Creativity in Early Years Science Education

CEYS Curriculum Development Guide

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1. INTRODUCTION

The '*Creativity in Early Years Science Education'* (CEYS) project was 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 (http://www.ceys-project.eu), an Erasmus+ funded partnership from September 2014 to August 2017, worked on expanding the existing state of the art in early years and early primary inquiry-based science education and creativity, as this had been explored and described by the research project CLS.

The CEYS project has sensitized large numbers of 900 in-service teachers to the synergies between inquiry-based learning and creative approaches identified in CLS, and trained them to foster these in their classrooms. In this way, the CEYS project has not only transformed the previous outputs into actual practice and provided the means (i.e. the training for early years teachers) for their dissemination, but has also provided the conditions for further and substantial 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 aimed to change this situation by implementing a usable and flexible training curriculum, which easily can be incorporated into 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. The CEYS project involved teachers as co-designers in the iterative phases of development of its interventions, sharing their ownership and thus facilitating their adoption.

The CEYS project aimed 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.

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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.

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. The CEYS project had an emphasis on forging partnerships among teachers and also between teachers and researchers i.e. schools and Universities (the majority of the latter group also being active teacher educators).

This Curriculum Development Guide is aimed at schools and teacher training providers. It reports on the lessons learned from the implementation and evaluation of CEYS curriculum development which encompasses the:

a) curriculum development methodology;
b) curriculum development workshops;
c) partnerships forged within the CEYS project; and
d) products, in the form of curriculum materials.

The Guide presents first an overview of the CEYS curriculum development processes, described and evaluated in detail in the reports Curriculum Development Methodology (O2-A1) and CEYS Curriculum Development and Evaluation Workshops (O2 A2), which can be downloaded from the project's website (www.ceys-project.eu). It then identifies important lessons for schools or teacher training providers that wish to explore the potential of school-university partnerships in the context of continuous professional development in the field of early years/primary science education.

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2. OVERVIEW OF CEYS CURRICULUM DEVELOPMENT

2.1 The Creative Little Scientists (CLS) Conceptual Framework

The CEYS project builds on the CLS project, and its Conceptual Framework (Figure 1) underpinned the CEYS Curriculum Development process. This framework set out key characteristics of the creative, inquiry based approaches to early years science that the project was seeking to promote. This was significant in offering a common framework and language to support planning, discussion and evaluation of learning and teaching processes.

Key components of the Conceptual Framework are shown below in **Figure 1 Definitions of creativity** and **Figure 2 Factors associated with creative, inquiry-based approaches.**

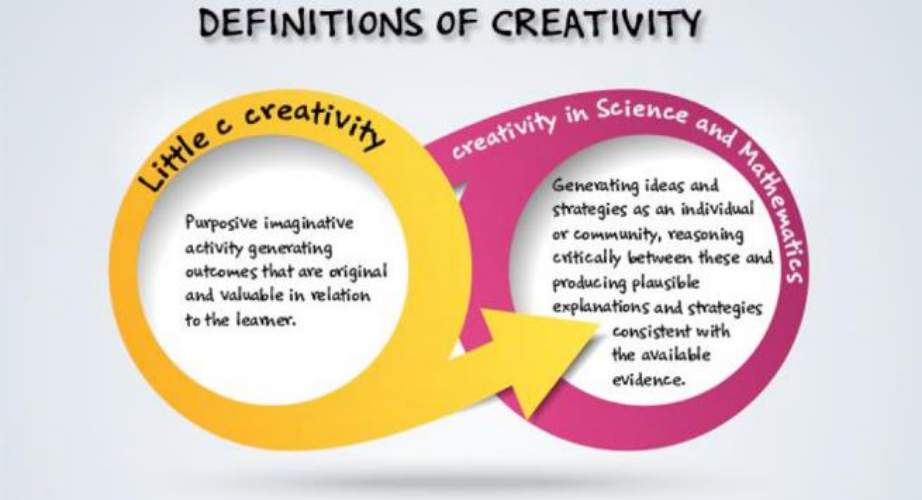

Figure 1 *Definitions of creativity (Creative Little Scientists, 2014, p5)*

Creativity in science and mathematics was defined as *"generating ideas and strategies as individual or community, reasoning critically between these and producing plausible explanations and strategies consistent with the available evidence"*.

The CLS project also based its framework on the curriculum spider web dimensions (van den Akker, 2007, p39): rationale, aims and objectives, content, learning activities, teacher role, materials and resources, grouping, location, time and assessment. In Figure 2 specific factors identified as associated with creative, inquiry-based approaches are linked to specific dimensions of the vulnerable spider web, namely to aims, learning activities, teacher role and assessment. However all the dimensions of the spider web were considered important in the CEYS Curriculum Development process.

More particularly, in relation to the action research-informed learning sequences designed by the CEYS teachers to foster creativity and inquiry in their early years science classroom:

- Nature of Science together with Creative Dispositions formed the main aims and objectives of their learning journeys;
- Features of Inquiry informed the learning activities they used; and
- Synergies between creative approaches (CA) and inquiry based science

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education (IBSE), as documented through CLS (e.g. Cremin, Glauert, Craft, Compton and Stylianidou, 2015) were used as foci for their pedagogy and for teacher's role (see Figure 2).

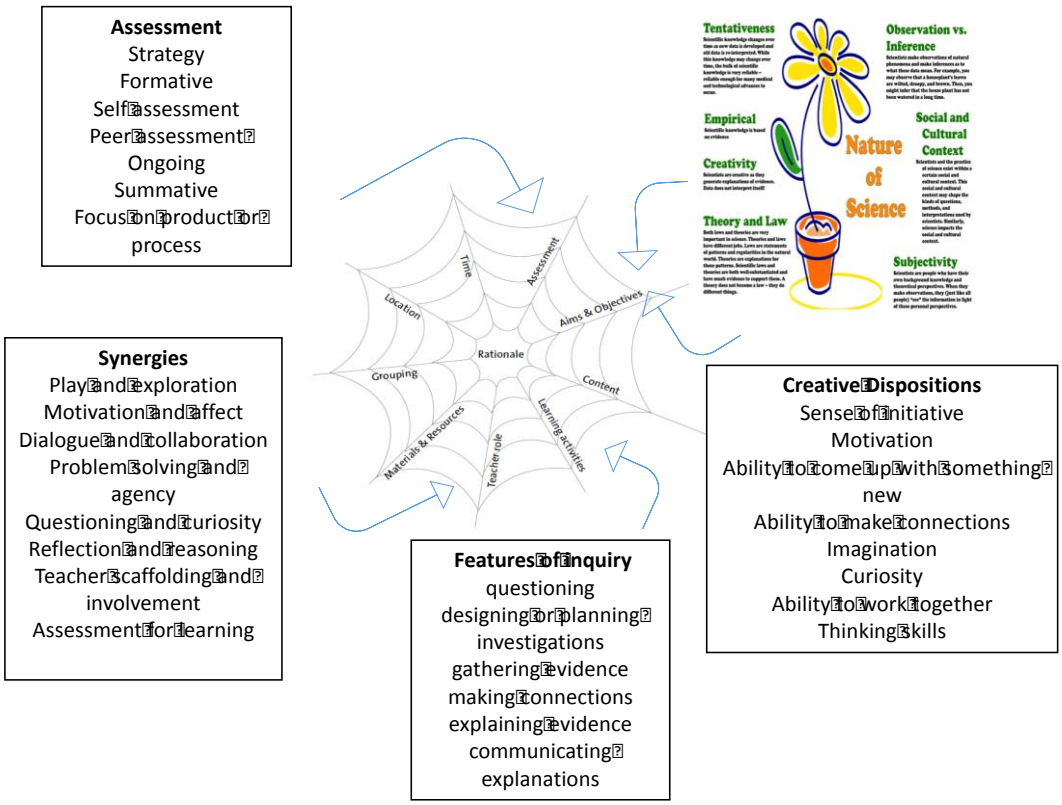

Figure 2 *Factors associated with creative, inquiry-based approaches*

2.2 The curriculum development process

The CEYS curriculum development process followed Plomp's (2009) model, which includes three phases:

a) analytical;
b) prototyping; and
c) assessment.

The **analytical phase** focused on the elicitation of present state and the definition of desired state and included:

- focus groups with teacher education stakeholders;
- induction workshops with early years and primary education teachers; and
- a baseline teachers' questionnaire on teachers' beliefs, attitudes and self-reported practices related to the teaching, learning, and assessment of science and their links to creativity in the early years. The practices noted in the questionnaire items were grounded in the concepts and synergies identified in the CLS Conceptual Framework.

The **prototyping phase** adopted action research methodology and included five curriculum development workshops.

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In the prototyping phase of the curriculum development process, the CEYS partnership worked collaboratively with 'lead' teachers in each country, enabling them to design, develop and evaluate classroom projects through action research, focusing on the promotion of creative, inquiry based approaches to science teaching in early years education. The teachers were 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 offered guidance about the process and about documenting their own and the children's learning.

The **assessment phase** focused on monitoring and evaluation of curriculum development process, methodology and products. These included:

- curriculum materials, which record and illustrate the learning journeys of the 'lead' teachers and the children in their classes;
- the application of these curriculum materials in the CEYS professional development course/programme for early years teachers;
- approaches to the curriculum development process tested during and informed by evaluation of the curriculum development workshops (CDWs), the modules of the CEYS professional development programme/course and the partnerships forged between the CEYS teacher educators and the 'lead' teachers.

The overall methodological overview including the analytical, prototyping and assessment phase of the curriculum development process is presented in Table 1.

This CEYS Curriculum Development Guide draws on lessons learned from the prototyping phase based on results reported in the assessment phase of the curriculum development process. These phases are described more in details in separate sections below.

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<table>
<tr><th colspan="6">CEYS CURRICULUM DEVELOPMENT PROCESS (based on Plomp, 2009)</th></tr>
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(elicitation of present state and definition of desired state)</td><td>PROTOTYPING PHASE
(action research cycles during CDWs)</td><td colspan="4">ASSESSMENT PHASE
(monitoring and evaluation of the curriculum development process, methodology and products)</td></tr>
<tr><td rowspan="2">Focus groups with teacher education stakeholders</td><td rowspan="2">CDW 1
+
CEYS Teachers' Portfolio</td><td>Evaluation of the workshops</td><td>Evaluation of the partnerships</td><td>Evaluation of the curriculum materials (for the PD course)</td><td>Evaluation of the curriculum development methodology</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="3">Induction workshops with early years and primary teachers</td><td rowspan="3">CDW 2
+
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a) Teachers' reflections
b) 3 cases per teacher - children's observations</td><td>Mini feedback sessions at the end of 1st, 2nd, and 4th CDWs</td><td>End-of-workshop cycle CEYS teachers' questionnaire (after CDW 5)</td><td rowspan="3">End-of- 5-day international training course (Yr1) questionnaire for participants/ teachers</td><td>Evaluation of CEYS teachers' progress (teachers' portfolio)</td></tr>
<tr><td>Interim CEYS teachers' questionnaire (after CDW 3)</td><td>Interim questionnaire on partnership for CEYS teachers (after all 5 CDWs)</td><td>Pre/post survey of CEYS teachers' beliefs, attitudes and practices in early years science education</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td>End-of-workshop cycle CEYS teachers' questionnaire
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<tr><td rowspan="2">Initial survey with CEYS participating teachers</td><td rowspan="2">CDW 3
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a) Teachers' reflections
b) 3 cases per teacher - children's observations</td><td>End-of-workshop cycle CEYS teachers' questionnaire (after CDW 5)</td><td rowspan="2">End-of assessment phase questionnaire for the CEYS teacher educators (on-going and after 5-day training course (Yr2))</td><td rowspan="2">End-of-5-day international training course (Yr2) questionnaire for participants/ teachers</td><td rowspan="2">After questionnaire for the CEYS participating teachers</td></tr>
<tr><td>CEYS teacher educators' on-going evaluation of CDWs</td></tr>
<tr><td rowspan="2"></td><td>CDW 4
+
CEYS Teachers' Portfolio
a) Teachers' reflections
b) 3 cases per teacher - children's observations</td><td colspan="4">5-day international training course (Yr1)
(Testing of 1st phase developed modules and of programme for a professional development course of several days and collecting feedback)
- Including the use of the Curriculum Materials produced by the CEYS teachers
- Including lessons learned about partnerships</td></tr>
<tr><td>CDW 5
+
Teachers' Portfolio</td><td colspan="4">5-day international training course (Yr2)
(Testing of 2nd phase modules and of programme for a professional development course of several day and collecting feedback)
- Integrating feedback received in Yr1 training course
- Including the use of the Curriculum Materials produced by the CEYS teachers</td></tr>
</table>

Table 1 *Overview of the CEYS Curriculum Development Process (based on Plomp, 2009)*

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2.3 The prototyping phase

Key components of the curriculum development methodology during the prototyping phase were:

a) 5 one-day curriculum development workshops carried out with the CEYS teacher educators and CEYS teachers;

b) action research cycles carried out by the CEYS teachers;

c) use of teachers' portfolios, which offered guidance about the process and about documenting the CEYS teachers' and the children's learning ;

d) additional on-going support provided by the CEYS teacher educators and CEYS teachers in diverse ways as appropriate in each context.

2.3.1 CEYS Curriculum Development Workshops

The 5 curriculum development workshops were held in the four CEYS partner countries to support CEYS teachers' action research in their own classrooms using a common methodology introduced by the project. They were spread over a year to ensure a long-lasting impact, implementation and sustainability of the desired change.

Table 2 below describes the workshops' overall common focus over the 4 terms. Whereas the organisation and detailed emphasis of each workshop varied depending on the national context and in response to the needs of each group of CEYS teachers, this common methodology and focus ensured consistency and coherence of outcomes.

Workshop Focus	**Main Focus of the Term**
Workshop 1: Late Summer term[1] The first workshop will focus on introducing teachers to action research; the key principles/frameworks underpinning the project, 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 of their beliefs, attitudes and practices in early years science education, discussing this and revisiting the project expectations, the teacher portfolio and its role in the wider project. 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 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	**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 following term to document the children and their own professional learning.* *During the latter part of this term, teachers are invited to make use of the currently available CLS materials to support them as they explore teachings science creatively and pay increased attention to creativity in this context. Through this they are expected to identify at least two foci for AR in the following term.*

[1] The school year terms mentioned here correspond to the planned time frames of the CEYS curriculum development workshops, are indicative and help exemplify the time lapse from one workshop to the next. As used here, Autumn term runs from early September to mid December; Spring Term from early January to Easter; and Summer Term from Easter to mid July.

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second workshop early in the following term preparing to commence their AR first cycle. Time set aside for written reflection highlighting effective teaching and learning strategies and management of change.	
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 will 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 reading and discussing articles about doing AR in science; considering ethical issues. Time set aside for written reflection highlighting effective teaching and learning strategies and management of change. 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 by reading articles about science and creativity, the teachers will begin to explore the development of quality indicators for classroom material. 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 management of change.	**Phase 2: Developing the first action research cycle and exploring quality indicators** *With support, teachers will plan and implement an AR cycle to start later in the same term. 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* *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.*
Workshop 4: Spring term 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 us of their own and others' insights and share these with staff.	**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*

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At this session each participating teacher will be encouraged to bring a teacher from their school for at least part of the day. Time set aside for written reflection highlighting effective teaching and learning strategies and management of change.	*all staff to foster creativity in science.*
Workshop 5: Summer term 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 (of their beliefs, attitudes and practices in early years science education) will be undertaken. Time set aside for written reflection highlighting effective teaching and learning strategies and management of change.	**Phase 4: Synthesising and presenting findings across both AR cycles** *Towards the middle of the Summer Term 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. They will also be engaged in contributing to the protypical design materials* *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 and on their own pedagogic practice:* ○ *What key issues has this work raised?* ○ *What are the implications for further development?*

Table *2* *Foci of the CEYS Curriculum Development Workshops*

2.3.2 CEYS teachers as action researchers

Action research 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.

Figure 3 below represents the CEYS action research cycle. 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.

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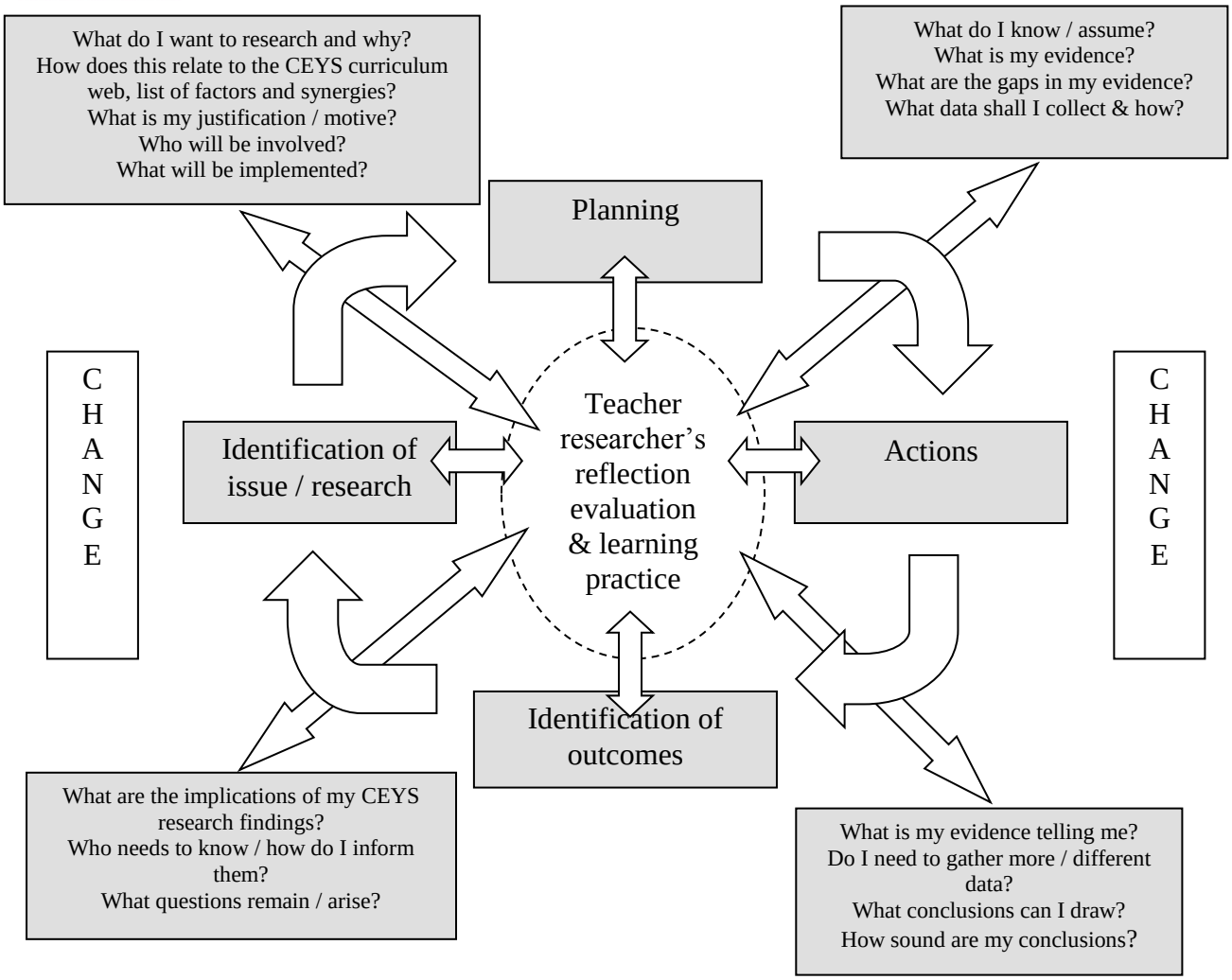

Figure 3 *The CEYS action research cycle (adapted from Cremin et al, 2008:10)*

The CEYS teachers were expected to frame their research questions with the CEYS adopted framework for creativity in early years science education and whilst developed in response to needs in their classrooms and schools, would link directly to one or more aspects of this.

Each teacher was 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 action research cycles. It was recommended that 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 were asked to try to create a mixed gender group that reflects the diversity of their school community.

It was important that each teacher documented the three focus children's learning and engagement to the new actions taken in the two action research cycles. Therefore, the CEYS teachers were invited to make termly observational notes on each of their 3 focus pupils In addition to providing contextual information, this might encompass making use of:

- *photographs* - especially as a series of digital images in sequence;

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- *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;
- *children's reflections on their learning.*

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

2.3.3 CEYS' use of teachers' portfolios

The use of teachers' portfolios is a popular means for documenting on-going teachers' professional learning as well as their reflections on the learning and engagement of the children.

The CEYS curriculum development process made use of teachers' portfolios. These provided guidance to support teachers' reflections upon their professional learning about fostering creativity in science education in the early years. Reflective prompt sheets and supporting material that draw upon the curriculum dimensions in van den Akker's (2007) spider's web and the factors associated with creative, inquiry-based approaches (see Figure 2) were included in the portfolio given to the CEYS teachers to support them, as were sessions within the 5 days when evidence of their development work was shared and examined in the group. Moreover, relevant prompt sheets also supported their observation, documentation and assessment of children's achievements and next steps in learning.

2.3.4 CEYS additional on-going teacher support

In addition to supporting teachers during curriculum development workshops, additional support may be suggested.

In CEYS the following steps for providing additional support were used. These were optional and were adapted according to contextual circumstances.

- In-between workshop 1 and workshop 2: Skype conference to refocus, discuss the issues that appeared, provide 'status report' regarding the choice of 1st action research cycle project/question to explore.
- After workshop 2: 1st support visit from university partner (teacher educator and facilitator) for modelling, coaching, collecting evidence (about children), dialogue with head teacher, raising the profile of the project.
- After workshop 3: 2nd support visit from university partner (teacher educator and facilitator) around processes of moving forward.

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2.4 The assessment phase

The assessment phase was dedicated to the monitoring and evaluation mainly of the curriculum development process and methodology and partially of its products. Thus the following elements were evaluated:

a) the CEYS Curriculum Development Methodology;
b) the CEYS Curriculum Development Workshops and related Action Research process;
c) the partnerships forged between the CEYS university partners (teacher educators and facilitators) and the CEYS teachers; and
d) the Curriculum Materials developed by the CEYS teachers.

Each element was evaluated by a set of data-collection tools ranging from mini oral feedback sessions, questionnaires, surveys to reflection and self-evaluation forms. These data-collection tools yielded rich quantitative and qualitative data corpus from the CEYS Teachers, the CEYS Partners, as well as other teachers participating in the CEYS training course.

2.5 The Curriculum Materials developed by the CEYS teachers

The Curriculum Materials were one of the products of the CEYS Curriculum Development process. They record and illustrate the learning journeys of the CEYS teachers and the children in their classes, during action research and supported by the Curriculum Development Workshops, in developing creative, inquiry-based approaches to learning and teaching in early years science. They are intended for use both in the modules of the professional development course/programme produced by the CEYS project and by individual teachers to illustrate both the opportunities and challenges associated with implementing creative inquiry based approaches in the classroom.

It was agreed that the aim of the Curriculum Materials should be to illustrate ways of opening up practice over time to foster inquiry and creativity in varied contexts, offering insights into teachers' decision-making and evidence of children's learning. It was decided therefore that the materials should provide description and analysis of learning and teaching sequences *over time*, linked explicitly to the CEYS conceptual framework.

As previously mentioned the CEYS teachers' Professional Development Portfolios were designed to support ongoing recording of evidence and reflections on teaching and children's learning. This provided the basis for the teachers' production of the Curriculum Materials during the final Curriculum Development Workshops.

While the learning journeys provide rich examples of activities and approaches that might be used or adapted in the classroom, they aim more importantly to capture teaching and learning processes. They offer insights into teachers' decision-making and reflections and evidence of children's learning, that illustrate the scope for extending opportunities for inquiry and creativity in varied local and national contexts.

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3. Evaluation of the CEYS Curriculum Development Process

3.1 Evaluation of the CEYS Curriculum Development Methodology

The curriculum development methodology that combined five curriculum development workshops and two action-research cycles for all CEYS 'lead' teachers was evaluated and triangulated through four different data-collection tools:

1) The CEYS teachers' on-going reflections and self-evaluation of the impact on their own professional development;
2) A pre-post survey (initial and final teachers' survey) collected data about the CEYS teachers' beliefs, attitudes and practices related to the teaching, learning, and assessment of science and their links to creativity in the early years;
3) End-of-workshops' cycle teachers' questionnaire;
4) After questionnaire for the CEYS teachers.

The teachers' on-going reflections clearly indicated that, as a consequence of their participation in the curriculum development workshops and action research cycles, they introduced changes in their practice that resulted in more **child-led** *aims and objectives***,** more **cross-curricular** *content***, more thought through and carefully chosen and planned** *materials and resources and grouping* and purposefully **extended** time to create more **opportunities for working 'scientifically'.** Children were encouraged to **work in teams, ask questions and solve problems** by the teachers' **stepping back** and **documenting the children's learning journeys through observing the children's agency, drawings, photos** and so forth**.** Thanks to this the children demonstrated all the listed creative dispositions and features of inquiry including initiative, motivation, curiosity, making connections, asking questions, planning investigation, gathering evidence, explaining evidence, developing thinking skills etc.

The teachers also used a high level of self-reflection on their own professional development and praised the adopted curriculum development methodology contributing to their new '*interconnected 'systems' view.*

The teachers' pre-post survey on their beliefs, attitudes and practices related to the teaching, learning, and assessment of science and their links to creativity in the early years beliefs showed that teachers improved **fostering of science learning outcomes, use of diverse approaches to science teaching, encouraging children to undertake science activities, use of diverse forms of children's assessment** and **rewarding/praising children's creative dispositions.**

The teachers were particularly appreciative of the effects of the adopted curriculum development methodology on their **growth in confidence**, their **stronger roles in schools as science experts**, their **roles of co-researchers** and, last but not least, of the **sustainable changes/improvements in their teaching practices** that resulted in benefits for their children's learning and, as seen, for their own professional development.

Based on all findings presented it is clear that the adopted curriculum methodology proved to be highly beneficial for teachers, schools, children and even their parents (as reported in the teachers' accounts) and was very effective in achieving sustainable changes/improvements in early years science teaching and learning practices.

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3.2 Evaluation of the CEYS Curriculum Development Workshops and related Action Research process

The data about the Curriculum Development Workshops (CDWs) and related Action Research process were collected and triangulated through three different data collection tools:

1) Mini oral feedback sessions with CEYS teachers at the end of the 1st, 2nd and 4th workshop;
2) CEYS teachers' questionnaires: interim after the 3rd workshop and final after the 5th workshop;
3) CEYS university partners (teacher educators and facilitators) on-going reflective evaluation of workshops - after each workshop.

Both the quantitative and the qualitative data analysis, as well as the literature reviewed, 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.

Key challenges in implementing the *action research process* reported by the teachers were related to **time** and **everyday constraints.** The research literature supports this by evidencing how teacher research can be challenging as it takes time and requires commitment over a longer period of time. There is evidence (Briscoe and Wells, 2002) that when teachers engage in action research, or implement change generally, they face exactly the same obstacles and constraints as the CEYS teachers, i.e. a lack of time or a sense of the change being too demanding to implement in everyday contexts due to daily work-load constraints. Or as one of CEYS teachers put it *'it's very hard to work on it when you are in the hustle and bustle of the school'.*

Potential improvements that the teachers suggested in the interim phase, and which got implemented on the way, related to **support and guidance** which resonates with the literature emphasising the need for support both within the school and the wider community. Without such support action research may not be as effective in bringing about change. **The workshop facilitators** were commended for their supportive and careful guidance of the teachers throughout the action research process.

On the other hand, **key strengths** of the *curriculum development workshops* referred to their **collaborative nature** thus reinforcing 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 (Goodnough 2003; Capobianco and Feldman 2006; Briscoe and Wells 2002). **Time for reflection** was highly appreciated by the CEYS teachers, particularly because it surpassed the so-called 'technical' reflection that is limited to only 'trialling' something new and thinking back about it (Kemmis, 2006), rather than reflecting on one's approach to extended learning sequences and overall attitude towards both creative teaching and teaching for creativity in science. **Strong theoretical background** combined with **the highly valued action research approach** provided the foundation for teachers to raise **awareness of changes** in their practices that they identified as desirable, initiated and experienced during the workshops. The teachers concluded their evaluation of the workshops praising them as **valuable professional development** which brought them **enjoyment** and **growth in confidence.**

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'I feel that the workshops were the biggest benefits…' (CEYS Teacher, Final questionnaire)

The quotation above sums up the value of the CEYS Curriculum Development Workshops and their impact on the CEYS teachers' professional development.

3.3 Evaluation of the partnerships forged in the CEYS project

The CEYS project had partnerships at its core (it was carried out in a partnership of 5 European educational institutions) and in its overall methodology (based on co-designing the curriculum in partnership with the teachers). Hence it was important to evaluate the impact of the partnership approach on the curriculum development methodology as well as on the final product, i.e. curriculum materials to be included in the professional development programme/course.

There were three different partnerships relevant to the CEYS curriculum development process:

1. partnership between teacher educators (CEYS partners) and teachers;
2. partnerships among teachers from different schools.

The listed partnerships were evaluated in the following ways:

1) through the end-of-workshops' cycle teachers' questionnaire (final questionnaire) - after the 5th workshop;
2) through an interim questionnaire about CEYS teachers' and partners' partnership (after all 5 workshops);
3) through on-going reflection tool for teacher educators (CEYS partners)- there was a separate question on partnership between CEYS partners and teachers;
4) through an end-of assessment phase questionnaire for the CEYS partners.

The interim questionnaire on partnership was distributed a few weeks after workshop 5. The purpose of the questionnaire was 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 CEYS teachers and the CEYS partners seemed to agree that their partnership was, as the teachers described it, **enriching** and **meaningful collaboration** in **supportive** and **respectful** atmosphere that made it possible to develop **honest**, **open** and **friendly** relationships. The teachers would have liked even **more meetings** in any of the possible form, either **individual**, group **face-to-face**, **virtual** or **school visits** and it may be a suggestion for future projects to incorporate more time spent with teachers although this has cost ramifications and close attention needs to be paid to geography/logistics.

The CEYS partners noted that the main **challenges** in fostering partnerships with the CEYS teachers were **limited access to classrooms**, **limited school support** and **limited teachers' time** that were all addressed by providing extra support and school visits where that was geographically/logistically possible.

Once again, the importance of creating a collaborative environment and fostering a community of practice has proven to be vital and the partnership approach inherent

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within the CEYS project was pertinent here; the CEYS partners and CEYS teachers' partnership played a key role in facilitating these conditions.

> *'The partnerships developed at each level of CEYS have been a strength of the project from my perspective.' (CEYS partner, UK, end-of-assessment questionnaire on partnership)*

A CEYS partner's quotation above illustrates how significant a part the partnerships played in the CEYS project.

3.4 Evaluation of the CEYS Curriculum Materials

To support CEYS teachers and CEYS partners in finalising the Curriculum Materials, CEYS partners developed a set of criteria for evaluation and moderation of the Curriculum Materials alongside exemplars of Curriculum Materials to illustrate expectations concerning quality and presentation. Moderation processes across the CEYS partnership also played an important role in developing guidance regarding the optimum presentation of materials and reaching a shared understanding of their potential use.

Furthermore, the CEYS Curriculum Materials were trialled and evaluated with varied audiences and in a wide range of contexts across the project, for example in

- Implementing and validating the Training Modules of the CEYS professional development course/programme across the participating countries
- Two 5-day international training courses (Yr1 and Yr2) (see Table 1)
- National dissemination activities.

They were evaluated by means of questionnaires and oral feedback sessions with teachers participating in the above activities. These experiences contributed in the identification both of appropriate Curriculum Materials for use in each Training Module and of effective ways of using the Curriculum Materials in training sessions.

The evaluation results are reported in detail in the report O4 'Report on Implementation and Validation of Training Activities', which can be downloaded from the CEYS website (www.ceys-project.euk). They have indicated that both the content and presentation of these materials are stimulating and inspiring and that participants have valued their use in the training modules. In addition, the experiences of CEYS partners and CEYS teachers suggest the materials can also be used independently of the modules, for example, in sharing with colleagues or staff meetings. School mentors and teacher educators have reported using the materials with trainee teachers to discuss processes of planning, teaching, assessment and evaluation in early years science.

Overall, the Curriculum Materials produced by the CEYS Curriculum Development process have an excellent potential for supporting professional development in early years science in a variety of contexts – with individual or small groups of teachers, in school staff meetings and in initial and continuing teacher education.

Erasmus+

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4. Lessons learned

Based on the evaluation results of CEYS Curriculum Development methodology, process and product summarised in the previous sections, the following more general lessons can be drawn for each of the components of curriculum development.

4.1 Curriculum Development Workshops and related Action Research

Curriculum Development Workshops features and processes

- Strong and substantial theoretical background both about professional development and the process of teacher change, and about the academic research and underpinning concepts examined in the curriculum development workshops is valued by teachers.
- Inputs in the form of research articles and classroom examples either in a written or visual form are highly appreciated by teachers. It should be noted however that since academic articles are often very theoretical, their access and usability by teachers in workshops may need to be facilitated. For example, in the CEYS Curriculum Development Workshops the articles were first summarized by the CEYS teacher educators and then discussed with the teachers. Also some of the texts needed to be adapted to local (national) contexts, in order to be of most use to teachers. In some cases it proved necessary to replace them or complement them with more readily accessible material in the home language. Additionally, videos of demonstrated creativity and inquiry-based approaches in the early years science classroom were found very valuable, though classroom videos of good quality and in various languages are scarce.
- The number and timing of the workshops are important considerations, as well as their organisation and overall approach. CEYS teachers appreciated that they were spread over a year, were well organised and communicated, and had an interactive style.
- Distribution of time spent in particular activities within the workshop is also crucial. Time for discussion and sharing of ideas amongst teachers, as well as time devoted to reflection on one's own learning and practice are well sought after by teachers. The awareness of change the CEYS teachers started feeling in their practices or in their attitudes towards science teaching were often attributed to the benefit of having time for reflection.
- Teachers' reflection needs to be supported by appropriate processes and means. Relevant prompt sheets in the CEYS Teacher Portfolio scaffolded teachers' written reflection highlighting effective teaching and learning strategies and management of change.
- Opportunities for teachers to exchange experiences and examples amongst teachers from both the same phase of education and other times from consecutive phases (e.g. early years and primary education) help teachers enrich their repertoire and understand how a curriculum intervention can contribute to children's learning over time.
- Finally it is important to include processes for teachers to give feedback to the content and processes of the curriculum development workshops, both formally

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and informally and at regular intervals, so as to integrate response to this feedback in following workshops.

Action Research strengths and challenges

In the implementation of the action research approach in particular, teachers require help with:

- defining a 'researchable' question;
- developing observational skills;
- developing recording strategies for capturing evidence of children's learning;
- making explicit decision making across learning activities;
- planning extended learning activities;
- giving constructive and detailed feedback;
- tracking development of their practices and their children's learning?.

CEYS teachers found it demanding to make observations on children's behaviour and attitudes during science lessons at the same time as gathering evidence about the changes. Everyday constraints and **time** were challenges in implementing the action research approach. However, on the whole they found the reflective and practical nature of the action research approach helpful. Introducing and then writing up accounts of their interventions helped raise the level of the teachers' confidence.

4.2 Partnerships forged during curriculum development

- All partnerships forged as part of the curriculum development process should be enriching and meaningful.
- The partnership in particular between teachers and teacher educators should be characterised by a supportive and respectful atmosphere in which teachers can feel safe to ask and explore anything without any fear of criticism.
- Such a partnership should also support and encourage teachers to contribute their own ideas, questions and dilemmas. The CEYS teachers often reported that they developed a relationship of honesty, openness and friendship with their CEYS teacher educators.
- Teacher educators should provide sensitive, individualised support and guidance on relevant content- and process-related issues, including on the implementation of change.
- In addition to the workshops, visits by teacher educators to their teachers' schools are considered very useful and beneficial for teachers. Also some individual 'face-to-face' or virtual meetings in-between the workshops, provide opportunities for more personalised approaches to be used.
- The partnership amongst teachers is also a very significant motivating force of the curriculum development process, whether it is between teachers of the same school, with colleagues from other schools in the same country, or with teachers in other European countries. The CEYS teachers reported that the experience of sharing ideas with their colleagues was valuable and they acknowledged the rich professional dialogue they built with other teachers.

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- Finally, teachers value opportunities to visit the schools of the other teachers in the curriculum development group, observe their efforts to change practice and get inspired.

4.3 Development of Curriculum Materials for teachers

The processes involved in the production of the CEYS Curriculum Materials underlined the importance of the processes of moderation and evaluation in developing a common vision of their purpose and presentation including:

- Importance of the Conceptual Framework as a reference point.
- Role of moderation across the curriculum development stakeholders in developing a shared understanding and interpretation of the Conceptual Framework and criteria for evaluating the curriculum materials.
- Value of iterative processes of trial and evaluation with teacher educators, teachers and varied audiences in ensuring materials are accessible and identifying strategies for effective use.

Furthermore the processes of evaluation, trialling and moderation of the CEYS Curriculum Materials helped to highlight and support features of the materials that are particularly valuable for their use in training and have contributed to their positive reception by varied audiences for example:

- The materials provide examples of the *processes* of learning and teaching *over time*, not just of activities.
- They are *written by teachers for teachers*. The personal voice of the teacher gives insight into the processes involved in the curriculum change intended.
- *Teachers' decision-making* is made explicit, for example: the rationale for activities, reflections on their success and implications.
- *The voices of the children* are given high profile and a variety of evidence included of their responses to activities, useful in fostering discussion about assessment and in illustrating young children's capabilities.
- The materials include explicit links to the *Conceptual Framework* underpinning the change of practice, in order to support identification of examples of relevant learning and teaching.
- The materials highlight inspiring moments and opportunities for fostering the intended change *within everyday activities over time and in varied contexts*– not just one off WOW moments.
- Finally, the structure and presentation of the materials help teachers recognise *how they can build on what they are doing already* in order to develop further their practice.

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5. Conclusion

The CEYS project's Curriculum Development, aiming to be 'living what it is teaching', used in its prototyping phase an educational design research approach and in its assessment phase iterative cycles similar to those of action research. Thus, the CEYS partners together with the CEYS teachers adopted an on-going process of evaluation through collecting data from different sources and through their continual reflection. As a consequence, all four categories of curriculum development e.g. curriculum development workshops, partnerships, curriculum development methodology and curriculum materials were continuously monitored, evaluated and improved and were, in the end, assessed by all involved in the CEYS project as successful, effective and impactful.

As mentioned in CEYS curriculum development methodology, in order to support the teachers through the action research cycle that brought about changes on different levels, it is worth emphasising the importance of: 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, Hiatt, 2006). The **action research approach** (with its on-going reflective phase) was an appropriate choice for raising awareness of the need for change. **The CEYS partnership** facilitated change already built into the initial phase of the CEYS project (induction workshops) and through two action research cycles undertaken by the teachers. **The 5 curriculum development workshops** clearly contributed to the body of knowledge on how to change and the teachers' action research and reflections upon it, alongside their discussions with peers and the CEYS partners at the workshops, led to an enhanced **capacity to foster creativity in early years science education** and produce materials to feed forward into changes in teaching. The CEYS partners and the CEYS teachers provided reinforcement through their partnerships for the **sustainability of the changed practice** through collaborating together in an open and honest relationship.

Figure 4 *ADKAR Model (Hiatt, 2006)*

The CEYS development process with all its phases was complex and was made possible by effective and supportive Partnerships that contributed to the enriching Curriculum Development Workshops. These in turn resulted in insightful Curriculum Materials underpinned by the co-created and participatory Curriculum Development Methodology.

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