consistent with the available evidence.</p> 	<p><b>Curriculum Strands:</b></p> <p>Aims/purpose/priorities</p> <p>Teaching, learning and assessment</p> <p>Contextual factors</p>	
<p><b>Synergies between creative and inquiry-based approaches:</b></p> <ul style="list-style-type: none"> <li>- Play and exploration</li> <li>- Motivation and affect</li> <li>- Dialogue and collaboration</li> <li>- Questioning and curiosity</li> <li>- Problem-solving and agency</li> <li>- Reflection and reasoning</li> <li>- Teacher scaffolding and involvement</li> <li>- Assessment for learning</li> </ul>	<p><b>Curriculum spider web dimensions:</b> rationale, aims and objectives, content, learning activities, teacher role, materials and resources, grouping, location, time and assessment</p> 	

**Table 2** Overview of the principles/practices/priorities underpinning the CLS methodology

The CEYS project will apply the same principles/practices/priorities and will extend the scope for exploring pedagogy including pedagogical framing (planning, resources, assessment etc.) and the wider context of staff development and liaison with outside professionals. In this case these will be the partner CEYS co-ordinators.

The CLS project adopted the interpretive paradigm and through a qualitatively-focused approach to research encompassed both the processes and outcomes of learning. The CEYS project will also use interpretivism, which is usually defined as “a view, which argues that there are no absolutes, but that all phenomena can be studied and interpreted in different ways” (Burgess *et al.*, 2006, p.55). This qualitatively-focused approach will be employed in order to co-design curriculum with the 25 teachers for the planned early years professional development programme. The CEYS approach will focus on both children’s and teachers’ learning in alignment with the CLS work.

As mentioned earlier, CLS used van den Akker’s (2007) curriculum spider web as a tool for exploring the *product* of the curriculum process. Plomp’s (2009) educational research phases were used to frame the *process* of curriculum design (see Figure 5)



**Figure 5** Curriculum design research model of the Creative Little Scientists project

Out of the three phases in Plomp’s (2009) model (the analytical, the prototyping and the assessment one) it should be noted that the assessment phase did not form part of the work assigned to the CLS project, according to its Description of Work. The implementation and evaluation of the proposed curriculum design principles, guidelines and related teaching materials (see deliverable D5.3) in teacher education settings with student teachers or in-service teachers were hoped to be the focus of future studies. The CEYS project is the ‘future study’ that will exploit the outputs of the CLS project in order to develop a prototypical professional development course that aims to sensitise in-service teachers to the synergies between inquiry-based learning and creative approaches and to train them to foster these in the classrooms.

The CEYS project will also use the curriculum strands, van den Akker’s (2007) curriculum spider web and the List of Factors as a framework for describing the *product* of the curriculum development process i.e. the curriculum for a professional development training of teachers and Plomp’s (2009) model for framing the *process* of the curriculum development with the emphasis on all three phases and especially on the third phase (Table 3).

In the 3-year long CEYS project partners will:

- carry out teacher training needs analysis through 2 focus groups;
- organise 2 induction workshops (for up to 50 early years teachers, school staff, teacher educators etc.);

- select 5 lead schools from which 5-10 early years teachers would be ‘recruited’;
- deliver 5 days of curriculum development workshops for the 5-10 ‘recruited’ teachers;
- support 5-10 ‘recruited’ teachers to undertake two cycles of action research and collect data on the impact of the changes implemented by documenting minimum 3 children’s learning and engagement in on-going reflection in their portfolio;
- develop curriculum, syllabus, training modules, training guide and scenarios of use for a professional training course of early years teachers that will support them in promoting the use of creative and inquiry-based approaches in science education;
- test and evaluate the developed curriculum, syllabus, training modules, training guide and scenarios of use for a professional training of early years teachers during the two 6-day long Summer Schools (July 2016 and 2017);
- develop prototypical classroom materials for early years science education;
- develop the CEYS Curriculum Development Guide.

In the CEYS project it is suggested that the following terms are used:

- **Lead school:** the actual school/pre-school selected for the participation in the project
- **Setting:** the type of education offered (pre-school or school)
- **Participating teachers:** the early years teachers ‘recruited’ from the lead schools
- **Case:** a child that is observed by a teacher

For the fieldwork in the CEYS project, each partner will work in collaboration with a minimum of 5 participating teachers from 5 lead schools (both pre-school and school) through 5-days of curriculum development workshops and through guidance and support offered to the teachers in diverse ways. The teachers will be undertaking two action research cycles and observing 3 focus children and reflecting upon their learning and that of the children. Each teacher will record much of this learning in their professional learning journey portfolios (see section 5).

To sum up, the following structure for the CEYS overall methodological framework (for the curriculum development process and product) is suggested:

THE CEYS CURRICULUM DEVELOPMENT OVERALL METHODOLOGICAL FRAMEWORK					
Process (How?) – Educational design (Plomp, 2009)			Product (What?)		
Analytical phase	Prototyping phase	Assessment phase	Curriculum Strnads	Curriculum web dimensions (van den Akker, 2007)	Synergies between CA and IBSE approaches
(the elicitation of present state and the definition of desired state)	(action research cycles during curriculum development workshops)	(monitoring and evaluation of curriculum development process, methodology and products)	Aims/purpose/ priorities  Teaching, learning and assessment  Contextual factors	- Rationale - Aims and objectives - Content - Learning activities - Teacher role - Materials and resources - Grouping - Location - Time - Assessment	- Play and exploration - Motivation and affect - Dialogue and collaboration - Questioning and curiosity - Problem-solving and agency - Reflection and reasoning - Teacher scaffolding and involvement - Assessment for learning

**Table 3** Overview of the CEYS Curriculum development methodology framework



Even though the CEYS project does not aim to carry out a comparative study, it is important to emphasise that for working across various countries, cultures or regions the same methods of data collection and analysis are required. On the other hand, the CEYS partnership needs to consider the cultural differences in the various countries and their impact on both the data collection and analysis.

During data collection (on the part of both CEYS coordinators and teachers in their classrooms) the elements of the curriculum web, the List of Factors and synergies between inquiry based science and creative approaches (as described in Table 4) will be utilised as an underpinning framework and as prompts for data collection (e.g. within the focus groups, interviews, teachers' reflections, teachers' observations of focus children, feedback sessions etc.)

CURRICULUM DEVELOPMENT – PRODUCT		
Curriculum Web (van den Akker, 2007)	Curriculum Strands, Dimensions and Relevant Questions	Synergies between creative approaches (CA) and inquiry-based science education (IBSE) in the early years
Rationale	<b>Aims/purpose/priorities:</b> <u>Rationale or vision:</u> Why are teachers learning? <u>Aims and objectives:</u> Toward which goals are teachers learning?	<b>Play and exploration:</b> recognising that playful experimentation/exploration is inherent in all young children's activity; such exploration is at the core of IBSE and CA in the Early Years.  <b>Motivation and affect:</b> highlighting the role of aesthetic engagement in promoting children's affective and emotional responses to science activities  <b>Dialogue and collaboration:</b> accepting that dialogic engagement is inherent in everyday creativity in the classroom, plays a crucial role in learning in science and is a critical feature of IBSE and CA, enabling children to externalise, share and develop their thinking.  <b>Questioning and curiosity:</b> recognising that across science teaching and learning creative teachers often employ open ended questions, and promote speculation by modelling their own curiosity.  <b>Problem-solving and agency:</b> recognising that through scaffolding the learning environment children can be provided with shared, meaningful, physical experiences and opportunities to develop their creativity as well as their own questions and ideas about scientifically relevant concepts.  <b>Reflection and reasoning:</b> emphasising the importance of metacognitive processes, reflective awareness and deliberate control of cognitive activities, which may still be developing in young children but which are incorporated into Early Years practice, scientific and mathematical learning and IBSE.
Aims and objectives		
Learning activities	<b>Teaching, learning and assessment:</b> <u>Learning Activities:</u> How are teachers learning? <u>Pedagogy:</u> How is the teacher educator facilitating learning? <u>Assessment:</u> How is the teacher educator assessing how far teachers' learning has progressed, and how is s/he using this information to inform planning and develop practice?	
Pedagogy		
Assessment	<b>Contextual factors:</b> <u>Content:</u> What are teachers learning? <u>Location:</u> Where are teachers learning? <u>Materials and Resources:</u> With what are teachers learning? <u>Grouping:</u> With whom are teachers learning? <u>Time:</u> When are teachers learning?	
Content		
Location		
Materials and resources		
Grouping		
Time		

		<p><b>Teacher scaffolding and involvement:</b> emphasising the importance of teachers mediating the learning to meet the children’s needs, rather than feeling pressured to meet a given curriculum.</p> <p><b>Assessment for learning:</b> emphasising the importance of formative assessment in identifying and building on the skills attitudes, knowledge and understandings children bring to school; supporting and encouraging children’s active engagement in learning and fostering their awareness of their own thinking and progress.</p>
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**Table 4** *Overview of the CEYS Curriculum development - product*

## 2.2 The analytical phase

In the first phase, i.e. in the analytical phase of the curriculum development process, the CEYS partnership will elicit the present and desired states in:

- a) early years teacher education; and
- b) early years science education

The following instruments will be used:

- Focus groups (with teacher educators, early years teachers/practitioners, early years student teachers, school staff and potentially policy makers) – see Report on Focus Groups
- Induction workshops with the survey at the end (with early years teachers, teacher educators and school staff members) – see Report on Induction Workshops
- 1 initial teachers’ survey – see Appendix B in Teachers’ portfolio
- 1 Semi-structured group interview at the Curriculum Development Workshop 1 – see Appendix 1

Purposes of each data collection process with accompanying logistics are presented in a tabular form below:

<b>ANALYTICAL PHASE (the elicitation of present and desired state)</b>			
<b>Purpose of data collection</b>	<b>Data collection</b>	<b>Participants</b>	<b>Logistics</b>
To explore teachers' and teacher educators' ideas about <u>training needs</u> for ITT or CPD that would promote CA and IB approaches to early years science education	Focus group  (2 Focus groups per partner = 10 across the CEYS partnership)	5 – 10 per focus group  (50-100 across the CEYS partnership)  <u>Profile of participants:</u> - Teacher educators - Early years teachers - Policy maker (optional) - School staff member (optional)	<b>Timing:</b> prior to the first CPD curriculum development workshop <b>Length:</b> up to 2 hours (see Document on focus groups) <b>Recording:</b> audio (iPad/VRP7 and laptop/QuickTime) <u>each partner adapts to their resources</u> <b>Location:</b> Universities or local pre-schools/schools
To explore teachers' attitudes to workshop approach as tool to gaining insights into creative and inquiry-based approaches to early years science education	Induction workshop  (survey at the end of the induction workshop)  (2 workshops per partner = 10 across the CEYS partnership)	25 per induction workshop  (250 across the CEYS partnership)  <u>Profile of participants:</u> - Teacher educators - Early years teachers - School staff member (optional)	<b>Timing:</b> prior to the first CPD curriculum development workshop <b>Length:</b> <u>induction workshop:</u> up to 3 hours (see Document on induction workshops) <u>survey:</u> 8 questions (see Appendix 7 in Document on induction workshops) <b>Location:</b> Universities or local pre-schools/schools
To explore teachers' attitudes, experience and beliefs about creativity and science in early years	1 baseline teachers' questionnaire  (5-10 per partner = 25-50 across the CEYS partnership)	5-10 per partner  (25-50 across the CEYS partnership)	<b>Timing:</b> At the first curriculum development workshop <b>Length:</b> 11 questions (see Appendix B in Teachers' portfolio) <b>Location:</b> Universities or local pre-schools/schools
To explore the 'recruited teachers' present and desired science teaching practices	1 Semi-structured group interview  (5 across the CEYS partnership)	5-10 per partner  (25-50 across the CEYS partnership)	<b>Timing:</b> at the first CPD curriculum development workshop <b>Length:</b> 45-60 minutes Semi-structured interview schedule: 8 questions (see Appendix 1) <b>Location:</b> Universities or local pre-schools/schools

**Table 5** Overview of the analytical phase of the CEYS Curriculum development process

## 2.3 The prototyping phase (action research)

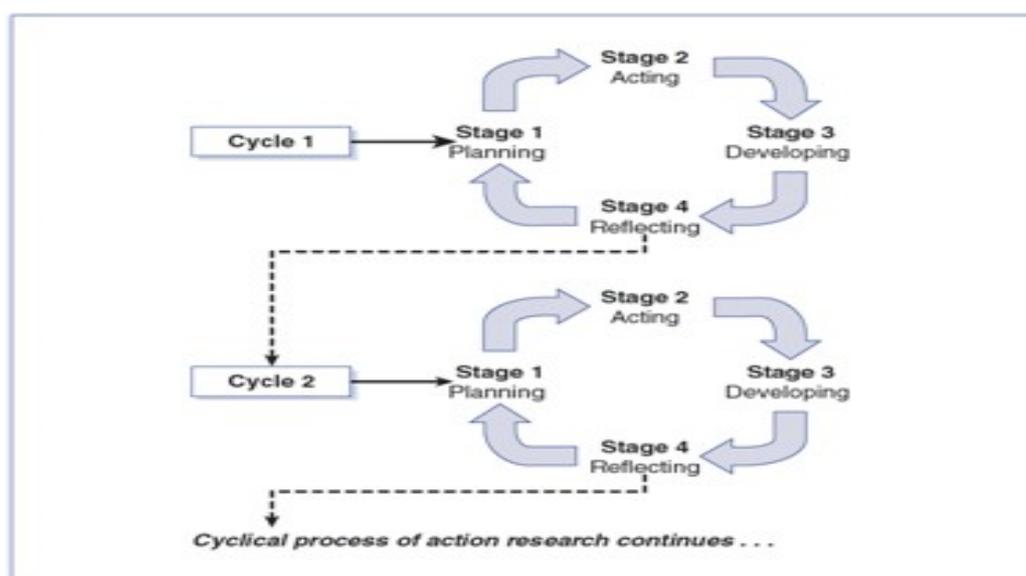
In the second phase, i.e. in the prototyping phase of the curriculum development process, the CEYS partnership will, working collaboratively with teachers, enable them to employ action research. The teachers will be supported by:

- a) 5 days of curriculum development workshops
- b) additional on-going support in diverse ways as appropriate in each context
- c) teachers' portfolios, which offer guidance about the process and about documenting their own and the children's learning

Action research, as noted earlier, is one way of implementing change and supporting staff and curriculum development. It involves collecting a range of evidence on which to base rigorous reflection. It is based on the following assumptions:

- Teachers and schools work best on issues they have identified for themselves.
- They need time and space to reflect on, evaluate and to experiment with practice in order to respond to the circumstances and needs of particular children, schools and communities.
- Teachers and schools can best help each other by working collaboratively.
- Action research involves collecting a range of evidence (qualitative and quantitative) on which to analyse strengths and weaknesses.
- Action research contributes to a culture of self-evaluation and school improvement.

When teachers carry out an action research project it is likely that it will have an impact on others. Hitchcock and Hughes describe the principal features of action research as '*change* (action) and *collaboration* between researchers and researched' (1995:27). Action research is systematic and cyclical with reflective practice, Hitchcock and Hughes (1995: 29) argue, at the centre of that cycle. It involves interrelated, overarching strands of data collection and analysis. (see Figure 6).

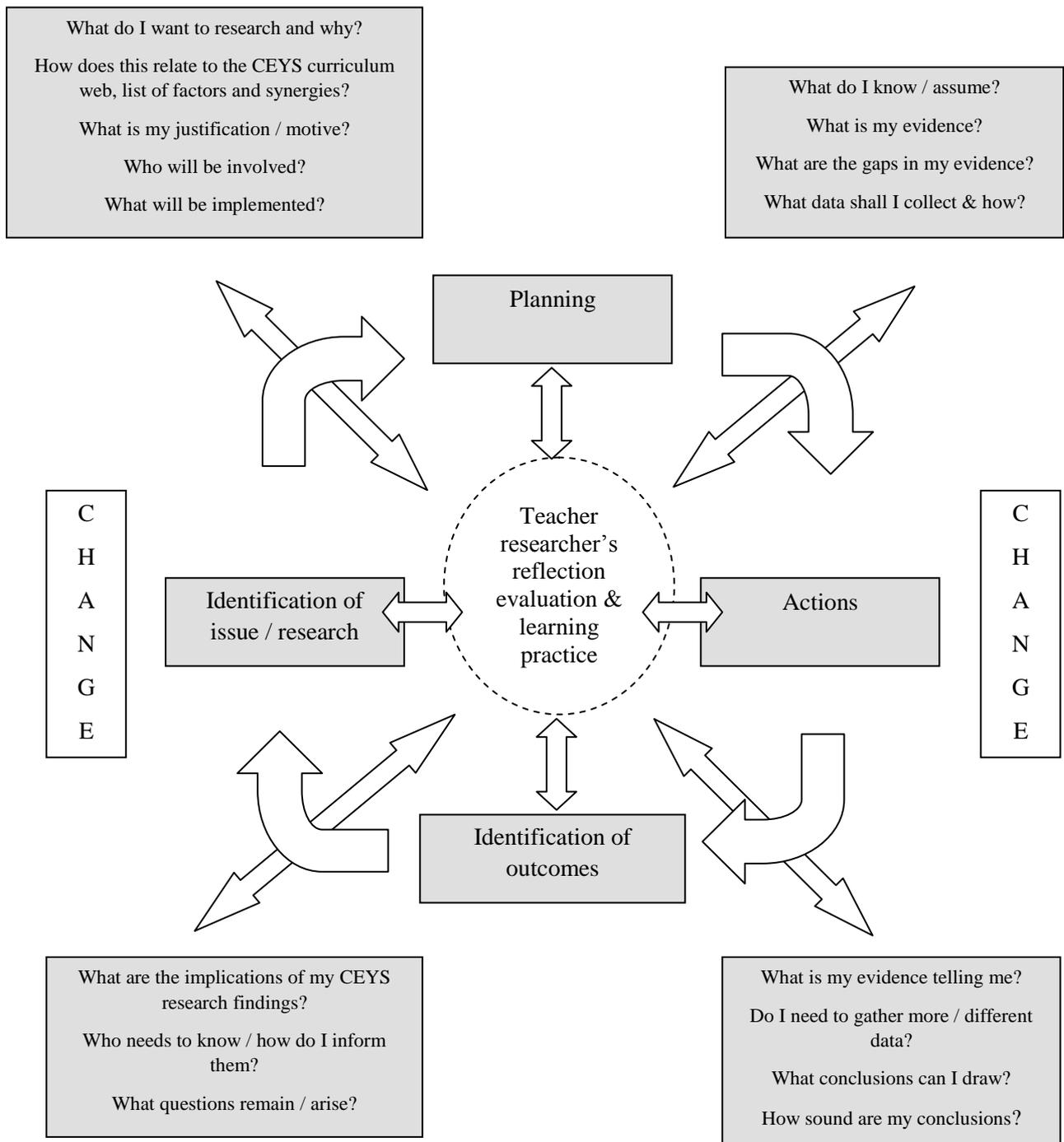


**Figure 6** The iterative cyclical process of action research (from Mertler, 2012b, p. 38)

However, the CEYS project team sees the process of reflection as intrinsic to every stage and aspect of action research. This reflects McNiff *et al.*'s (2003) stance that an action research

project should involve ‘putting the “I” at the centre of the research’. Furthermore, ‘observing’ (and other forms of data collection) may precede action – for example the collection of ‘baseline’ data; and action and reflection are both likely to incorporate change to greater or lesser degrees.

Therefore, the cycle shown below represents the CEYS project stages as the inner boxes show on-going reflection about one’s values, learning and interaction with the research process, as well as on-going review of the evidence to support and inform that process.



**Figure 7** The CEYS action research cycle (adapted from Cremin et al, 2008:10)

The prototyping phase of the CEYS curriculum development process will include the following elements:

<b>PROTOTYPING PHASE</b> ( <b>action research cycles</b> during curriculum development workshops)
Curriculum development workshop 1 (1 day) (5 across the CEYS partnership)  + <u>Teachers' Portfolio</u> (see separate Document)
Curriculum development workshop 2 (1 day) (5 across the CEYS partnership)  + <u>Teachers' Portfolio</u> a) Teachers' reflections b) 3 cases per teacher - 3 children's observations (75 cases across the CEYS partnership)
Curriculum development workshop 3 (1 day) (5 across the CEYS partnership)  + <u>Teachers' Portfolio</u> a) Teachers' reflections b) 3 cases per teacher - children's observations
Curriculum development workshop 4 (1 day) (5 across the CEYS partnership)  + <u>Teachers' Portfolio</u> a) Teachers' reflections b) 3 cases per teacher - children's observations
Curriculum development workshop 5 (1 day) (5 across the CEYS partnership)  + <u>Teachers' Portfolio</u>

**Table 6** Overview of the prototyping phase of the CEYS Curriculum development process

### 2.3.1 Curriculum development workshops

The curriculum development workshops will each have their focus in alignment with the two action research cycles. They will be spread over four terms in order to ensure a long-lasting

impact, implementation and sustainability of the designed change. Their structure will follow the principles of action-research, which means that there will be introductory content input (curriculum spider web, list of factors and synergies between CA and IBSE) and after that the participating teachers will collaborate in both content inputs and the structure of the workshops. Hence the overview of the phases of curriculum development workshops offered below, is deliberately not too directional. It will be necessary to develop this in action with the 5 teachers in each context, depending for example upon their research enquiries, focus for 'action' and development work. A more detailed description of each workshop is however presented in Chapter 3.

#### Phase 1: Getting Started and Planning

In this phase teachers will be developing their knowledge and understanding of the project's remit, of action research as a tool for CPD and curriculum development. They will also be considering ways in which they might develop their practice within CEYS principles and how they might seek in the autumn term of 2015 to document the children and their own professional learning. During the latter part of the summer term (or start of autumn term), teachers are invited to make use of the currently available CLS materials to support them as they explore teaching science creatively and pay increased attention to creativity in this context. Through this each teacher is expected to identify at least two foci for AR in autumn term 2015. Introduction to CLS framework and survey may help to frame these as well as clear connections to national curricula in partner countries.

#### Phase 2: Developing the first action research cycle and exploring quality indicators

With support, teachers will plan and implement an AR cycle to start early in the autumn term 2015. They will be trying new strategies, reviewing and evaluating their effectiveness and sharing practice. Thus implementing and evaluating the first AR cycle. In this phase teachers will also be identifying and gathering a range of start data from their focus pupils and evidence of activities taken. As the term progresses teachers will become better acquainted with using appropriate, workable ways of documenting any evidence of impact on the children's behaviours, attitudes and learning and on reflecting upon their own learning. They will also work to develop quality indicators for classroom material.

#### Phase 3: Action research cycle two and staff development in school

In this phase teachers will implement and evaluate the second AR cycle. Teachers will continue to document any evidence of impact on the children's behaviours, attitudes and learning and reflect upon their own learning. In addition teachers will support school staff in various ways e.g. through a staff meeting, team teaching and being observed in order to enable all staff to foster creativity in science.

#### Phase 4: Synthesising and presenting findings across both AR cycles

Towards the middle of the summer term 2016 the linked CEYS coordinator will support the teachers as they gather their end-of-project data and prepare to share this at the final workshop as a form of dress rehearsal for the Summer school. In this phase teachers will need to return to all parts of their data and reflect upon, analyse and evaluate the impact of their project development work, both on the focus children's learning and on their own pedagogic practice.

### 2.3.2 Identification of lead schools and participating teachers

The five lead schools, selected by each partner through the process of the CEYS induction workshops and follow up conversations and meetings in schools (with head teachers and potential participating teachers), will each ‘contribute’ at least one such teacher to the CEYS project (summer 2015 - summer 2016). The schools will sign an agreement with CEYS in their country regarding their involvement and commitment as a school to the work.

The teachers selected by their head teachers and senior leadership teams to participate in CEYS will be supported in undertaking action research in their classroom and through case studies, will document the learning and development of small groups of pupils with regard to creativity in early years science education. They will be co-researchers and curriculum co-developers in the CEYS project. Over time the participating teachers will become project ambassadors and will be hopefully disseminating the project’s outcomes among their colleagues within their own school and beyond. The involvement of two teachers per school will be welcomed, though the resource set aside for summer school involvement relates to one teacher per lead school only.

The lead schools will be selected on the basis of a range of criteria (see Table 7). These are related to their commitment to continuous professional development (CPD) of teachers, to innovative teaching practices, to development of early years science education and to the development of creativity in early years science education and across the curriculum. They will also need to be prepared to undertake action research as a form of curriculum development. Experience of such is not deemed to be a requirement, but would be desirable. Where such experience is not present, the CEYS project partners will provide appropriate support and guidance.

The CEYS project partners will each identify an additional/‘reserve’ school as contingency plan in case any of the selected schools decide to withdraw from the project and will thus attempt to work with six (rather than five) schools from the beginning of the project.

The selection criteria for the lead schools and for participating teachers/ambassadors as well as benefits for the lead schools and for the participating teachers are presented below:

SELECTION CRITERIA	
SCHOOLS	TEACHERS/AMBASSADORS
Should be schools with minimum (preferably more) <i>two classes 3-8 years</i> .	Should be prepared to commit themselves to the project 2015-6 and its multiple development activities, leading towards their development as CEYS Ambassadors.
Should be committed to <i>continuous professional development</i> (CPD) of teachers and prepared to support the lead teacher in attendance and development work in school.	Should be prepared to commit to attending 5 days of professional development (1 day summer term 2015, 2 days autumn term 2015, 1 day spring term 2016, 1 day summer term 2016).
Should be aware of the potential of <i>action research</i> to support curriculum development and if possible experienced in utilising this approach within school.	Should be prepared to undertake action research in their classroom and through case studies document small groups of pupils developing creativity in early years science.

Should be committed to development of <i>science education</i> as a school across the year 2015-6.	Should be willing to lead professional development about CEYS within the school, among teachers in their school staff (in diverse ways).
Should be committed as a school to development of <i>creativity in science</i> and across the curriculum.	Should show enthusiasm for and interest in innovative teaching practice in science.
Should be committed to integrating creativity in <i>early years</i> science education.	Should show enthusiasm for and interest in an early years focus on science and creativity.
Should be willing to develop their own <i>policies and practice</i> with regard to science and creativity in the early years.	Should be willing to develop their practice through testing and trialing the existing materials on creativity in early years science and leading adaptation of school policy documents.
Should be prepared to enter into the 3-year long contract and fund 5 days of supply for professional development of minimum 1 teacher (1 day summer term 2015, 2 days autumn term 2015, 1 day spring 2016, 1 day summer 2016)	Should be willing to be involved in dissemination of the project outcomes through (co)presenting at national conference at the end of the project.
Should be prepared to submit application to the national agency for Erasmus funded Summer School Greece 2016.	Should be willing to attend a summer school during term time in the summer of 2016 in Greece.

**Table 7** Selection criteria for the lead schools and participating teachers/ambassadors

### 2.3.3 The framing of the teachers' action research questions

The teachers will be introduced to the curriculum dimensions in the spider web and the CLS List of Factors, as well as the pedagogical synergies. It is thus expected that their research questions will be framed by the work of the CLS project and whilst developed in response to needs in their classrooms and schools, will link directly to one or more aspects of these.

### 2.3.4 Teacher identification of focus children

*Selecting children:* Each teacher is invited to select a small focus group of 3 children and make some close observations of their creativity and science learning over the period of the project. It is recommended three children be selected, who are more, less and much less experienced or confident as scientists and investigators. Generally it is wise not to include children with severe special needs or statements. The teachers will need to try to create a mixed gender group that reflects the diversity of their school community.

### 2.3.5 Teachers' action research instruments for data collection

*Documenting children's learning and engagement:* Each teacher will be documenting the three children's responses to the new actions taken in the two action research cycles in Autumn 2015 and Spring 2016. They will be invited to make termly observational notes on each of their 3 focus pupils. Support for this process is offered in the teachers' professional learning portfolio. In addition to providing contextual information, this might encompass making use of:

- *photographs* - especially as a series of digital images in sequence
- *children's drawing and writing* – this might also include photographs of any work created outdoors and their engagement and production of artefacts in science based activities
- *audio-video recording*
- *observational notes* - this might include a summary of the activities, so it can be used as (an inspiration for) classroom material, notes of conversations and comments made by the children. In the teachers' portfolio guidance and a prompt sheet is offered to support observation and documentation and assessment of children's achievements and next steps in learning (see Appendix D in Teachers' portfolio).
- *children's reflections on their learning*

The workshops will provide opportunities for reflection upon these three children and enable the teachers to include additional data. Over the year this will build up into a detailed profile of three young learners in each of the 25 teachers' classes as young scientists in different contexts in school, outdoors and in other contexts e.g. perhaps in museums or science centres.

*Documenting their own professional learning:* Teachers will be supported to reflect upon their own professional learning about fostering creativity in science education in the early years at workshops. Reflective prompt sheets and supporting material that draw upon the curriculum dimensions in van den Akker's (2007) spider's web and the List of Factors will serve to support teachers, as will sessions within the 5 days when evidence of their development work will be shared and examined in the group. (See appendices B, D and E in the teacher's portfolio).

### 2.3.6 CEYS additional teacher support

In addition to supporting the participating teachers during the 5 curriculum development workshops, the following steps for providing additional support are suggested. These are optional and each partner will carry them out or adapt according to their contextual circumstances.

- In-between workshop 1 and workshop 2 (Summer 2015): Skype conference to refocus, discuss the issues that appeared, provide 'status report' regarding the choice of 1<sup>st</sup> action research cycle project/question to explore
- After workshop 2 (early November 2015): 1<sup>st</sup> support visit from university partner (facilitator) for modelling, coaching, collecting evidence (about children), dialogue with head teacher, raising the profile of the project
- After workshop 3 (late February 2016): 2<sup>nd</sup> support visit from university partner (facilitator) around processes of moving forward
- Before attending Summer School in summer 2016 (early July 2016): Skype conference to discuss the presentations at the summer school, to coach regarding any issue, to explore the coming opportunities related to the summer school

### 2.3.7 Ethical procedures

With regard to overall CEYS project and the other phases (the analytical and the assessment one) of the curriculum development process, the following informed consents will need to be obtained:

- a) Informed consent for participation in the focus groups (already obtained, see Document on focus groups)
- b) Informed consent for semi-structured interview groups (Appendix 11)
- c) Informed consent for any recordings during workshops (see Appendix 12)
- d) Potential school consent for running some specific activities or for visits/ data collection by the CEYS team (if needed to be developed locally by each CEYS partner)
- e) Parent/carer participation consent form (Appendix 13)

Informed consent for using any of the teachers' developed classroom materials for designing the training manual will be needed and should be developed locally by each CEYS partner.

As in any other research where children and/or young people are involved, the CEYS fieldwork, which will include early years teachers exploring their own practice through action research, can also potentially carry ethical implications. Ethical implications could refer to the conduct of the researcher and to the collection and use of data following the fieldwork period.

The following minimum standards that were applied in the CLS project are suggested to be followed by all partners during the CEYS project as well:

- Participation in the research will be on an informed voluntary basis. Letters for parents/carers will be developed for this purpose (see Teachers' portfolio, Appendix F). Written consent will be obtained before the fieldwork is to be undertaken. The right to withdrawal will be clearly communicated.
- Explicit permission will be requested to take and use photographs (and videos where appropriate) of the children and staff for the project in project reports and publications.
- Any electronic data collected will be stored on password protected encrypted storage systems, where only authorised staff has access.
- In all cases the importance of confidentiality and anonymity will be emphasised. The sites used, and the adults and children who will be involved will be given pseudonyms to protect their identities.

Each partner will be required to identify and meet the ethical approval policies for their institution, school system, region and country as appropriate. This includes for example gaining ethical approval from institutional ethics committees, municipal education authorities or educational directorates.

In addition, teachers will need support with ethical procedures and even though the CEYS coordinators will provide the majority of consent forms, it will be important to set time aside to discuss ethical procedures and considerations during the curriculum development workshops in order to equip teachers with both theoretical and practical knowledge about research ethics. There is a section in the teachers' portfolio on this.

## 2.4 The assessment phase

The assessment phase will be dedicated to the monitoring and evaluation of the curriculum development process, methodology and product (i.e. curriculum and professional development training). Thus the following elements will be evaluated:

- a) Workshops (see Appendices 4 and 5)
- b) Partnerships (see Appendices 4 and 5 and Appendices 6 and 7)

- c) Curriculum (see Appendices 8 and 9)
- d) Curriculum development methodology (including the professional training and teachers' and children's progress) (see Teachers' Portfolio Appendices B, C and D and Appendices 5 and 10 of the Methodology document)

This phase is elaborated further in Chapter 4 on evaluation processes.

<b>ASSESSMENT PHASE</b>			
(monitoring and evaluation of the curriculum development process, methodology and products)			
Evaluation of the workshops	Evaluation of the partnerships	Evaluation of the curriculum	Evaluation of the curriculum development methodology
Mini feedback sessions at the end of 1 <sup>st</sup> , 2 <sup>nd</sup> , and 4 <sup>th</sup> workshops	End-of-workshop cycle teachers' questionnaire (after workshop 5) Appendix 5	End-of- summer school 2016 questionnaire for teachers/participants Appendix 8	Evaluation of teachers' progress (teachers' portfolio – self-evaluation forms and initial and final teachers' survey) Appendix B and C in Teachers' portfolio
Interim teachers' questionnaire (after workshop 3) Appendix 4	Interim questionnaire for teachers and partners (after all 5 workshops) Appendix 6		Evaluation of children's progress (through observations included in teachers' portfolio) Appendix D in Teachers' portfolio
			End-of-workshop cycle questionnaire Appendix 5
End-of-workshop cycle teachers' questionnaire (after workshop 5) Appendix 5	End-of assessment phase questionnaire for the CEYS partners (after summer school 2017) Appendix 7	End-of- summer school 2017 questionnaire for teachers/participants Appendix 9	Autumn 2016 questionnaire for the CEYS participating teachers
Partners' on-going evaluation of curriculum development workshops Appendix 15			Appendix 10
Summer school 2016 in Greece (1 <sup>st</sup> testing of the developed curriculum and collecting feedback)  1 feedback session with the group			
Summer school 2017 in Greece (2 <sup>nd</sup> round of testing the curriculum - with integrated feedback to summer school 2016)  1 feedback session with the group			

**Table 8** Overview of the assessment phase of the CEYS Curriculum development process

## 2.5 Summary

The overall methodological overview of the curriculum development process is thus as follows:

CURRICULUM DEVELOPMENT – PROCESS (Plomp, 2009)					
ANALYTICAL PHASE (the elicitation of present state and the definition of desired state)	PROTOTYPING PHASE ( <b>action research cycles</b> during curriculum development workshops)	ASSESSMENT PHASE (monitoring and evaluation of the curriculum development process, methodology and products)			
		Evaluation of the workshops	Evaluation of the partnerships	Evaluation of the curriculum	Evaluation of the curriculum development methodology
2 Focus groups per partner (10 across the CEYS partnership)	Curriculum development workshop 1 (5 across the CEYS partnership) + <u>Teachers' Portfolio</u>				
2 Induction workshops (10 across the CEYS partnership)	Curriculum development workshop 2 (5 across the CEYS partnership) + <u>Teachers' Portfolio</u> a) Teachers' reflections b) 3 cases per teacher - children's observations (75 cases across the CEYS partnership)	Mini feedback sessions at the end of 1 <sup>st</sup> , 2 <sup>nd</sup> , and 4 <sup>th</sup> workshops	End-of-workshop cycle teachers' questionnaire (after workshop 5)	End-of-summer school 2016 questionnaire for teachers/ participants	Evaluation of teachers' progress (teachers' portfolio)
		Interim teachers' questionnaire (after workshop 3)	Interim questionnaire for teachers and partners (after all 5 workshops)		Evaluation of children's progress and classroom material (through observations and recorded evidence of learning and teaching activities and processes included in teachers' portfolio)
					End-of-workshop cycle questionnaire
1 initial teachers' survey (25 across the CEYS partnership)	Curriculum development workshop 3 (5 across the CEYS partnership) + <u>Teachers' Portfolio</u> a) Teachers' reflections b) 3 cases per teacher - children's observations	End-of-workshop cycle teachers' questionnaire (after workshop 5)  Partners' on-going evaluation of curriculum development workshops Appendix 15	End-of assessment phase questionnaire for the CEYS partners (after summer school 2017)	End-of-summer school 2017 questionnaire for teachers/ participants	Autumn 2016 questionnaire for the CEYS participating teachers

1 Semi-structured group interview at the beginning of workshop 1 (5 group interviews across the CEYS partnership)	Curriculum development workshop 4 (5 across the CEYS partnership) + <u>Teachers' Portfolio</u> a) Teachers' reflections b) 3 cases per teacher - children's observations	Summer school 2016 in Greece (1 <sup>st</sup> testing of the developed curriculum and collecting feedback)  1 feedback session with the group
	Curriculum development workshop 5 (5 across the CEYS partnership) + <u>Teachers' Portfolio</u>	Summer school 2017 in Greece (2 <sup>nd</sup> round of testing the curriculum - with integrated feedback to summer school 2016)  1 feedback session with the group

**Table 9** Overview of the CEYS Curriculum development - process (based on Plomp, 2009)

## 3 CURRICULUM DEVELOPMENT WORKSHOPS

### 3.1 Aims of the series

The overall aims of the curriculum development workshops are:

- a) to promote the use of creative approaches in early years science teaching;
- b) for participating teachers to take part in professional development and in curriculum development as co-designers in the iterative phases of development of the CEYS course, enhancing their ownership and thus facilitating their adoption of the creative approaches through the use of action research;
- c) to support the process of development of appropriate content for the CEYS professional development training of teachers i.e. the CEYS Training Course for early years teachers that will be based on the participating teachers' feedback

### 3.2 Overview of all 5 workshops

It is clear that with 5 teachers undertaking related but unique action research projects in 6 partner contexts across 5 countries, there will be both variation and local responsiveness with regard to the experience of the curriculum workshops. Nonetheless the outline is offered and supporting material is detailed to enable each partnership to progress in a commonly supportive and collaborative manner, with key protocols and proformas for the teachers to undertake. It is recognized however, that the detailed workshop protocols may well need to be adapted according to context with regard to the time set aside for activities and in response to the teachers' developing commitment, and for example, in response to the classroom materials and evidence of the children's learning that they each bring to share and discuss. As partners seek to bring each of the planned sessions to life and make local adaptations, they will need to be cognisant of each of the workshop's particular scope and the project's overall aims.

#### Timing: Summer 2015

##### Workshop 1:

- The first workshop will focus on introducing teachers to action research; the key principles/frameworks underpinning the project, the description of the operating principles of action research, the pedagogical synergies from CLS, spider web of curriculum dimensions; the contextual factors and the key priorities from CLS in order to help them identify an area for their AR project.
- This will be further supported by teachers completing the initial survey (see Appendix B in Teachers' portfolio) and discussing this and revisiting the project expectations and portfolio. It will also include a group interview/discussion on creativity and science
- The session will also involve an activity exploring some of the CLS materials enabling the teachers to ascertain the ways in which they might document their focus on children's learning.
- The work set will involve experimenting with some of the CLS materials /strategies for the remainder of the summer term in order to identify appropriate research

questions to bring to the second workshop in early autumn preparing to commence their AR first cycle.

- Time set aside for written reflection highlighting effective teaching and learning strategies and difficulties overcome. (Appendix C in Teachers' portfolio)

### **Timing: Autumn 2015**

#### Workshop 2: early autumn term

- This workshop will help teachers to refine their research questions connected to spider web; identify justify and document their choices for focus children; and offer support for planning an extended learning sequence with appropriate resources within which the AR cycle will be nested.
- They will be exploring ways to identify and document children's learning in order to extend their repertoires (e.g. observational proforma - see Appendix D, Teachers' portfolio) reading and discussing articles about doing AR in science – see Appendix 3; considering ethical issues (see Appendix E, Teachers' portfolio).
- Time set aside for written reflection highlighting effective teaching and learning strategies and difficulties overcome. (Appendix C, Teachers' portfolio).
- The work set will involve undertaking the AR first cycle and bringing materials to workshop 3.

#### Workshop 3: later autumn term

- This workshop will involve discussing and peer reviewing the teachers' first AR cycle; examining the data as documented and the insights gained. A key focus will be drawing out strategies adopted to facilitate change and any challenges encountered and ways to overcome these. Again reading articles about science and creativity, the teachers will begin to explore the development of quality indicators for classroom material. The quality indicators might be based on curriculum spider web, list of factors or synergies between inquiry-based and creative approaches to early years science teaching. The participating teachers will all together (supported by the CEYS partner) create a list of quality indicators for classroom material. The list will then be used throughout workshops for both analysis of the classroom material brought in by teachers and as a template for development of new classroom material and later for development of prototypical classroom material for teacher training of early years teachers. They will also be supported in planning another extended learning sequence with appropriate resources within which the second AR cycle will be nested in the spring term.
- The work set will involve undertaking the AR second cycle and bringing materials to workshop 4.
- Time set aside for written reflection highlighting effective teaching and learning strategies and difficulties overcome. (Appendix C in Teachers' portfolio)

### **Timing: Spring 2016**

#### Workshop 4:

- This workshop will involve discussing and peer reviewing the teachers' second AR cycle; examining the data as documented and the insights gained. Again reading articles about science and creativity will be undertaken. In addition a focus on leading

staff development in school will enable the teachers to make use of their own and others' insights and share these with staff.

- At this session each participating teacher will be encouraged to bring a teacher from their school for at least part of the day. The purpose of bringing a colleague from the same school will be to set foundation for dissemination process as well as for whole school professional development and potential changes in the use of creative and inquiry-based teaching across subjects.
- Additionally, arrangements for the summer school will be discussed.
- Time set aside for written reflection highlighting effective teaching and learning strategies and difficulties overcome. (Appendix C in Teachers' portfolio)

### Timing: Summer 2016

#### Workshop 5:

- This workshop will in part take the form of a presentation to head teachers and other senior leaders in order to disseminate the new insights. The final teacher survey (Appendix B Teachers' portfolio) will be undertaken and arrangements for the summer school will be finalised.
- There will be a focus on the possible ways in which teachers may contribute to their country's professional dissemination conference in 2017.
- Time will be set aside for written reflection highlighting effective teaching and learning strategies and difficulties overcome (Appendix C in Teachers' portfolio) followed by discussion and advice on changing practices.

### 3.3 Timetabling

The presented phases will be synchronised as suggested in the table below. Each partner can decide to adapt the suggested time frame to their contextual circumstances. There is also a summary of the timetable and contents in the teachers' portfolio.

Timing + Length	Workshop	Main Focus
<u>Summer term 2015</u> 1 full day: morning session: 9.00-12.00 (coffee/tea break 10.30-10.45) afternoon session: 12.30 – 15.30 (coffee/tea break 14.00-14.15)	<u>Workshop 1</u>	<u>Phase 1:</u> Getting Started and Planning
<u>Autumn 2015</u> 1 full day: morning session: 9.00-12.00 (coffee/tea break 10.30-10.45) afternoon session: 12.30 – 15.30 (coffee/tea break 14.00-14.15)	<u>Workshop 2:</u> early autumn term  <u>Workshop 3:</u> later autumn term	<u>Phase 2:</u> Developing the first action research cycle and exploring quality indicators

<u>Spring 2016</u> 1 full day: morning session: 9.00-12.00 (coffee/tea break 10.30-10.45) afternoon session: 12.30 – 15.30 (coffee/tea break 14.00-14.15)	<u>Workshop 4:</u>	<u>Phase 3:</u> Action research cycle two and staff development in school
<u>Summer 2016</u> 1 full day: morning session: 9.00-12.00 (coffee/tea break 10.30-10.45) afternoon session: 12.30 – 15.30 (coffee/tea break 14.00-14.15)	<u>Workshop 5:</u>	<u>Phase 4:</u> Synthesising and presenting findings across both AR cycles

**Table 10** *Timetable of the curriculum development workshops*

### 3.4 Workshop 1 protocol

As the 1<sup>st</sup> curriculum development workshop focuses on introducing teachers to action research and the CEYS projects’ underpinning concepts and frameworks, it is suggested that the curriculum development workshop 1 includes the following activities (see Appendix 14 for a detailed suggested script for Workshop 1):

- a) Content input:
  - the curriculum spider web;
  - the list of factors;
  - synergies between creative and inquiry-based approaches to science education;
  - what is action research and its benefits;
  - teachers as researchers;
  - nature of science.
- b) Initial survey on teachers’ beliefs and attitudes towards science, creativity and inquiry-based approaches followed by group discussion.
- c) Group semi-structured interview about the teachers’ current science teaching practices and the desired ones.
- d) Brainstorming first ideas about what to research prompted by the set of questions used in the planning phase of action research prompted by the following questions:

What do I want to research and why? How does this relate to the CEYS curriculum web, list of factors and synergies? What’s my justification / motive? Who will be involved? What will be implemented?
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- e) Agreement on the identification of 3 key questions (per participating teacher) to explore, which will be discussed at workshop 2.
- f) Exploration of some of the CLS materials.

- g) Time for reflection –highlighting effective teaching and learning strategies and management of change. (Teachers’ portfolio Appendix C)
- h) Mini feedback session about the workshop 1.

The suggested detailed protocol is presented below.



## Curriculum development workshop 1

### Protocol

Summer 2015 (month) – at local University or school (to be added by each partner)

Morning session: 9.00-12.00 (coffee/tea break 10.30 - 10.45)

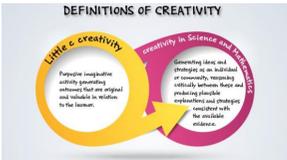
Lunch break: 12.00-12.30

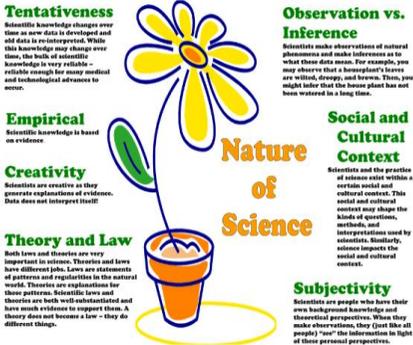
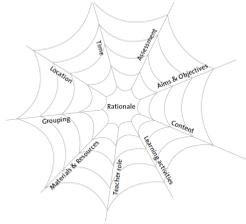
Afternoon session: 12.30-15.30 (coffee/tea break 14.00 – 14.15)

#### Workshop 1 MORNING SESSION:

<b>Learning objectives</b> 	<b>Content + Activities/Exercises</b> 	<b>Methods</b> 	<b>Time</b> 	<b>Materials</b> 
<u>Learning objectives:</u> a) to get familiar with the key concepts/ frameworks that informed the CEYS project b) to get familiar with the action-research approach c) to explore own beliefs and attitudes towards science, creativity and inquiry-based approaches d) to discuss and explore potential questions to research	<u>Welcome</u> The CEYS coordinator/s welcomes the group and introduces him/herself and her/his role in the curriculum development process  <u>Mini presentation</u> of the main aims of all 5 workshops: <ul style="list-style-type: none"> <li>- to promote the use of creative approaches in early years science teaching</li> <li>- for participating teachers to take part in professional development and in curriculum development as co-designers in the iterative phases of development of the CEYS course, enhancing their ownership and thus facilitating their adoption of the creative approaches though the use of action research.</li> <li>- to support the process of development of appropriate content for the CEYS professional development training of teachers i.e. the CEYS Training Course for early years teachers that will be based on the participating teachers' feedback</li> </ul>	Presentation (CEYS coordinator/s)  Presentation (CEYS coordinator/s)	5'  8'-10'	Power point presentation (laptop + projector)  Power Point

<p>e) to plan for the ‘experimenting’ phase between workshop 1 and workshop 2</p>	<p>and main aims of the CEYS project:</p> <ul style="list-style-type: none"> <li>- to propose concrete <b>training materials</b> that can be used in teacher education for early years and primary teachers in order to foster their use of creative and inquiry-based approaches in science teaching.</li> <li>- to involve <b>teachers as co-designers</b> in the iterative phases of development of its interventions, sharing their ownership and thus facilitating their adoption.</li> <li>- to implement and validate a number of <b>training activities</b> at national and international levels with the scope to improve early years and primary teachers’ knowledge and skills.</li> <li>- to develop a <b>systematic evaluation methodology</b> in order to identify the impact of the proposed training process and materials in terms of both effectiveness and efficiency</li> </ul> <p><u>Mini presentation</u> of the participants (in 2 groups share information and then present each other to the group)</p> <ul style="list-style-type: none"> <li>- My name, my school, my role</li> <li>- In my role as a teacher I would like to emphasize the following 2 positive characteristics I have...</li> <li>- In my role as a teacher I would like to develop the following 2 characteristics ...</li> </ul> <p><u>Activity/Exercise:</u> Two 'amphorae' drawn on the flip-chart board/paper. One has the caption 'to give' and the other 'to get'. Teachers are asked to write on the provided post-it papers:</p> <p>a) what would they want to offer to the other teachers, the CEYS coordinator/s, to the curriculum development process through workshops and action-research</p> <p>b) what would they like to get out of being part of the CEYS project and the curriculum development process through workshops and action-research</p> <p>Once both amphorae are full, the CEYS coordinator initiates discussion about how to ensure that all participating teachers both contribute what they would like to contribute and get what they would like to get out of their participation in the CEYS project</p> <p><u>Initial survey:</u> Teachers fill in the initial survey</p>	<p>Introductory exercise/energizer</p> <p>Presentations (participants)</p> <p>Expectation and commitment elicitation</p>	<p>5’ (in groups) + 7’ (plenary)</p> <p>5’-8’</p> <p>10’</p>	<p>Music for exercises in the background (Audio equipment)</p> <p>Post-it papers Flip-chart board and papers Markers</p> <p>Hand-out (printed copies of the initial survey)</p>
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	<p><u>Discussion:</u></p> <ul style="list-style-type: none"> <li>- first in two separate groups teachers discuss their own beliefs about science, creativity etc. and their impact on our practices</li> <li>- groups present in a plenary their opinions about the importance of beliefs and their impact on our practice</li> </ul> <p><u>Content input – part 1:</u></p> <p>The CEYS coordinator presents the underpinning concepts/frameworks of the project</p> <p>a) <b>Creativity in science:</b> generating ideas and strategies as individual or community, reasoning critically between these and producing plausible explanations and strategies consistent with the available evidence.</p>  <p>b) <b>Synergies between creative and inquiry-based approaches:</b></p> <p>Here the CEYS partners might add extra introduction to creative and inquiry-based approaches before presenting synergies (if they find it necessary).</p> <ul style="list-style-type: none"> <li>- Play and exploration</li> <li>- Motivation and affect</li> <li>- Dialogue and collaboration</li> <li>- Questioning and curiosity</li> <li>- Problem-solving and agency</li> <li>- Reflection and reasoning</li> <li>- Teacher scaffolding and involvement</li> <li>- Assessment for learning</li> </ul> <p>c) <u>Input on Nature of Science (based on Akerson's flower) – see Appendix K</u></p>	<p>Presentation (the CEYS coordinator/s)</p>	<p>10' (in groups) + 10' (plenary)</p> <p>8'-10'</p>	<p>Power point slides Hand-outs (synergies + Akerson's flower)</p> <p>A4 papers + pens</p> <p>Music for exercises in the background (audio equipment)</p>
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	<p style="text-align: center;"><b>Nature of Science</b></p>  <p><b>Tentativeness</b> Scientific knowledge changes over time as new data is developed and old data is reinterpreted. While this knowledge may change over time, the bulk of scientific knowledge is very reliable – reliable enough for many medical and technological advances to occur.</p> <p><b>Empirical</b> Scientific knowledge is based on evidence.</p> <p><b>Creativity</b> Scientists are creative as they generate explanations of evidence. Data does not interpret itself.</p> <p><b>Theory and Law</b> Both laws and theories are very important in science. Theories and laws have different jobs. Laws are statements of patterns and regularities in the natural world. Theories are explanations for these patterns. Scientific laws and theories are both well substantiated and have much evidence to support them. A theory does not become a law – they are different things.</p> <p><b>Observation vs. Inference</b> Scientists make observations of natural phenomena and make inferences as to what these data mean. For example, you may observe that a houseplant's leaves are wilted, droopy, and brown. Then, you might infer that the house plant has not been watered in a long time.</p> <p><b>Social and Cultural Context</b> Scientists and the practice of science exist within a certain social and cultural context. This social and cultural context may shape the kinds of questions, methods, and interpretations used by scientists. Similarly, science impacts the social and cultural context.</p> <p><b>Subjectivity</b> Scientists are people who have their own background knowledge and theoretical perspectives. When they make observations, they (just like all people) "see" the information in light of these personal perspectives.</p> <p><b>Discussion:</b></p> <ul style="list-style-type: none"> <li>- first in two separate groups teachers find examples from their own practices of the use of some of the above mentioned synergies</li> <li>- groups present in a plenary their examples and build on each others' examples</li> </ul>	Self-reflection	10' (in groups) + 15' (plenary)	
	<p style="text-align: center;"><b>COFFEE/TEA BREAK</b></p> 		15'	Coffee/tea, juice, water, biscuits, fruit
	<p><b>Content input – part 2:</b></p> <p>a) <b>Curriculum spider web:</b> rationale, aims and objectives, content, learning activities, teacher role, materials and resources, grouping, location, time and assessment</p>  <p>Figure 2: Curricular Spider Web (van den Akker, 2007, p. 41)</p> <p>b) <b>Curriculum strands and dimensions:</b></p> <p><u>Aims/purpose/priorities:</u></p> <p>Rationale or vision: Why are children/teachers learning?</p>	Presentation (the CEYS coordinator/s)	12' -15'	Power point presentation Hand-outs (spider web)  Power point presentation



## Workshop 1 AFTERNOON SESSION:

<b>Learning objectives</b> 	<b>Content + Activities/Exercises</b> 	<b>Methods</b> 	<b>Time</b> 	<b>Materials</b> 
	<p><u>Group semi-structured interview:</u> The CEYS coordinator guides the group through a semi-structured interview to elicit the current/present and desired states in their science teaching practice</p> <p><u>Questions and answers session:</u> (Participants ask questions based on the presentations they heard before lunch and discuss any issues related to either logistics of action research or to understanding of key concepts)</p> <p>a) about action research b) about teachers as researchers c) about teachers' portfolio</p> <p><u>Group Brainstorming:</u> After the group interview, teachers create a long list (on the flip chart board) of all the potential questions/issues they would like to work on during the action research cycles</p> <p>Prompt:</p> <p>What do I want to research and why? How does this relate to the CEYS curriculum web, list of factors and synergies? What's my justification / motive? Who will be involved? What will be implemented?</p> <p style="text-align: center;"><b>COFFEE/TEA BREAK</b> </p>	<p>Group work guided by the CEYS coordinator</p> <p>The CEYS coordinator facilitation</p> <p>Group brainstorming</p>	<p>45' -50'</p> <p>20'</p> <p>15' -20'</p> <p>15'</p>	<p>Flip chart board/papers</p> <p>Markers</p> <p>Coffee/tea, juice, water, biscuits, fruit</p>



### 3.5 Workshop 2 protocol

The 2<sup>nd</sup> workshop focuses on discussing and reviewing the teachers' explicit plans for their first AR cycle. The following activities are suggested:

- a) Mini reports about experimenting between workshop 1 and workshop 2 (the reports can be presented through power point presentations or simply as oral presentation with accompanying classroom material used in actual learning sequences). Though we consider PPT will be advantageous, as this will enable the teachers to share their work at the summer school and with other teachers in CPD or in staff meetings. The basic questions to answer in their presentations: What have I experimented with? What have I done differently? What have I tested?
- b) Discussion of 3 key research questions (per participating teacher) to work on and the selection of the one as main focus for the 1<sup>st</sup> action research cycle (prompted by the following questions):

What do I want to research and why?  
How does this relate to the CEYS curriculum web, list of factors and synergies?  
What's my justification / motive?  
Who will be involved?  
What will be implemented?

If necessary the CEYS coordinator offers some tools for easier selection process e.g. Force Field Analysis (see Appendix 2), a tool created by Kurt Lewin in the 1940s and used in his work as a social psychologist. Nowadays Force Field Analysis is also used in business for making and communicating decisions.

The tool is easy to use as it involves listing all of the factors (forces) for and against a decision or change. Each of the factor/force is scored (from 1 = weak to 5 = strong) based on its influence, and in the end all scores are added up to find out which of these forces (for or against) wins.

- c) Development of the plan prompted by the following questions:

What do I know / assume?  
What is my evidence?  
What are the gaps in my evidence?  
What data shall I collect & how?

- d) Data analysis activity: show a video of teaching interaction of approximately 10 minutes (publicly available and/or commercially made – (each partner chooses the appropriate videos in local languages) and ask teachers to use the observation form from Teachers' portfolio – followed by discussion and further guidance on how to collect data and use data collection instruments: observations forms, photographs, children's drawings, videos, field notes etc.
- e) Discuss ethical procedures and considerations (including selection of children).
- f) Time for reading extracts from articles about doing AR in science followed by discussion (see Appendix 3 for list of suggested articles – (each partner chooses appropriate articles or reports in local languages).
- g) Revising the plan in the light of the previous activities and readings.
- h) Agreement on what to bring for a presentation (15-20 minutes) next time: videos, observations notes, children's drawings etc.

- i) Time for reflection –highlighting effective teaching and learning strategies and management of change. (Teachers’ portfolio Appendix C)
- j) Mini feedback session about the Workshop 2



## Curriculum development workshop 2

### Protocol

Autumn 2015 (month) – at local University or school (to be added by each partner)

Morning session: 9.00-12.00 (coffee/tea break 10.30 - 10.45)

Lunch break: 12.00-12.30

Afternoon session: 12.30-15.30 (coffee/tea break 14.00 – 14.15)

#### Workshop 2 MORNING SESSION:

Learning objectives 	Content + Activities/Exercises 	Methods 	Time 	Materials 
<u>Learning objectives:</u> a) to review the teachers' explicit plans for their first AR cycle b) to read and discuss articles about doing AR in science c) to consider and discuss ethical procedures and considerations d) to identify and document choices for focus children	<u>Welcome</u> The CEYS coordinator/s welcomes the group  <u>Mini presentation</u> of the aims of the 2nd workshop: <ul style="list-style-type: none"> <li>- to choose the research question</li> <li>- to develop the plan for the 1<sup>st</sup> AR cycle</li> <li>- to consider and discuss ethical procedures and considerations</li> <li>- to practice data collection and analysis</li> <li>- to plan an extended learning sequence with appropriate resources</li> </ul>	Presentation (CEYS coordinator/s)	5'–8'	Power point presentation (laptop + projector)

<p>e) to plan an extended learning sequence with appropriate resources within which the AR cycle will be nested.</p>	<p><u>Mini presentations/reports</u></p> <p>Teachers first present/report individually on</p> <p>a) what they were experimenting with between workshop 1 and 2 (Teachers can choose how to present: with Power point, oral presentation, display of classroom material etc. The basic questions to answer in their presentations: What have I experimented with? What have I done differently? What have I tested</p> <p>b) their first thoughts about potential research questions/issues to explore</p> <p><u>Discussion:</u></p> <p>The whole group discusses their 3 key research questions (per participating teacher) and the ways to select the one that will be researched in the 1st AR cycle. Prompts might be questions from the AR graph and the CEYS coordinator may offer some tools for easier selection as:</p> <ul style="list-style-type: none"> <li>- Force field analysis</li> </ul> <p>Prompt 1: questions</p>	<p>Presentation (teachers)</p> <p>Discussion</p> <p>Self-reflection and analysis</p>	<p>5'-6' per person</p> <p>25'-30' (all together)</p> <p>25'-30'</p>	<p>Power Point?</p> <p>Hand-outs (Force field analysis worksheet)</p> <p>Music for exercises in the background (Audio equipment)</p>
	<p>What do I want to research and why?</p> <p>How does this relate to the CEYS curriculum web, list of factors and synergies?</p> <p>What's my justification / motive?</p> <p>Who will be involved?</p> <p>What will be implemented?</p>			
	<p>Prompt 2: Force field analysis worksheet</p> 			



	<p><u>Content input:</u></p> <ul style="list-style-type: none"> <li>a) Ethical procedures</li> <li>b) Ethical considerations</li> <li>c) Selection of children</li> </ul> <p><u>Discussion:</u></p> <p>Teachers and the CEYS coordinator/s discuss about ethical procedures, consent forms, who to inform about their research etc.</p>	<p>Presentation (the CEYS coordinator/s)</p>	<p>10'-12'</p>	<p>Power point</p>
<p style="text-align: center;"><b>LUNCH BREAK</b></p> <div style="text-align: center;">  </div>	<p>10'-15'</p>			
	<p>30'</p>			



	<p>presentation of 15-20 min</p> <p>c) Mini feedback session (oral) about the workshop format:</p> <ul style="list-style-type: none"> <li>- What would you like less of next time?</li> <li>- What would you like more of next time?</li> </ul>		10'-15'	Flip-chart board/papers
	<b>THE END</b>			

### 3.6 Workshop 3 protocol

The 3<sup>rd</sup> workshop focuses on discussing and reviewing the teachers' first AR cycle and on examining the data as documented and the insights gained. Teachers are encouraged to bring a colleague from their school for at least a part of the day. The following activities are suggested:

- a) Mini presentations (15-20 minutes) of the 1<sup>st</sup> cycle of action research followed by discussion, comments, feedback etc.
- b) Self-reflection (see questions below) followed by plenary discussion

What is my evidence telling me?

Do I need to gather more / different data?

What conclusions can I draw?

How sound are my conclusions?

- c) Self-reflection (see questions below) followed by plenary discussion

What are the implications of my research findings?

Who needs to know / how do I inform them?

What questions remain / arise?

- d) Preparation for the 2<sup>nd</sup> cycle of action research: identification of a research question, lessons learned from the 1<sup>st</sup> cycle
- e) Time for reading extracts from articles about doing AR in science followed by discussion (see Appendix 3 for list of suggested articles – (each partner chooses appropriate articles or reports in local languages)
- f) Revising the plan in the light of the previous activities and readings
- g) Time for reflection –highlighting effective teaching and learning strategies and management of change. (Teachers' portfolio Appendix C)

Interim teachers' questionnaire (see Appendix 4)

The detailed protocol for workshop 3 is presented below.



<b>COFFEE/TEA BREAK</b> 			15'-20'	Coffee/tea, juice, water, biscuits, fruit
<u>Presentations – continued (if necessary):</u>		Presentation (teachers)	20'-30'	
<u>Discussion:</u> The whole group discusses their 1st AR cycles and the most valuable insights and how they can inform their 2nd AR cycles		Discussion		
<u>Self-reflection A:</u> If teachers did not present answers to the questions below in their presentations they are encouraged to answer them now		Self-reflection	5'-6'	
What is my evidence telling me? Do I need to gather more / different data? What conclusions can I draw? How sound are my conclusions?				
<u>Self-reflection B:</u> What are the implications of my research findings? Who needs to know / how do I inform them? What questions remain / arise?		Self-reflection	5'-6'	
<u>Discussion:</u> The whole group discusses the answers to the above questions and what would be the main research questions in the 2nd AR cycle		Discussion	10'-15'	
<b>LUNCH BREAK</b> 			30'	Music for exercises in the background (Audio equipment)



	<u>Conclusion and agreements:</u> a) Agreements on what to 'bring' to workshop 4 (video, drawings, observation notes etc.) for another presentation of 15-20 min b) Interim teachers' questionnaire:			Hand-outs (copies of questionnaire)
	<b>THE END</b>			

### 3.7 Workshop 4 protocol

The 4<sup>th</sup> workshop focuses on critically reviewing the teachers' second AR cycle and on examining the insights gained. In addition a focus on leading staff development in school will enable the teachers to make use of their own and others' insights and share these with staff.

Additionally, arrangements for the summer school will be discussed.

The following activities are suggested:

- a) Mini presentations (15-20 minutes) of the 2<sup>nd</sup> cycle of action research followed by discussion, comments, feedback etc.
- b) Self-reflection (see questions below) followed by plenary discussion

What is my evidence telling me?

Do I need to gather more / different data?

What conclusions can I draw?

How sound are my conclusions?

- c) Self-reflection (see questions below) followed by plenary discussion

What are the implications of my research findings?

Who needs to know / how do I inform them?

What questions remain / arise?

- d) Content input: key issues for staff development
- e) Brainstorming of ideas for cascading research findings within own schools
- f) Discussion of the arrangements/logistics for summer school attendance and teachers' expectations
- g) Time for reflection –highlighting effective teaching and learning strategies and management of change. (Teachers' portfolio Appendix C)

The detailed protocol for workshop 4 is presented below.



<b>COFFEE/TEA BREAK</b> 			15'	Coffee/tea, juice, water, biscuits, fruit
<u>Presentations – continued (if necessary):</u>				
<u>Discussion:</u> The whole group discusses their 2nd AR cycles and the most valuable insights and compare 1st and 2nd AR cycles		Presentation (teachers)	15'-20'	
<u>Self-reflection A:</u> If teachers did not present answers to the questions below in their presentations they are encouraged to answer them now		Discussion	20'-30'	
What is my evidence telling me? Do I need to gather more / different data? What conclusions can I draw? How sound are my conclusions?		Self-reflection	5'-6'	
<u>Self-reflection B:</u>		Self-reflection	5'-6'	
What are the implications of my research findings? Who needs to know / how do I inform them? What questions remain / arise?				
<u>Discussion:</u> The whole group discusses the answers to the above questions		Discussion	10-15	
<b>LUNCH BREAK</b> 			30'	
				Music for exercises in the background (Audio equipment)



	<p><u>Discussion on arrangements for summer school:</u></p> <p>The CEYS coordinator/s present logistics for summer school and invites teachers to start thinking about what they will be presenting there</p> <p><u>Questions and answers session:</u></p> <p>a) on final presentation at workshop 5  b) additional support from the CEYS coordinators and from other teachers  c) on summer school</p> <p><u>Conclusion and agreements:</u></p> <p>a) Agreements on what to 'bring' to workshop 5 (one presentation of both AR cycles and one plan for presentations at summer school)  b) Mini feedback session (oral) about the workshop format:  - What would you like less of next time?  - What would you like more of next time?</p> <p>The CEYS coordinator writes on the flip-chart board teachers' answers in order to integrate the feedback into the next workshop</p>	Discussion	15'-20'  15'-20'  15'-20'	Power point  Hand-outs (copies of questionnaire)  Flip-chart board/papers markers
<b>THE END</b>				

### 3.8 Workshop 5 protocol

The 5<sup>th</sup> workshop will in part take the form of a presentation to head teachers and other senior leaders in order to disseminate the new insights. The final teacher survey will be undertaken and arrangements for the summer school will be finalized. The following activities are suggested:

- a) Identification of the materials to be presented and shared with international colleagues
- b) Setting time aside for drawing upon the two action research cycles and producing written materials
- c) Rehearsals/presentations of the conclusions drawn from both action research cycles with accompanying materials (preparation for summer school)
- d) Time for reflection –highlighting effective teaching and learning strategies and management of change. (Teachers’ portfolio Appendix C)
- e) End-of-workshops’ cycle teachers’ questionnaire (Appendix 5)

The detailed protocol for workshop 5 is presented below.



## Curriculum development workshop 5

### Protocol

Summer 2016 (month) – at local University or school (to be added by each partner)

Morning session: 9.00-12.00 (coffee/tea break 10.30 - 10.45)

Lunch break: 12.00-12.30

Afternoon session: 12.30-15.30 (coffee/tea break 14.00 – 14.15)

#### Workshop 5 MORNING SESSION:

<b>Learning objectives</b> 	<b>Content + Activities/Exercises</b> 	<b>Methods</b> 	<b>Time</b> 	<b>Materials</b> 
<p><u>Learning objectives:</u></p> <p>a) to draw upon both AR cycles and produce written materials</p> <p>b) to develop plan for presentations at summer school</p>	<p><u>Welcome</u></p> <p>The CEYS coordinator/s welcomes the group</p> <p><u>Mini presentation</u> of the aims of the 5th workshop:</p> <ul style="list-style-type: none"> <li>- to draw upon both AR cycles and produce written materials</li> <li>- to develop the plan for presentations at summer school</li> </ul> <p><u>Final presentations (possibly in front of head teacher/s, senior staff):</u></p> <p>Teachers present/report individually on both AR cycles (present their data collection processes, analysis, insights etc.) and insights they gained</p>	<p>Presentation (CEYS coordinator/s)</p> <p>Presentation (teachers)</p>	<p>5' – 8'</p> <p>15'-20' per person</p> <p>75'-100' (all together)</p>	<p>Power point presentation (laptop + projector)</p> <p>Power Point?</p>

	<p style="text-align: center;"><b>COFFEE/TEA BREAK</b> </p>			<p>Coffee/tea, juice, water, biscuits, fruit</p>
	<p><u>Presentations – continued (if necessary):</u></p>	Presentation (teachers)	15’-20’	
	<p><u>Discussion and questions and answers (from the group or from head teachers/senior staff):</u> The whole group discusses and answers about both AR cycles and the most valuable insights</p>	Discussion	20’-30’	Hand-outs (samples of written materials)
	<p><u>Time for drawing upon the two action research cycles and producing written materials:</u> Teachers individually produce written materials (samples are provided)</p>	Self-reflection	20’-25’	
	<p style="text-align: center;"><b>LUNCH BREAK</b> </p>		30’	Music for exercises in the background (Audio equipment)

## Workshop 5 AFTERNOON SESSION:

<b>Learning objectives</b> 	<b>Content + Activities/Exercises</b> 	<b>Methods</b> 	<b>Time</b> 	<b>Materials</b> 
	<p><u>Identification of the materials to be presented and shared with international colleagues:</u> Teachers are asked to first individually go through their materials and to choose what they would like to present at summer school</p> <p><u>Discussion:</u> Teachers share in the group their choices and discuss them</p> <p><u>Development of the summer school presentation plan:</u> Teachers draft their summer school presentations</p> <p><u>Rehearsals/Presentations:</u> Teachers rehearse parts of their summer school presentation in order to get feedback from their colleagues. Other colleagues are encouraged to give feedback by answering the following 3 questions:</p> <ol style="list-style-type: none"> <li>1. What specifically do I like about your presentation?</li> <li>2. What are possible improvements?</li> <li>3. What is my general impression?</li> </ol>	<p>Individual work</p> <p>Discussion</p> <p>Presentations</p>	<p>10'-15'</p> <p>15'-20'</p> <p>15'</p> <p>40'</p>	<p>A4 papers</p> <p>pens</p> <p>Teachers' portfolio</p>
	<p><b>COFFEE/TEA BREAK</b></p> 		<p>15'</p>	<p>Coffee/tea, juice, water, biscuits, fruit</p>
	<p><u>Teachers' reflection:</u> Teachers write in their portfolio</p> <p><u>Group brainstorming:</u> The CEYS coordinator/s guide the group through the questions based on list of factor (like they di at workshop 1) and this time focus only on how teachers learn etc. Asking the participating</p>		<p>10'-12'</p> <p>20'-30'</p>	<p>Teachers' portfolio</p>

	<p>teachers to answer now after having participated in 5 professional development workshops on curriculum development.</p> <p><b>Curriculum Strands and Dimensions:</b></p> <p><u>Aims/purpose/priorities:</u></p> <p>Rationale or vision: Why are children/teachers learning?  Aims and objectives: Toward which goals are children/teachers learning?</p> <p><u>Teaching, learning and assessment:</u></p> <p>Learning Activities: How are children/teachers learning?  Pedagogy: How is the teacher/teacher educator facilitating learning?  Assessment: How is the teacher/teacher educator assessing how far children's/teachers' learning has progressed, and how is s/he using this information to inform planning and develop practice?</p> <p><u>Contextual factors:</u></p> <p>Content: What are children/teachers learning?  Location: Where are children/teachers learning?  Materials and Resources: With what are children/teachers learning?  Grouping: With whom are children/teachers learning?  Time: When are children/teachers learning?</p> <p><u>Questions and answers session:</u></p> <p>a) on final presentation at summer school  b) additional support from the CEYS coordinators and from other teachers before and at summer school</p> <p><u>Conclusion and agreements:</u></p> <p>a) Agreements on what to 'bring' to summer school 5 (video, drawings, observation notes etc.) for another presentation of 15-20 min  b) End-of-workshops' cycle teachers' questionnaire:</p>	<p>Self-reflection</p> <p>Group brainstorming/  Discussion</p>	<p>10'-15'</p> <p>15'</p>	<p>Power point</p> <p>Hand-outs (copies of list of factors and questions)</p> <p>Flip-chart board/papers markers</p>
	<p><b>THE END</b></p>			

## 4 EVALUATION OF CURRICULUM DEVELOPMENT PROCESS (WORKSHOPS, CURRICULUM, METHODOLOGY AND PARTNERSHIPS)

The overall evaluation process of all three phases (the analytical, the prototyping and the assessment one) of the CEYS curriculum development process will encompass the following categories:

- a) evaluation of the workshops
- b) evaluation of the partnerships
- c) evaluation of the curriculum
- d) evaluation of the curriculum methodology.

It will not encompass a thorough evaluation of the classroom materials or materials for teacher education.

<b>ASSESSMENT PHASE</b> (monitoring and evaluation of the curriculum development process, methodology and products)			
<b>Evaluation of the workshops</b>	<b>Evaluation of the partnerships</b>	<b>Evaluation of the curriculum</b>	<b>Evaluation of the curriculum development methodology</b>
Mini feedback sessions at the end of 1 <sup>st</sup> , 2 <sup>nd</sup> , and 4 <sup>th</sup> workshops	End-of-workshop cycle teachers' questionnaire (after workshop 5) Appendix 5	End-of- summer school 2016 questionnaire for teachers/participants Appendix 8	Evaluation of teachers' progress (teachers' portfolio – self-evaluation forms and initial and final teachers' survey) Appendix B and C in Teachers' portfolio
Interim teachers' questionnaire (after workshop 3) Appendix 4	Interim questionnaire for teachers and partners (after all 5 workshops) Appendix 6		Evaluation of children's' progress (through observations included in teachers' portfolio) Appendix D in Teachers' portfolio
End-of-workshop cycle teachers' questionnaire (after workshop 5) Appendix 5	End-of assessment phase questionnaire for the CEYS partners (after summer school 2017) Appendix 7	End-of- summer school 2017 questionnaire for teachers/participants Appendix 9	End-of-workshop cycle questionnaire
Partners' on-going reflective evaluation of workshops (after each workshop) Appendix 15			Autumn 2016 questionnaire for the CEYS participating teachers Appendix 10
Summer school 2016 in Greece (1 <sup>st</sup> testing of the developed curriculum and collecting feedback) 1 feedback session with the group			

Summer school 2017 in Greece  
(2<sup>nd</sup> round of testing the curriculum - with integrated feedback to summer school 2016)  
1 feedback session with the group

**Table 8** *Overview of the assessment phase of the CEYS Curriculum development process*

## 4.1 Evaluation of workshops

The curriculum development workshops will be evaluated by:

- 1) mini feedback sessions at the end of the 1<sup>st</sup>, 2<sup>nd</sup> and 4<sup>th</sup> workshop

At the end of workshop 1, 2 and 4 there will be a mini oral feedback session facilitated by the CEYS coordinator who will be asking the group of participating teachers only these two questions:

- What would you like more of in the next workshop?
- What would you like less of in the next workshop?

The questions are purposefully open-ended in order to allow for a wide spectrum of answers addressing different elements of workshops (content, structure, delivery, logistics etc.) The answers will be collected and recorded in a table drawn on the flip-chart board/paper by the CEYS coordinator. The purpose of this evaluation is to provide immediate feedback without overwhelming teachers with a questionnaire/survey etc. The same format is repeated at the end of the 2<sup>nd</sup> and later at the end of the 4<sup>th</sup> workshop. Extra care will be taken to integrate the feedback so that teachers can see that they can shape and impact the content, structure and delivery style of workshops.

- 2) an interim teachers' questionnaire - after the 3<sup>rd</sup> workshop (Appendix 4)

The interim teachers' questionnaire aims to collect teachers' opinion about workshops' content, structure and delivery in a written form. The questionnaire is planned for after workshop 3, as it is believed that by then teachers would have experienced enough of different exercises and activities to be able to provide a more specific feedback. The interim teachers' questionnaire combines numeric and qualitative questions that will consequently result in both numeric and qualitative data analysis.

- 3) an end-of-workshops' cycle teachers' questionnaire - after the 5<sup>th</sup> workshop (Appendix 5)

The end-of-workshops' cycle teachers' questionnaire also aims to collect teachers' opinions about workshops' content, structure and delivery in a written form. This questionnaire has an additional focus on questions on partnerships (between teacher-educators and teachers and among teachers from different schools) and on the overall curriculum development methodology. The interim questionnaire also combines numeric and qualitative questions.

- 4) partners' on-going reflective evaluation of workshops - after each workshop (Appendix 15)

Partners will reflect after each workshop on how well aims and objectives were achieved, on strengths and areas for development, training approach and evidence of impact on teachers' strategies and attitudes to EY science education.

It is believed that 3 oral and 3 written feedback gathered over the course of all 5 workshops will prove to be valuable and of high quality and as such will inform the continuous planning and co-designing of both workshops and curriculum itself.

## 4.2 Evaluation of partnerships

The CEYS project has partnerships in the centre of its nature (it is carried out by the partnership of 5 European educational institutions) and of its overall methodology (based on co-designing curriculum in partnership with teachers). Hence it is important to evaluate the impact of the partnership approach on the curriculum development methodology as well as on the final product i.e. curriculum training materials.

There are three different partnerships present within the CEYS project:

1. partnership among the CEYS partners;
2. partnership between teacher educators (Universities) and teachers (schools);
3. partnerships among teachers from different schools (within each partner country) and from different cultures (during summers schools).

It is suggested that the listed partnerships are evaluated in the following ways:

- 1) through the end-of-workshops' cycle teachers' questionnaire - after the 5<sup>th</sup> workshop (Appendix 5)
- 2) through an interim questionnaire for teachers and partners (after all 5 workshops) (Appendix 6)

This questionnaire could be distributed a few weeks after the workshop 5 and before the summer school 2016 and is planned to be filled in by both participating teachers and the CEYS partners. The purpose of the questionnaire is to gather feedback about the quality and usefulness of the established partnerships between teacher educators (universities) and teachers (schools) and among teachers from different schools. The feedback will inform the CEYS partners of potential changes that can be implemented during the 2016 summer school.

- 3) through an end-of assessment phase questionnaire for the CEYS partners (after summer school 2017, Appendix 7)

This questionnaire will aim to collect data from the CEYS partners only about how they experienced their partnership.

## 4.3 Evaluation of curriculum

The curriculum for the professional development programme for early years teachers will be tested and evaluated through two main data collection instruments:

- 1) End-of- summer school 2016 questionnaire for teachers/participants (Appendix 8)

This questionnaire will collect data immediately after teachers/participants of the 1<sup>st</sup> summer school have completed the 1<sup>st</sup> summer school. The purpose of the questionnaire is to collect enough valuable data to inform the introduction of potential changes in the curriculum that will be then tested again during the 2<sup>nd</sup> summer school.

- 2) End-of- summer school 2017 questionnaire for teachers/participants (Appendix 9)

This questionnaire will collect data that can illustrate how much of the previous feedback was integrated and whether the improvements were achieved.

## 4.4 Evaluation of curriculum development methodology

The curriculum development process is at the core of the CEYS project. In order to evaluate how effective the adopted approach combining workshops and action research was a several instruments will be used:

- 1) For evaluation of teacher' development and learning:
  - a) The teachers' portfolios will be used to document teachers' on-going reflections and self-evaluation of impact on their own professional development (Appendix C in Teachers' portfolio)
  - b) Initial and final teachers' survey will collect data about teachers' beliefs and attitudes towards science and science teaching (Appendix B in Teachers' portfolio)
- 2) For evaluation of children's development and learning:
  - a) Observation notes that will be used to document children's scientific approaches and creative dispositions (Appendix D in Teachers' portfolio)
  - b) Preliminary classroom material analysis through quality indicators (the participating teachers will develop a list of quality indicators for classroom material and this will be used to evaluate the developed material used to enhance children's learning)
- 3) End-of-workshops' cycle teachers' questionnaire (Appendix 5)

This questionnaire includes a question that specifically asks participating teachers about their opinion and suggestions/comments about the adopted curriculum development methodology.

- 4) Autumn 2016 questionnaire for the CEYS participating teachers (Appendix 10)

This questionnaire will be filled in only by the CEYS participating teachers and not by other potential attendees of the summer school 2016. The questionnaire aims to elicit on one hand teachers' opinion about specific data collection tools that have been used (e.g. observation notes etc.) and on the other hand opinions about the whole process and all the steps that were involved (workshops, action research etc.)

## 4.5 Summer schools 2016 and 2017

Both summer schools are in their nature a form of evaluation of what has been developed i.e. curriculum, curriculum development methodology, workshop format and partnerships. As both summer schools present an opportunity to test and review different elements of curriculum (according to the curriculum web, van den Akker, 2007) it is suggested that on the day before the last day of each summer school (in 2016 and in 2017) the CEYS coordinators carry out a group feedback session that can use as starting points the previously used questions:

- What would you like more of in the summer school?
- What would you like less of in the summer school?

The answers will be collected and recorded in a table drawn on the flip-chart board/paper by the CEYS coordinator.

## 4.6 Conclusion

The CEYS project seeks to be 'living what it is teaching' i.e. in its evaluation phase it is using similar iterative cycles to action research and Plomp's (2009) prototyping phase in educational design research. Thus the CEYS coordinators together with teacher-

/researchers are adopting an on-going process of evaluation through collecting data from different sources and through the continual reflection.

## 5 TEACHERS' PORTFOLIO

see separate Document

## 6 APPENDICES

### Appendix 1 – Group semi-structured interview schedule



#### CREATIVITY IN EARLY YEARS SCIENCE EDUCATION

#### GROUP SEMI-STRUCTURED INTERVIEW SCHEDULE

##### **I Questions on the present state of the teachers' current science teaching practice:**

1. How often do you currently teach science/offer opportunities to focus upon science (per week/per month)?
2. What approaches to teaching science in early years do you usually use?

*Look/prompt for concrete examples from their practice*

3. Which approaches have been most successful so far? Explain why.

##### **II Questions on the desired state of the teachers' science teaching practice:**

4. Which concrete things would you like to change/improve in your current science teaching practice?

*Look/prompt for concrete issues from their current practice*

5. What other approaches would you like to introduce/experiment with in your science teaching practice?
6. How could action research be useful?
7. What would be the best way to introduce the desired change/s? How would you do it?

##### **III Questions on the future steps/sustainability:**

8. If you were to be satisfied with the introduced changes, how do you plan to sustain them?

## Appendix 2 – Force field analysis worksheet



### Force Field Analysis Worksheet

- For instructions on Force Field Analysis, visit [www.mindtools.com/rs/ForceField](http://www.mindtools.com/rs/ForceField).
- For more business leadership skills visit [www.mindtools.com/rpages/HowtoLead.htm](http://www.mindtools.com/rpages/HowtoLead.htm).

Forces FOR change	Score		Forces AGAINST change	Score
		<b>Change proposal</b>		
<b>TOTAL</b>			<b>TOTAL</b>	

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## Appendix 3 – List of core and additional articles

### Core articles:

1. Cremin, T. Glauert, E. Craft, A. Compton, A. and Stylianidou, F. (2015) Creative Little Scientists: Exploring pedagogical synergies between inquiry-based and creative approaches in Early Years science, *Education 3-13, International Journal of Primary, Elementary and Early Years Education* Special issue on creative pedagogies. <http://dx.doi.org/10.1080/03004279.2015.1020655>
2. Goodnough, K. (2003). 'Facilitating action research in the context of science education: reflections of a university researcher,' *Educational Action Research*. 11:1, pp41-64.
3. Davies, D. (2011) *Teaching Science Creatively*, London: Routledge. Chapter 3: 'Teaching Science Creatively in the Early Years'

### Additional articles:

1. Akerson, V.L., Morrison, J.A. and McDuffie, A.M. (2006) 'One Course Is Not Enough: Preservice Elementary Teachers' Retention of Improved Views of Nature of Science', *Journal of Research in Science Teaching* Vol. 43, No. 2, pp. 194–213.
2. Armga, C., Dillon, S., Jamsek, M., Jolley, P.D., Morgan, E.L., Peyton, D. and Speranza, H. (2002) Tips for helping children do science, *Texas Child Care / Winter 2002*.
3. Cullen, T., Akerson, V. and Hanson, D., (2010) Using action research to engage K-6 teachers in nature of science inquiry as professional development, *Journal of Science Teacher Education*, 21(8), 971-992 DOI 10.1007/s10972-010-9218-8
4. Guskey, T.R. (2002) Professional Development and Teacher Change, *Teachers and Teaching: theory and practice*, 8:3, 381-391 DOI: 10.1080/135406002100000512
5. Haefner, L.A. and Zembal-Saul, C. (2004): Learning by doing? Prospective elementary teachers' developing understandings of scientific inquiry and science teaching and learning, *International Journal of Science Education*, 26:13, 1653-1674 To link to this article: <http://dx.doi.org/10.1080/0950069042000230709>
6. Roehrig, G.H., Dubosarsky, M., Mason, A., Carlson, S. and Murphy, B. (2011) 'We Look More, Listen More, Notice More: Impact of Sustained Professional Development on Head Start Teachers' Inquiry-Based and Culturally-Relevant Science Teaching Practices, *Journal Science Education Technology* (2011) 20:566–578 DOI 10.1007/s10956-011-9295-2

## Appendix 4 – Interim teachers’ questionnaire



### CREATIVITY IN EARLY YEARS SCIENCE EDUCATION

#### INTERIM TEACHERS’ QUESTIONNAIRE

(after Curriculum development workshop 3)

This questionnaire aims to collect information about your opinion of curriculum development workshops, their structure, content and delivery.

The overall aims of the curriculum development workshops are:

- a) to promote the use of creative approaches in early years science teaching
- b) for participating teachers to take part in professional development and in curriculum development as co-designers in the iterative phases of development of the CEYS course, enhancing their ownership and thus facilitating their adoption of the creative approaches through the use of action research.
- c) to support the process of development of appropriate content for the CEYS professional development training of teachers i.e. the CEYS Training Course for early years teachers that will be based on the participating teachers’ feedback

Name:

School:

Email address:

Date:

## **I General opinion:**

	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
Overall impression	very good	good	acceptable	poor
Fulfilment of your expectations	very good	good	acceptable	poor
Logistics of workshops (timing, location, catering etc.)	very good	good	acceptable	poor

Additional comments:

## II Content, structure and delivery:

	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
Content input	very good	good	acceptable	poor
Structure of workshops (how the content and exercises are combined)	very good	good	acceptable	poor
Workshop delivery through partnership between teacher educators and teachers	very good	good	acceptable	poor
Usefulness of the action research approach	very good	good	acceptable	poor
How far have we achieved above-mentioned aims of all 5 workshops?	very good	good	acceptable	poor

### Additional comments:

--

### **III Your suggestions:**

1. What did you particularly like in the first three workshops?

2. What would you specifically like to be included in the next two workshops?  
?

Thank you for filling out this questionnaire. Your help will enable us to get a better understanding of how we can improve the workshops' content, structure and delivery.

## Appendix 5 – End-of- workshops’ cycle teachers’ questionnaire



### CREATIVITY IN EARLY YEARS SCIENCE EDUCATION

#### END-OF-WORKSHOPS’ CYCLE TEACHERS’ QUESTIONNAIRE

##### (after Curriculum development workshop 5)

This questionnaire aims to collect information about your opinion of curriculum development workshops, their structure, content and delivery.

The overall aims of the curriculum development workshops are:

- a) to promote the use of creative approaches in early years science teaching
- b) for participating teachers to take part in professional development and in curriculum development as co-designers in the iterative phases of development of the CEYS course, enhancing their ownership and thus facilitating their adoption of the creative approaches through the use of action research.
- c) to support the process of development of appropriate content for the CEYS professional development training of teachers i.e. the CEYS Training Course for early years teachers that will be based on the participating teachers’ feedback.

Name:

School:

Email address:

Date:

## **I General opinion:**

	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
Overall impression	very good	good	acceptable	poor
Fulfilment of your expectations	very good	good	acceptable	poor
Logistics of workshops (timing, location, catering etc.)	very good	good	acceptable	poor

Additional comments:

## II Content, structure and delivery:

	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
Content input	very good	good	acceptable	poor
Structure of workshops (how the content and exercises are combined)	very good	good	acceptable	poor
Workshop delivery through partnership between teacher educators and teachers	very good	good	acceptable	poor
Usefulness of the action research approach	very good	good	acceptable	poor
How far have we achieved above-mentioned aims of all 5 workshops?	very good	good	acceptable	poor
Usefulness of staff meeting/dissemination'/trialing modules	very good	good	acceptable	poor

Additional comments:

### III Your concluding remarks:

1. How did you like the process of curriculum development supported by workshops and fieldwork through action research?

2. How did you experience working in partnerships:
  - a) between teacher educators and teachers and
  - b) among teachers from different schools?

Thank you for filling out this questionnaire. Your help will enable us to get a better understanding of how we can improve the workshops' content, structure and delivery.

## Appendix 6 - Interim questionnaire on partnerships - for teachers and partners (after all 5 workshops and before the 2016 Summer School)



### CREATIVITY IN EARLY YEARS SCIENCE EDUCATION

#### INTERIM QUESTIONNAIRE on PARTNERSHIPS - for TEACHERS and PARTNERS (before Summer School 2016)

This questionnaire aims to collect information on the quality and usefulness of the established partnerships between teacher educators (universities) and teachers (schools) and among teachers from different schools.

1. How did you experience working in partnerships:
  - a) between teacher educators and teachers and
  - b) among teachers from different schools?

2. What would you change in the way we were working in partnerships:
- a) between teacher educators and teachers and
  - b) among teachers from different schools?

Thank you for filling out this questionnaire. Your help will enable us to get a better understanding of how we can improve working together.

## Appendix 7 - End-of assessment phase questionnaire on partnership - for the CEYS partners (after summer school 2017)



### **CREATIVITY IN EARLY YEARS SCIENCE EDUCATION**

#### **END-of-ASSESSMENT PHASE QUESTIONNAIRE on PARTNERSHIP - for the CEYS Partners (after Summer School 2017)**

This questionnaire aims to collect information on the quality and usefulness of the established partnerships among the CEYS partners.

1. How did you experience working in partnership?

2. What would you change in the way we were working in partnership:

Thank you for filling out this questionnaire. Your help will enable us to get a better understanding of how we can improve working together.

## Appendix 8 & Appendix 9 - End-of- summer school 2016 and 2017 questionnaire for teachers/participants

### Creativity through Early Years Science Education Summer School 2016/2017

#### END EVALUATION

NAME OF PARTICIPANT

1. OVERALL QUALITY OF THE SUMMER SCHOOL

VERY GOOD

GOOD

SATISFACTORY

POOR

2. EXTENT TO WHICH THE SUMMER SCHOOL LEARNING OBJECTIVES WERE MET

FULLY

MOSTLY

PARTIALLY

NOT AT ALL

3. USEFULNESS OF SUMMER SCHOOL TO YOUR PRACTICE

VERY GOOD

GOOD

SATISFACTORY

POOR

4. PERSONAL INTEREST/ENJOYMENT

VERY GOOD

GOOD

SATISFACTORY

POOR

5. WHICH WAS THE MOST USEFUL/ENJOYABLE/INSPIRATIONAL/EXCITING ASPECT OF THE SUMMER SCHOOL AND WHY?

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6. WHAT ARE IN YOUR OPINION THE MAJOR OBSTACLES FOR BEING ABLE TO IMPLEMENT THE METHODS PRESENTED IN THE SUMMER SCHOOL IN YOUR CLASSROOM?

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7. PLEASE IDENTIFY IN WHAT WAYS THE TRAINING APPROACHES THAT YOU EXPERIENCED IN THIS SUMMER SCHOOL ENABLED YOUR LEARNING

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8. PLEASE IDENTIFY EXAMPLES OF EVIDENCE WHICH ACCORDING TO YOU WOULD SHOW THAT YOU HAVE MET YOUR LEARNING OBJECTIVES IN RELATION TO THE COURSE

---

---

---

---

9. HOW COULD THE SUMMER SCHOOL AS A WHOLE BE IMPROVED?

---

---

---

10. ANY COMMENTS ABOUT THE KNOWLEDGE/COMMUNICATION/RESPONSIVENESS OF THE PRESENTER(S)?

---

---

---

11. VENUE AND CATERING

<input type="checkbox"/>	VERY GOOD
<input type="checkbox"/>	GOOD

<input type="checkbox"/>	SATISFACTORY
<input type="checkbox"/>	POOR

12. REGISTRATION AND ADMINISTRATION

<input type="checkbox"/>	VERY GOOD
<input type="checkbox"/>	GOOD

<input type="checkbox"/>	SATISFACTORY
<input type="checkbox"/>	POOR

13. WOULD YOU RECOMMEND THIS SUMMER SCHOOL TO OTHERS?

<input type="checkbox"/>	YES
--------------------------	-----

<input type="checkbox"/>	NO
--------------------------	----

14. ANY FURTHER COMMENTS/CONCERNS/APPRECIATIONS REGARDING THE WHOLE ORGANISATION OF THE SUMMER SCHOOL (PLEASE COMMENT ON THE PREPARATION PHASE, THE USE OF THE ONLINE SHARED WORKSPACE, THE VISITS TO THE MUSEUM, THE SOCIAL OCCASIONS)?

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15. DO YOU CONSIDER THAT THIS COURSE WILL BE THE STARTING POINT FOR YOU TO BE ENGAGED IN INTERNATIONAL COOPERATION WITH OTHER TEACHERS?

<input type="checkbox"/>	CERTAINLY
<input type="checkbox"/>	UNLIKELY

<input type="checkbox"/>	PROBABLY
<input type="checkbox"/>	HIGHLY UNLIKELY

*PLEASE TICK THIS BOX IF YOU DO NOT WISH THIS INFORMATION TO BE USED IN REPORTS OR RESEARCH. ANY INFORMATION PROVIDED IN THIS DOCUMENT WILL ONLY BE USED IN RESEARCH REPORTS WITHOUT THE USE OF ANY NAMES OR PERSONAL DATA.*

**Thank you for completing this questionnaire.**

The Organisers

**ELLINOGERMANIKI AGOGI**

## Appendix 10 - Autumn 2016 questionnaire for the CEYS participating teachers



### **CREATIVITY IN EARLY YEARS SCIENCE EDUCATION**

#### **Autumn 2016 questionnaire for the CEYS participating teachers**

This questionnaire aims to collect information about your opinion of the curriculum development process, which included workshops, action research and summer school 2016.

Name:

School:

Email address:

Date and location:

**I General opinion about the curriculum development methodology:**

	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
Combination of workshops and action research	very good	good	acceptable	poor
Teachers as researchers	very good	good	acceptable	poor
Usefulness of the action research approach	very good	good	acceptable	poor
Self-evaluation of own progress through the curriculum development process	very good	good	acceptable	poor
Evaluation of the children's progress through observation notes	very good	good	acceptable	poor
Improvement of own science teaching practice	very good	good	acceptable	poor
Changes in beliefs and attitudes towards science, creativity and inquiry-based approaches	very noticeable	noticeable	slightly noticeable	not noticeable

Additional comments:

## **II Your concluding remarks:**

1. How did you experience the adopted curriculum development methodology?

2. Do you have any message for the CEYS partners?

Thank you for filling out this questionnaire. Your help will enable us to get a better understanding of how we can improve the curriculum development methodology.

## Appendix 11 – Consent form for group semi-structured interview



### CREATIVITY IN EARLY YEARS SCIENCE EDUCATION

#### CONSENT FORM

for

#### GROUP SEMI-STRUCTURED INTERVIEW

I agree to take part in the above project. I have read the Information Sheet. I understand that agreeing to take part means that I am willing to:

- Be interviewed (in a group of participating teachers) by the CEYS project's partner for up to approximately 60 minutes.
- Allow the CEYS project partner to take notes of the interview.

I give permission for the CEYS partner to store securely, analyse and publish data as part of the project and also for this information to be used within future written reports, presentations and journal articles which make reference to this projects on the understanding that real names and contact information will not be used.

I understand that my participation is voluntary, that I can choose not to participate in the group interview, and that I can withdraw my participation at any stage of the interview.

(Consent can be withdrawn by contacting Mr/Ms ....and simply requesting withdrawal)

Name and signature

..... (please print)

Date: .....

## Appendix 12 - Consent form for photographs, video and sound recording at workshops



### CURRICULUM DEVELOPMENT WORKSHOPS

(June 2015 – June 2016)

#### Informed Consent

Personal data provided by participants will only be used for research purposes and are protected according to the EC directive 95/46/EC. All data gathered during the project will be stored in a secure location accessible only to the researchers. In reports of the research no real names or information will be included that can identify comments of particular participants.

I hereby give permission to the CEYS partnership to record me at the curriculum development workshops by photograph and/or video/film and/or sound recording.

**Name:**

**Organisation:**

**Contact details:**

**Signature:**

**Date:**

If you require any further information about the curriculum development workshops or the project, please contact Dr Tatjana Dragovic, The Open University, email: [Tania.Dragovic@open.ac.uk](mailto:Tania.Dragovic@open.ac.uk)

## Appendix 13 - Parent/Carer participation consent form



### Creativity in Early Years Science Education

#### PARENT/CARER PARTICIPATION CONSENT FORM

**Title of project:** .....

**Name of CEYS teacher:** .....

*Please initial each statement*

I agree that my child can take part in the above project.....

I confirm that I understand the information about the above project.....

I understand that participation is voluntary and I am free to withdraw my child at any time without giving any reason.....

I understand that my child's responses will be anonymised before analysis.....

I agree that photos of my child engaged in learning activities can be shared with others for educational purposes.....

.....  
Name of parent/carers                      date                      signature

.....  
Researcher                      date                      signature

## Appendix 14 - Curriculum development workshop 1 – suggested script

### CURRICULUM DEVELOPMENT WORKSHOP 1

#### Suggested script

OVERVIEW: Curriculum development workshop 1		
Logistics	Learning objectives	Structure and Content
<p><u>Timing:</u></p> <p>Summer term 2015</p> <p>Morning session: 9.00-12.00</p> <p>(coffee/tea break 10.30 - 10.45)</p> <p>Lunch break: 12.00-12.30</p> <p>Afternoon session: 12.30-15.30</p> <p>(coffee/tea break 14.00 – 14.15)</p>	<p>a) to get familiar with the key concepts/ frameworks that informed the CEYS project</p> <p>b) to get familiar with the action-research approach</p> <p>c) to explore own beliefs and attitudes towards science, creativity and inquiry-based approaches</p> <p>d) to discuss and explore potential questions to research</p> <p>e) to plan for the ‘experimenting’ phase between workshop 1 and workshop 2</p>	<p><u>Morning session:</u></p> <p><b>1. Welcome</b></p> <ul style="list-style-type: none"> <li>- presentation of facilitator/s,</li> <li>- presentation of CEYS aims</li> <li>- presentation of O2 aims + workshop 1</li> <li>- presentation of participating teachers</li> </ul> <p><b>2. Introductory exercises and activities</b></p> <ul style="list-style-type: none"> <li>- ‘amphorae’</li> <li>- initial survey with discussion</li> </ul> <p><b>3. Content input (with discussions and activities)</b></p> <p>Part 1:</p> <ul style="list-style-type: none"> <li>a) Creativity and creative approaches to science education (definitions)</li> <li>b) Inquiry-based approaches to science education and synergies between CA and IB</li> <li>c) Nature of science</li> </ul> <p>Part 2:</p> <ul style="list-style-type: none"> <li>a) Curriculum spider web</li> <li>b) List of factors</li> </ul> <p>Part 3:</p> <ul style="list-style-type: none"> <li>a) Action research (Presentation of principles of action research and the way it will be used along the project lifetime)</li> <li>b) Teachers as researchers</li> <li>c) Teachers' portfolio</li> </ul> <p><u>Afternoon session:</u></p> <p><b>4. Exploratory exercises and activities</b></p> <ul style="list-style-type: none"> <li>- group semi-structured interview</li> <li>- Q&amp;A session (about content input)</li> <li>- group brainstorming (about research questions)</li> <li>- the CLS material</li> <li>- designing the plan (for in-between workshop 1 and 2)</li> <li>- teachers’ reflection</li> </ul> <p><b>5. Conclusion and agreements</b></p> <ul style="list-style-type: none"> <li>- Discussion about the need for additional support</li> <li>- Agreements on what to do in-between workshop 1 and 2</li> <li>- Agreements on what to 'bring' to workshop 2</li> <li>- Mini feedback session (oral) about the workshop format</li> </ul>
<p><u>Location and equipment:</u></p> <p>At local University or school (to be decided by each partner)</p> <p>Classroom equipped with:</p> <ul style="list-style-type: none"> <li>- flip chart board and papers</li> <li>- markers</li> <li>- A4 papers</li> <li>- LCD projector</li> <li>- Desktop computer (or a laptop)</li> <li>- Audio equipment (optional)</li> </ul>		

## Curriculum development workshop 1 – SUGGESTED SCRIPT

### Morning session:

Content + Activities/Exercises	Methods	Time	Materials
			
<b>1. WELCOME</b>			
a) Presentation of facilitator and his/her role	Presentation	5 min	Power point slide
b) Presentation of O2 aims (of the main aims of all 5 workshops) + overall structure of workshop 1 + time-table	Presentation	4-5 min	Power point slide
c) Presentation of the CEYS project's aims	Presentation	4-5 min	Power point slide
d) Presentation of participating teachers (activity 1)	Energizer/group work/interactive presentation	5 min in groups + 7 min plenary	Power point slide Music for exercises in the background (Audio equipment) - optional
<b>TOTAL</b>		<b>25-27 min</b>	

- a) The facilitator/s welcome/s the participants and introduce/s him/herself/themselves. He/she/they explain/s the facilitator/s' role/s in the process of the five curriculum development workshops and emphasize/s the partnership that will be forged between the CEYS team and the participating teachers. (Possible Power point slide – Welcome)



5 min

#### ***Here is an example:***

*My name is/Our names are ... and I am/we are members of an international team of teachers and teacher educators involved in an EU-funded project called 'Creativity in Early Years Science Education' (CEYS). Our role in this phase of the project is to forge a strong partnership between the CEYS coordinators/team members and participating teacher in order to (together) explore and test different innovative creative and inquiry-based approaches to early years science education. We like to think that this is a beginning of a wonderful learning experience for all of us – during the five curriculum development workshops we will provide conditions for fruitful cooperation and offer our support for creative teamwork*

resulting in a more creative and a more inquiry-based curriculum for early years science education. We will all be working together as co-researchers and partners ...

- b) The facilitator/s present/s the main aims of all 5 workshops and workshop 1 structure. (Possible Power point slides: a) The main aims of all 5 workshops, b) The structure of the 1st workshop, c) Time table)



4-5 min

**Here is an example:**

*The main aims of all 5 workshops are:*

- to promote the use of creative approaches in early years science teaching
- for participating teachers to take part in professional development and in curriculum development as co-designers in the iterative phases of development of the CEYS course, enhancing their ownership and thus facilitating their adoption of the creative approaches through the use of action research.
- to support the process of development of appropriate content for the CEYS professional development training of teachers i.e. the CEYS Training Course for early years teachers that will be based on the participating teachers' feedback

*The structure of the 1<sup>st</sup> workshop is as follows:*

1. Welcome
2. Introductory exercises and activities
3. Content input with discussions and exercises
4. Exploratory exercises and activities
5. Conclusion and agreements

*Timetable is:*

09.00 – 10.30 Workshop

10.30 – 10.45 Coffee/tea break

10.45 – 12.00 Workshop

12.00 – 12.30 Lunch break

12.30 – 14.00 Workshop

14.00 – 14.15 Coffee/tea break

14.15 – 15.30 Workshop

- c) The facilitator/s present/s briefly the CEYS project and its main aims. (Possible Power point slide: a) The CEYS project, b) The CEYS project aims)



4-5 min

**Here is an example:**

*The Creativity in Early Years Science project is a European Erasmus+ project with partner countries Greece, Romania, Belgium and the UK, that aims at the development of a teacher development course and accompanying materials to be used in European*

professional development. We aim to promote the use of creative approaches in teaching science in preschool and early primary education (up to age of eight).

It is a continuation of the project of Creative Little Scientists, where curriculum design principles to foster inquiry and creativity in science education were defined..

In summary the CEYS project overall aims to:

1. Propose concrete **training materials** that can be used in teacher education for early years and primary teachers in order to foster their use of creative and inquiry-based approaches in science teaching.
  2. Involve **teachers as co-designers** in the iterative phases of development of its interventions, sharing their ownership and thus facilitating their adoption.
  3. Implement and validate a number of **training activities** at national and international levels with the scope to improve early years and primary teachers' knowledge and skills.
  4. Develop a **systematic evaluation methodology** in order to identify the impact of the proposed training process and materials in terms of both effectiveness and efficiency
- d) The facilitator/s invite/s participating teachers to present themselves (Possible Power point slide – Activity 1 - Who are we?)



5 min (in groups) + 7 min (plenary)

**Here is an example:**

Enough of us talking...Now we would like to invite you to split into 2 mini groups and spend about 5 minutes 'interviewing' each other about the following:

- My name, my school, my role
- In my role as a teacher I would like to emphasize the following 2 positive characteristics I have...
- In my role as a teacher I would like to develop the following 2 characteristics...

We will leave the slide on so that you can remind yourselves what to share with each other. After 5 minutes we will ask you to present your colleague/s and they will be asked to present you. Enjoy your 'interviews'/conversations...and we will let you know when 5 min have passed – you will hear this sound (here the facilitator/s can use any device they find appropriate to signal the end of the 1<sup>st</sup> part of the exercise).

Please introduce your colleague/s to the rest of the group...Let's see what we have learned about each other...

Content + Activities/Exercises	Methods	Time	Materials
 <b>2. INTRODUCTORY EXERCISES AND ACTIVITIES</b>			
a) ‘Amphorae’ exercise (activity 2)	Presentation	5-8 min	Power point slide Post-it papers Flip-chart board and papers Markers Camera (optional)
b) Initial survey with discussion (activity 3)	Discussion	10-12 min (survey) + 10 min in groups (discussion) + 10 min plenary (discussion)	Teacher portfolio – Appendix B or Hand-out (printed copies of the initial survey)
<b>TOTAL</b>		<b>35-40 min</b>	

a) The facilitator introduces the ‘amphorae’ exercise/activity (Possible Power point slide – Activity 2-Amphoras)



*Here is an example:*

*Now we know a bit more about each other...Let’s discover even more. On the flip-chart board you can see 2 ‘amphorae’ with two different captions: ‘to give’ and ‘to get’ and on the power point slide you can see the 2 questions we are asking you to think about:*

- *What would you like **to offer** to the other teachers, the CEYS coordinator/s, to the curriculum development process through workshops and action-research?*
- *What would you like **to get** out of being part of the CEYS project and the curriculum development process through workshops and action-research?*

*Could you please take some post it papers and write as many answers to both questions as you wish and when you are ready come to the flip-chart board and put your post it papers in*

the corresponding 'amphora'. We have about 5-8 minutes to complete this exercise and we will let you know when the time is up – you will hear this sound.

Our 'amphorae' are now full and these are your inputs...

Here the facilitator/s reads teachers' input and initiates a brief discussion about how to ensure that all participating teachers both contribute what they would like to contribute and get what they would like to get out of their participation in the CEYS project. The facilitator/s may take a photo of the 'amphorae' and return to them at the 3rd workshop to check whether we are all 'giving' and 'getting' what we wanted and at the last workshop as well.

b) The facilitator invites the participating teachers to fill in initial survey (Possible Power point slide – Activity 3 – Survey: Our attitudes, experiences and beliefs)



10-12 min (survey) + 10 min (discussion in groups) + 10 min (discussion in plenary)

Here is an example:

Before we start exploring what we/you would like to introduce into curriculum for early years science education let's first see what our attitudes, experience and beliefs about creativity and science in early years have been so far... Could you please fill in the initial survey you can find in your Teachers portfolio – Appendix B. There is no need to think for too long before you answer the questions or 'tick' some of the offered answers...it is best to answer as spontaneously as possible...

Once all teachers are done with the survey the facilitator invites them to:

- first in two separate groups teachers discuss their own beliefs about science, creativity etc. and their impact on our practices and then
- groups present in a plenary their opinions about the importance of beliefs and their impact on our practice

The facilitator/s moderate/s the discussion and encourage/s teachers to share their opinions.

Content + Activities/Exercises	Methods	Time	Materials
			
<b>3. CONTENT INPUT (WITH DISCUSSIONS AND ACTIVITIES)</b>			
<b>Part 1:</b>			Power point slides
a) Creativity and creative approaches to science education (definitions from CLS)	Presentation	2-3 min	Teachers portfolio (or hand-out/copy of Nature of science flower)

b) Inquiry-based approaches to science education and synergies between CA and IB	Presentation	5-7 min	
c) Nature of science	Presentation	2-3 min	
Activity 4: self-reflection on synergies between CA and IB	Self-reflection/group work/interaction	10 min (in groups) + 15 min (in plenary)	
<b>Part 2:</b>			Power point slides
a) Curriculum Strands and Dimension web	Presentation	6-7 min	
b) List of factors	Presentation	6-7 min	
Activity 5: self-reflection on spider web/factors	Self-reflection/group work/interaction	10 min (in groups) + 15 min (in plenary)	
Activity 5a: self reflection on spider web/factors as learners		20 min	
<b>Part 3:</b>			
a) Action research (Presentation of principles of action research and the way it will be used along the project lifetime)	Presentation	8-10 min	Teachers portfolio
b) Teachers as researchers		4-5 min	
c) Teachers' portfolio		4-5 min	
<b>TOTAL</b>		<b>106 - 117 min</b>	

Part 1: a), b) and c) The facilitator presents briefly the CEYS underpinning concepts/frameworks and makes connections to the CLS project (Possible Power point slides: a) Definitions of creativity, b) Synergies between IBSE and CA, c) Nature of Science, d) Activity 4 - Synergies)

Here facilitator/s present/s the content inputs one after another making connections among them and to the CLS project. It would be good (if possible) to make connection to what teachers discussed earlier based on the survey they filled in...It would be also good to inform teachers that there will be a Q&A (questions and answers) session after lunch where we/they can explore in more detail each of the content inputs.



**9-13 min (brief presentations) + 10 min (discussion in groups) + 15 min (discussion in plenary)**

**Here is an example:**

*Based on what we discussed earlier (prompted by the survey) we would like to present briefly a few CEYS (and CLS) underpinning concepts/frameworks ...Later on (after lunch) we will have a Q&A session where we can go into more detail about each of the presented concept. Firstly let us share with you what is meant by 'creativity' as it is used in the CEYS project. To avoid misunderstandings, we like to clarify what we mean by this term in the context of science education. This definition was developed in the CLS project...*

Here the CEYS partners might add extra introduction to creative and inquiry-based approaches and creative approaches before the synergies (if they find it necessary).

*Also during the CLS project the following synergies between IBSE and CA have been identified:*

- *Play and exploration*
- *Motivation and affect*
- *Dialogue and collaboration*
- *Questioning and curiosity*
- *Problem-solving and agency*
- *Reflection and reasoning*
- *Teacher scaffolding and involvement*
- *Assessment for learning*

The facilitator/s may choose to add a sentence or two for each synergy.

*It might be also interesting to briefly introduce main elements of nature of science based on Akerson's flower, which you have in your Teachers portfolio – Appendix K:*

- *Observation vs. Inference*
- *Empirical*
- *Social and cultural context*
- *Subjectivity*
- *Theory and Law*
- *Tentativeness*
- *Creativity*

Once all content inputs are presented the facilitator/s invite/s teachers to:

- first in two separate groups find examples from their own practices of the use of some of the above mentioned synergies and then
- groups present in a plenary their examples and build on each others' examples

The facilitator/s moderate/s the discussion and encourage/s teachers to share as many and as diverse examples as possible. The facilitator/s announce/s time for coffee break. **(Possible Power point slide – Coffee/tea break)**

**Part 2: a) and b) The facilitator presents briefly the CEYS underpinning concepts/frameworks and makes connections to the CLS project (Possible Power point slides: a) Spider web, b) List of factors, c) Activity 5 – Spider web and list of factors: Analyse own practice, d) Activity 5a – Spider web and list of factors: Answer as learners)**

Again here facilitator/s present/s the content inputs one after another making connections among them and to the CLS project. It would be good (if possible) to make connection to what teachers discussed earlier (on synergies)



**9-13 min (brief presentations) + 10 min (discussion in groups) + 15 min (discussion in plenary)**

***Here is an example:***

*As one of the main aims of the 5 curriculum development workshops is to develop the curriculum for fostering creativity and inquiry-based approaches in early years science education, we would like to present a so-called curriculum spider web developed by van den Akker (2007).*

*Based on the curriculum web the following strand, dimensions and accompanying questions were used during the CLS project...*

*Aims/purpose/priorities:*

*Rationale or vision: Why are children/teachers learning?*

*Aims and objectives: Toward which goals are children/teachers learning?*

*Teaching, learning and assessment:*

*Learning Activities: How are children/teachers learning?*

*Pedagogy: How is the teacher/teacher educator facilitating learning?*

*Assessment: How is the teacher/teacher educator assessing how far children's/teachers' learning has progressed, and how is s/he using this information to inform planning and develop practice?*

*Contextual factors:*

*Content: What are children/teachers learning?*

*Location: Where are children/teachers learning?*

*Materials and Resources: With what are children/teachers learning?*

*Grouping: With whom are children/teachers learning?*

*Time: When are children/teachers learning?*

Once all content inputs are presented the facilitator/s invite/s teachers to:

- first in two separate groups find 1 or more examples of extended science learning sequence from their own practice and describe it through answering the curriculum spider web/ factors questions and then
- groups present their examples in plenary and then
- the group (through guidance by the CEYS coordinator) answers the factors questions from the perspective of teachers being learners (for example, Why are teachers learning?, Toward which goals are children/teachers learning? etc.)

Part 3: a), b) and c) The facilitator presents briefly the CEYS methodological approach and tools (Possible Power point slides: a) Action research, b) The CEYS action research cycle, c) The CEYS action research phases, d) The CEYS additional teacher support, e) Teachers portfolio)

Here facilitator/s present/s principles of action research and the way it will be used along the project lifetime as well as Teachers portfolio and teachers as researchers.



16-20 min (brief presentations)

Here is an example:

*As the CEYS team has adopted action research as its methodological approach it would be good to present some basic principles of action research and how it will be used along the project lifetime.*

*Action research is one way of implementing change and introducing new ideas into classrooms and schools based on evidence of what is currently happening in particular circumstances.*

*It is a process by which practitioners and schools initiate questions relating specifically to their particular contexts and seek solutions by examining and assessing their own work and considering ways of working differently.*

*Action research is systematic and cyclical with reflective practice at the centre of that cycle. It also involves interrelated, overarching strands of data collection and analysis.*

*In the CEYS project we will go through all 4 phases of action research:*

*planning,  
acting,  
observing and  
reflecting.*

*You can see here on our slide the CEYS action research cycle with all phases...*

*Today at our 1<sup>st</sup> workshop we will start thinking about planning through following questions:*

*What do I want to research and why?*

*How does this relate to the CEYS spider web?*

*What's my justification / motive?*

*Who will be involved?*

*What will be implemented?*

*Over the project lifetime, we will move to other phases and here is the overview of all the phases and main focuses of each term from now to summer 2016:*

*Workshop 1 (Summer 2015) → Main focus: Phase 1: Getting started and planning*

*Workshop 2 (early Autumn term 2015) and Workshop 3 (late Autumn term 2015) → Main focus: Phase 2: Developing the first action research cycle and exploring quality indicators*

*Workshop 4 (Spring term 2016) → Main focus: Action research cycle two and staff development in school*

*Workshop 5 (Summer term 2016) + Summer school (in Greece) → Main focus: Synthesising and presenting findings across both AR cycles*

*Additional support will be provided in the form of Skype conferences and/or school visits, email correspondence etc. These are some of the suggested forms of support... – each partner adapts these to their resources*

- In-between workshop 1 and workshop 2 (Summer 2015): Skype conference to refocus, discuss the issues that appeared, provide ‘status report’ regarding the choice of 1<sup>st</sup> action research cycle/project/question to explore
- After workshop 2 (early November 2015): 1<sup>st</sup> support visit from university partner (facilitator) for modelling, coaching, collecting evidence (about children), dialogue with head teacher, raising the profile of the project
- After workshop 2 (late February 2016): 2<sup>nd</sup> support visit from university partner (facilitator) around processes of moving forward
- Before attending Summer School in summer 2016 (early July 2016): Skype conference to discuss the presentations at the summer school, to coach regarding any issue, to explore the coming opportunities related to the summer school

Teachers portfolio is where you are going to note your ideas and the whole professional learning journey...As the project progresses, on-going support for developing **the Professional Learning Journey Portfolio** will be given by CEYS co-ordinators

The teachers’ portfolios are organised into four main sections:

- Section 1 is background information about the project, which is included within the guidance notes.
- The three other sections of the Portfolio will be created by the 25 plus project teachers across Europe and over the period of the project.
- A range of suggestions about what might be collected and documented in these are offered (see Appendices)

The facilitator/s announce/s lunch break.

### Afternoon session:

Content + Activities/Exercises 	Methods 	Time 	Materials 
<b>4. EXPLORATORY EXERCISES AND ACTIVITIES</b>			
a) group semi-structured interview	Group interview/discussion	45 min	Curriculum development methodology document -Appendix 1 or Hand-out (printed copy of the questions for facilitators)

b) Q&A session (about content input)	Discussion	20 min	
c) group brainstorming (about research questions)	Brainstorming	15-20 min	Flip-chart board + papers Markers Camera (optional)
d) the CLS material	Individual/group work	10 min (individually) + 15 min (plenary)	The CLS executive summary or Other CLS materials
e) designing the plan (for in-between workshop 1 and 2)	Individual work/group work	8 min (individually) + 10 min (plenary)	Teachers portfolio – Appendix I
f) teachers' reflection	Individual work	8-10 min	Teachers portfolio – Appendix I
<b>TOTAL</b>		<b>116 - 125 min</b>	

a) The facilitator invites the participating teachers to discuss (through a group interview) their current practice and any wishes for changes – see Appendix 1 in the Curriculum development methodology document



*Here is an example:*

*We have discussed many topics so far - there will be still some extra time to ask questions about the content input before lunch but now let us share ideas about what we are doing currently in early years science teaching and what we would like to do from now on...*

*This will be a discussion i.e. a group interview and please feel free to contribute as much as possible as thinking together and sharing our practices will be beneficial particularly for eliciting first ideas about what each of you would like to 'research', work on in the coming months and terms...*

Then the facilitator/s carry out group interview following the prepared questions (see Appendix 1) and allowing for additional prompting ones...

b) The facilitator encourages teachers to ask questions particularly about the last presented topics (where there were no interactive activities involved)



**Here is an example:**

Now we know more about what you are interested in trying out/experimenting with in the future...As we did not have much time to discuss the topics we presented just before lunch we are inviting you to ask anything you would like to hear more about:

- a) action research
- b) teachers as researchers
- c) teachers' portfolio

or about any other topic we have talked about...

- c) The facilitator encourages teachers to brainstorm as a group on potential research questions i.e. on what they would like to work on/change in their science teaching



15-20 min

**Here is an example:**

After all the questions clarified we are inviting you to start brainstorming as a group on what you would like to work on/change in your science teaching... We will be collecting your ideas/writing them down on the flip-chart board...and in the end take a photo ☺

Our starting point may be the questions for the 1<sup>st</sup> phase of action research cycle – planning:

What do I want to research and why?

How does this relate to the CEYS spider web?

What's my justification / motive?

Who will be involved?

What will be implemented?

The facilitator announces coffee/tea break.

- d) The facilitator/s choose/s extracts from the CLS executive summary or other CLS materials to explore together with teachers – first each individually and then as a group in plenary – this might vary among partners so no examples given



10 min (individually) + 15 min (plenary)

Some partners may choose to either add an exercise on 'Enabling creativity through science' (see Appendix J in Teachers portfolio) to the CLS material exploration or to do it instead of the CLS material – this might vary among partners so no examples given.

- e) The facilitator/s invite/s teachers to design the plan (for in between workshop 1 and 2)



8 min (individually) + 10 min (plenary)

**Here is an example:**

We hope you have got some inspiration from browsing and discussing the CLS material (or from doing the exercise) and now we are inviting you to open Teachers' portfolio and find Appendix I. Could you spend 8 minutes thinking about and filling in the right column for Workshop 1 in Appendix I...

Could you share with the group your first thoughts/ideas...

f) The facilitator/s invite/s teachers to reflect on the workshop and to fill in the reflection and planning sheet – Appendix I in the Teachers portfolio



8 min (individually) + 10 min (plenary)

Here is an example:

Now we are inviting you to spend 8 minutes again but this time thinking about and filling in the left column for Workshop 1 in Appendix I...

Could you share with the group your first thoughts/ideas...

Content + Activities/Exercises 	Methods 	Time 	Materials 
<b>5. CONCLUSION AND AGREEMENTS</b>			
a) Discussion about the need for additional support	Group discussion	8-10 min	Power point slides
b) Agreements on what to do in between workshop 1 and 2	Group discussion	2-3 min	Power point slides
c) Agreements on what to 'bring' to workshop 2	Group discussion	2-3 min	Power point slides
d) Mini feedback session (oral) about the workshop format		5-6	Power point slides + Flip chart board + papers
<b>TOTAL</b>		<b>17-22 min</b>	

a), b) and c) The facilitator/s invite/s teachers to 3 brief discussions so that all can agree what is next (Possible Power point slides: a) The CEYS additional support –between workshop 1 and 2, b) What to do between workshop 1 and 2?, c) What to bring to workshop 2?)



12-16 min

***Here is an example:***

*We are approaching the end of our 1<sup>st</sup> workshop...and before we finish we need to agree on next steps, so could we ask you to first have a look at what additional support can be offered and to share with us any ideas or needs you have for anything else...*

*Support: In-between workshop 1 and workshop 2 (Summer 2015):*

- *Skype conference to refocus, discuss the issues that appeared, provide 'status report' regarding the choice of 1<sup>st</sup> action research cycle project/question to explore*
- *Anything else?*

*Also it would be good to agree on what you would do between workshop 1 and 2 and what 'to bring' to workshop 2.*

*What to do between workshop 1 and 2:*

- *'Experimenting' with new ideas*
- *Introduce new approaches*
- *Follow your mini-plan (Appendix I)*
- *Think of potential research questions*
- *Anything else?*

*What to bring to workshop 2:*

- *3 potential research questions/issues to work on (per teacher)*
- *Mini 'report' about experimenting between workshop 1 and workshop 2*

*The reports can be presented:*

- through power point presentations or*
- simply as oral presentation with accompanying classroom material used in actual learning sequences.*

*The basic questions to answer in your reports/presentations:*

- *What have I experimented with?*
- *What have I done differently?*
- *What have I tested?*

d) The facilitator/s invite/s teachers to give a brief oral feedback on workshop 1 by answering two simple questions (Possible Power point slides: a) Workshop 1 – mini feedback, b) Thank you)



**5-6 min**

***Here is an example:***

*And just before we say goodbye may we ask you to give us your oral feedback by answering these 2 questions:*

- *What would you like less of next time?*
- *What would you like more of next time?*

*We will write down your answers and make sure we integrate your feedback into our next workshop/s.*

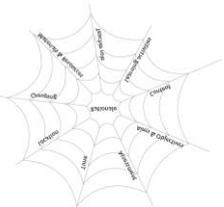
*Thank you for your time, energy, ideas, ...and we hope to hear from you soon and we wish you an adventurous and fruitful experimenting...*

## Appendix 15 - Partners' on-going evaluation of curriculum development workshops

### Curriculum development workshops' reflection sheet (for partners)

#### The main aims of all 5 curriculum development workshops

- to promote the use of creative approaches in early years science teaching
- for participating teachers to take part in professional development and in curriculum development as co-designers in the iterative phases of development of the CEYS course, enhancing your ownership and thus facilitating your adoption of the creative approaches through the use of action research.
- to support the process of development of appropriate content for the CEYS professional development training of teachers i.e. the CEYS Training Course for early years teachers that will be based on the participating teachers' feedback

Workshop No.	Aims and objectives of workshop (achieved/not achieved)  + Strengths and Areas for development (analysis based on the spider web elements)	Training approach			Professional reflection	
		Stop	Continue	Start	Evidence of impact	Partnership
		In order to achieve overall aims of CDWs, what do we think we need to stop doing?	In order to achieve overall aims of CDWs, what do we think we need to continue doing?	In order to achieve overall aims of CDWs, what do we think we need to start doing?  (mini action plan)	What impact is evident in teachers' strategies, creative engagement and attitudes to EY science education?  How do we know the work has impacted on the teachers? What is our evidence?	In what ways is our University/schools partnership valuable/not valuable?  What challenges have the teachers and we faced and in what ways have we (planned to) overcome these?

<b>1</b>	<u>Learning objectives:</u> a) to get familiar with the key concepts/ frameworks that informed the CEYS project b) to get familiar with the action-research approach c) to explore own beliefs and attitudes towards science, creativity and inquiry-based approaches d) to discuss and explore potential questions to research e) to plan for the ‘experimenting’ phase between workshop 1 and workshop 2						
	<b>Strengths</b>	<b>Areas for development</b>					

2	<u>Learning objectives:</u> <ul style="list-style-type: none"> <li>a) to review the teachers' explicit plans for their first AR cycle</li> <li>b) to read and discuss articles about doing AR in science</li> <li>c) to consider and discuss ethical procedures and considerations</li> <li>d) to identify and document choices for focus children</li> <li>e) to plan an extended learning sequence with appropriate resources within which the AR cycle will be nested.</li> </ul>					
	<b>Strengths</b>	<b>Areas for development</b>				

3	<u>Learning objectives:</u> a) to review the teachers' first AR cycle b) to discuss the insights gained from 1 <sup>st</sup> AR cycle c) to develop the plan for the 2 <sup>nd</sup> AR cycle d) to plan an extended learning sequence with appropriate resources within which the 2 <sup>nd</sup> AR cycle will be nested						
	<b>Strengths</b>	<b>Areas for development</b>					

4	<u>Learning objectives:</u> a) to review the teachers' 2 <sup>nd</sup> AR cycle b) to discuss the insights gained from 2 <sup>nd</sup> AR cycle c) to develop a plan for staff development within own schools d) to discuss arrangements for the summer school						
	<b>Strength</b>	<b>Areas for development</b>					

5	<u>Learning objectives:</u>						
	<ul style="list-style-type: none"> <li>a) to draw upon both AR cycles and produce written materials</li> <li>b) to develop plan for presentations at summer school</li> </ul>						
	<b>Strength</b>	<b>Areas for development</b>					

## Appendix 16 – Strands, Dimensions and Factors

	Dimensions Sub questions	Factors important to nurturing creativity in early years science and mathematics
Aims/purpose/priorities	<b>Rationale or Vision</b> <i>Why are they learning?</i>	<ul style="list-style-type: none"> <li>• science economic imperative</li> <li>• creativity economic imperative</li> <li>• scientific literacy and numeracy for society and individual</li> <li>• technological imperative</li> <li>• science and mathematics education as context for development of general skills and dispositions for learning</li> </ul>
	<b>Aims and Objectives</b> <i>Toward which goals are the children learning?</i>	<ul style="list-style-type: none"> <li>• Knowledge/understanding of science content</li> <li>• Understanding about scientific inquiry</li> <li>• Science process skills; IBSE specifically planned</li> <li>• Capabilities to carry out scientific inquiry or problem-based activities; use of IBSE</li> <li>• Social factors of science learning; collaboration between children valued</li> <li>• Affective factors of science learning; efforts to enhance children’s attitudes in science and mathematics</li> <li>• Creative dispositions; creativity specifically planned</li> </ul>
Teaching, learning and assessment	<b>Learning Activities</b> <i>How are children learning?</i>	<i>Focus on cognitive dimension incl. nature of science</i> <ul style="list-style-type: none"> <li>• Questioning</li> <li>• Designing or planning investigations</li> <li>• Gathering evidence (observing)</li> <li>• Gathering evidence (using equipment)</li> <li>• Making connections</li> </ul> <i>Focus on social dimension</i> <ul style="list-style-type: none"> <li>• Explaining evidence</li> <li>• Communicating explanations</li> </ul>
	<b>Pedagogy</b> <i>How is teacher facilitating learning?</i>	<ul style="list-style-type: none"> <li>• Role of play and exploration; role of play valued</li> <li>• Role of motivation and affect ; Efforts made to enhance children’s attitudes in science and mathematics</li> <li>• Role of dialogue and collaboration; <i>collab. between children valued</i></li> <li>• Role of problem solving and agency ; use of IBE/PBL, Children’s agency encouraged</li> <li>• Fostering questioning and curiosity - Children’s questions encouraged</li> <li>• Diverse forms of expression valued</li> <li>• Fostering reflection and reasoning; children’s metacognition encouraged</li> <li>• Teacher scaffolding, involvement, Sensitivity to when to guide/stand back</li> </ul>
	<b>Assessment</b> <i>How is the teacher assessing how far children’s learning has progressed, and how does this information inform planning and develop practice?</i>	<i>Assessment function/purpose</i> <ul style="list-style-type: none"> <li>• Formative</li> <li>• Summative</li> <li>• Recipient of assessment results</li> </ul> <i>Assessment way/process</i> <ul style="list-style-type: none"> <li>• Strategy</li> <li>• Forms of evidence ; excellent assessment of process +product, Diverse forms of assessment valued</li> <li>• Locus of assessment judgment – involvement of children in peer/self assessment</li> </ul>

	<b>Dimensions Sub questions</b>	<b>Factors important to nurturing creativity in early years science and mathematics</b>
<b>Contextual factors (Curriculum)</b>	<b>Materials and Resources</b> <i>With what are children learning?</i>	<ul style="list-style-type: none"> <li>• Rich physical environment for exploration; Use of physical resources thoughtful; Valuing potential of physical materials;</li> <li>• Environment fosters creativity in sci/math</li> <li>• Sufficient space</li> <li>• Outdoor resources; recognition of out of school learning</li> <li>• Informal learning resources</li> <li>• ICT and digital technologies; confident use of digital technology</li> <li>• Variety of resources</li> <li>• Sufficient human resources</li> <li>• NO reliance on textbooks or published schemes</li> </ul>
	<b>Location</b> <i>Where are they learning?</i>	<ul style="list-style-type: none"> <li>• Outdoors/indoors/both - recognition of out of school learning</li> <li>• Formal/non-formal/informal learning settings/</li> <li>• Small group settings</li> </ul>
	<b>Grouping</b> <i>With whom are they learning?</i>	<ul style="list-style-type: none"> <li>• Multigrade teaching</li> <li>• Ability grouping</li> <li>• Small group settings</li> <li>• Number of children in class</li> </ul>
	<b>Time</b> <i>When are children learning?</i>	<ul style="list-style-type: none"> <li>• Number of children in class</li> <li>• Sufficient time for learning science and mathematics</li> </ul>
	<b>Content</b> <i>What are children learning?</i>	<ul style="list-style-type: none"> <li>• Sci/ma as separate areas of knowledge or in broader grouping</li> <li>• Level of detail of curriculum content</li> <li>• Links with other subject areas / cross-curriculum approach; evidence of science and maths integration (planned or incidental)</li> <li>• Subject-specific requirements vs. broad core curriculum</li> <li>• Content across key areas of knowledge</li> </ul>

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