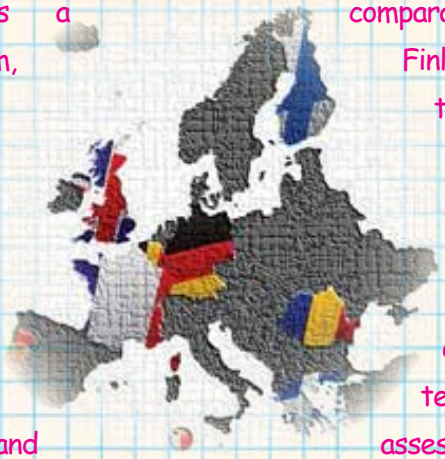
Creative Little Scientists

Enabling Creativity through Science and Mathematics in Preschool and First Years of Primary Education

About Creative Little Scientists

Creative Little Scientists is a comparative study working across nine participating countries: Belgium, Finland, France, Greece, Germany, Malta, Portugal, Romania and the UK. The project focuses on the relationships and synergies between science and mathematics education and creativity. Creative Little Scientists seeks to document current reality in the nine partner countries of the study, through survey and classroom focused research. The study aims to mainstream exceptional and excellent practices by proposing changes in teacher education and classrooms encompassing curriculum, pedagogy and assessment.



Why are we doing this study?

There are four key common drivers for an increased research focus on science and mathematics education and creativity in the early years classroom:

1. An economic imperative demanding capable scientists and creative thinkers in an increasingly knowledge-based globalised economy, which requires certain capabilities in the classroom, including reasoning skills, innovative thinking and powsitive attitudes;
2. The role played by science, mathematics and creativity in the development of children and of citizens; scientific literacy plays an increasingly important role not just for individuals but for 21st century society as a whole;
3. Rapid changes in digital technologies that are shaping learning processes and affording new opportunities for expression, communication and assessment of learning;
4. Growing recognition of young children's capabilities and the importance of early years education in building on early experiences and promoting knowledge and understanding, skills and dispositions.

The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 289081.

A comparative study

European integration and global competition have increased the need for comparative research and the European Union both encourages and funds such research between its member countries. International organisations such as UNESCO, OECD and the EU are particularly interested in the outcomes of this research project.

Creative Little Scientists is concerned with comparative pedagogy which focuses on one theme making cross-national comparisons in relation to a variety of educational issues and/or practice. In doing so, the project encompasses varied conceptualisations of early years education. These include recognising in the participating countries differing balances between education and care, and a wide span of purpose, from a 'readiness for school' approach (focusing on cognitive development) at one end of a continuum, to a 'foundation for lifelong learning' approach (underpinned by social pedagogy) at the other.

Teachers' perceptions of themselves and their work encompass values gained from their understanding of learning and of creativity and inquiry based approaches; the adoption of such values are influential in guiding pedagogical views and practice.

- Achieving a balance between structure and freedom; adopting a more dialogical pedagogical model in which teachers orchestrate standing back with collaborative interve ntion in science and mathematics classrooms.
- Negotiating the tension between formative and summative assessment in relation to assessment for learning versus assessment for comparative purposes.

The study explores both of these dimensions of teachers' practice.

What we are investigating

We are aiming to capture curriculum focus and design and to evidence and develop practice. The research questions apply to children aged 3-8, and probe both children's creativity and the creative pedagogy of teachers and early years practitioners.

Question 1: How are the teaching, learning and assessment of science and mathematics in Early Years in the partner countries conceptualised by teachers and what role if any does creativity play in these?

Question 2: What approaches are used in the teaching, learning and assessment of science and mathematics in Early Years in the partner countries and what role if any does creativity play in these?

Question 3: In what ways do these approaches seek to foster young children's learning and motivation in science and mathematics, and how do teachers perceive their role in doing so?

Question 4: How can findings emerging from analysis in relation to questions 1-3 inform the development of practice in the classroom and in teacher education (ITE and CPD)?

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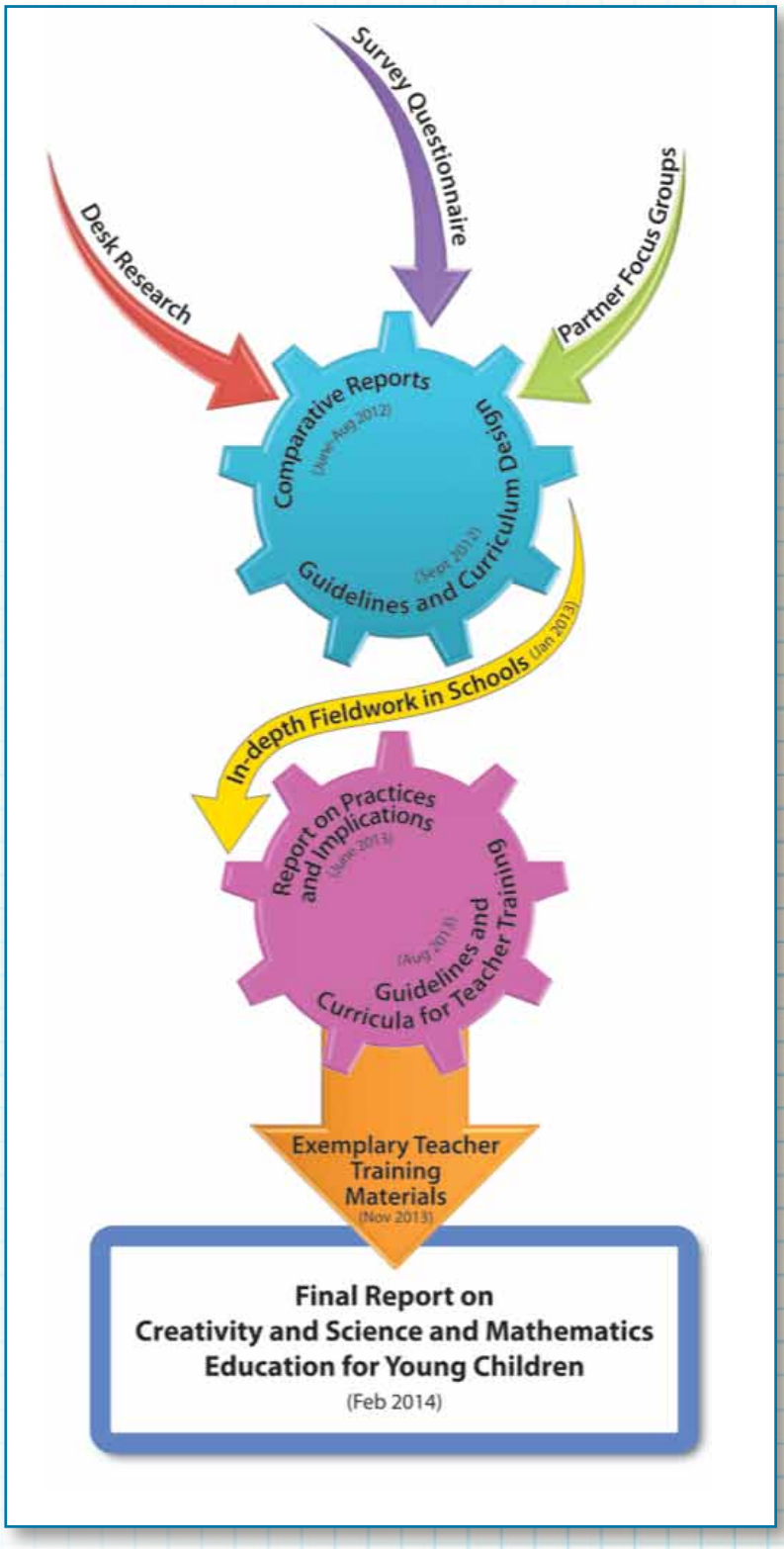
How we are finding out



We are undertaking the research using a number of approaches including desk studies and fieldwork. The research team first devised a conceptual framework for the study drawing on four substantial literature reviews mining the areas of science, mathematics, and creativity in the early years, teacher education across Europe, and the nature of comparative education. This was followed by desk surveys of curriculum policy across all participating countries, developing a list of comparative factors, and prototypical design features for initial teacher education. Empirical work undertaken so far includes a survey of early years teachers and preparations are under way to research cutting edge, excellent classroom practices in each of the participating countries.

The international teacher survey was constructed with the aim of exploring a wide range of aspects of early years science and mathematics education, such as use of creative approaches, the teaching and learning of science, experiences of teacher training, and educational assessment. The online questionnaire was completed by approximately 700 teachers from the nine partner countries, including all four home nations in the UK, and analysis of these submissions will allow a flavour of classroom practice from across Europe to be established. The results and subsequent reporting of the findings of the survey are to be published in November 2012.

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What do we know so far?

Developing a conceptual framework

Effective development in science and mathematics in the early years involves a complex interrelationship among:

- understanding of scientific procedures and process skills, often grouped into phases linked to the inquiry process,
- conceptual knowledge and understanding, and also
- affective aspects such as motivation and attitudes building on children's curiosity and concern to investigate and explain the world around them.

Creativity has a similar relationship to science and mathematics between process and outcome and has moved away from the traditional link with the arts to a focus on problem finding and problem solving. Motivation has an important role to play in creativity too.

Science, mathematics and creativity are three areas with different foci: creativity nurturing novelty, and science/mathematics nurturing children's curiosity and engagement with predicting, explaining and manipulating the world around them. They importantly however, share a recognition of the importance of hands-on and minds on exploratory engagement, and a focus on inquiry and investigation, often driven by young learners' curiosity and questions.

Nature of early years science and mathematics

Learning science and mathematics each involve knowledge inquiry processes and the skills and attitudes involved in gaining that knowledge. Across the phases of education there are debates concerning the relationships between these aspects and their relative importance for learning. However in the early years, the emphasis tends to be less content/knowledge driven and more focused on fostering positive attitudes and on children exploring, observing, and asking questions. It is these activities that are seen subsequently to build knowledge foundations for developing future concepts.

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In science, the perceived importance of understanding of the processes through which science knowledge is acquired, is reflected in moves toward more inquiry based learning approaches. This is epitomised in Inquiry Based Science Education (IBSE), an approach that emphasises children's understanding and skills in finding out and evaluating information around them[1]. An inquiry-based approach involves activities such as, "diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments" (Linn, Davis and Bell, 20042).

Inquiry-based approaches to learning mathematics foster the living dynamic between mathematics procedures and conceptual understanding where knowledge of content can provide the context for developing process skills, which in turn can help learners develop further concepts.

More than just supporting learning, there is also a growing recognition that affective factors are integrated to the meaning children give to their experiences. Science and mathematics provide a context for developing important attitudes and dispositions such as curiosity, motivation and confidence to engage in inquiry and debate, willingness to change ideas, flexibility, respect for evidence, and more widely positive attitudes to learning and respect for the environment.

1. ROCARD, M., CSERMELY, P., JORDE, D., LENZEN, D., WALBERG-HENRIKSSON, H. and HEMMO, V. 2007. Science education now: A renewed pedagogy for the future of Europe Brussels: Office for Official Publications of the European Communities.
2. LINN, M. C., DAVIS, E. A. and BELL, P. 2004. Internet environments for science education: Mahwah, NJ, Lawrence Erlbaum.

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Early years creativity

Of the many different framings of creativity, early years educators have mainly seen creativity as something that is accessible to all, particularly through play, and they have sought to develop creative classrooms. Children's creativity in the early years has in particular been characterised as involving problem finding and problem solving, involving playful exploration that prompts individual, collaborative and communal engagement. Creativity in young children has been understood as 'everyday' creativity or 'little c', often involving 'mini-c' creativity (this latter being leaps of personal understanding).

Broadly speaking, there are two main approaches to creativity in education:

- Creativity as de-contextualised and generalised, applied in a variety of situations.
- Creativity as contextually and culturally situated; the processes are specific to context.

In a way, the de-contextualised-approach echoes science and mathematics processes when these are presented as being a list of potential actions independent of context. However, creativity is increasingly understood as contextualised, social and ethically situated, whether concerned with both paradigm shifts or the everyday. This too draws parallels with arguments in science and mathematics where the domain context matters when considering processes.

Studies such as the work on 'possibility thinking' by researchers at the Open University, Exeter University, and Cambridge University, have investigated creativity as culturally situated. These confirm and document possibility thinking as driven by children's questions and responses in a playful and frequently narrative context, in which a leading question shapes both service and follow-through questions. Immersed, children behave with intentionality, are self-determined, use imagination, and innovate and take risks. Jeffrey and Woods[3], also in England highlight four features of everyday creativity in the primary classroom: a sense of relevance in the experience they are engaged in, control over its articulation, a feeling of ownership over learning, and opportunities to innovate. As with science and mathematics education, it is arguable that motivation plays an important role in creativity. Studies suggest that intrinsic motivation and curiosity, contribute positively to creativity, whereas extrinsic motivation is sometimes negatively related to it. More recently, studies have focused on the impact of emotional states on creative performance; however the findings are not consistent.

3. JEFFREY, B. and WOODS, P. 2003. The Creative School: a framework for success, quality and effectiveness. London: Routledge Falmer.

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Comparing Inquiry-Based Science Education and Creative Approaches

Inquiry Based Science Education (IBSE) teaching and learning and approaches which foreground creativity (Creative Approaches, CA) can enhance learning. Although definitions of IBSE vary, there is considerable agreement internationally, reflected in both policy and research, about the value of inquiry-based approaches to science education. CA on the other hand does not refer to a recognised set of approaches to education and learning, but nonetheless such approaches have gained considerable attention in research and policy contexts in recent years. IBSE and CA appear to have synergies and differences. Both sets of approaches being pedagogically associated with a range of child-centred philosophies from European and North American thinkers, these situate the child as an active and curious thinker and meaning maker and highlight the role of experiential learning.

Common synergies indicate an emphasis on:

Play and exploration, 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.

Motivation and affect, highlighting the role of aesthetic exp erience in promoting children's affective and emotional responses to science and mathematics activities.

Dialogue and collaboration, accepting that dialogic engagement is inherent in everyday creativity in the classroom, plays a crucial role in learning in science and mathematics and is a critical feature of IBSE and CA, enabling children to externalise, share and develop thinking.

Problem solving and agency, recognising that through scaffolding the learning environment children can be provided with shared, meaningful, physical experiences and opportunities to develop their own questions as well as ideas about scientifically relevant concepts.

Questioning and curiosity, central to IBSE and CA, recognising that creative teachers often employ open ended questions, and promote speculation by modelling their own curiosity.

Reflection and reasoning, emphasising importance of metacognitive processes, reflective awareness and deliberate control of cognitive activities, still developing in young children but incorporated into early years practice, scientific and mathematical learning and IBSE.

Teacher scaffolding and involvement, teachers mediating the learning to meet the child's needs, rather than feeling pressured to meet a given curriculum.

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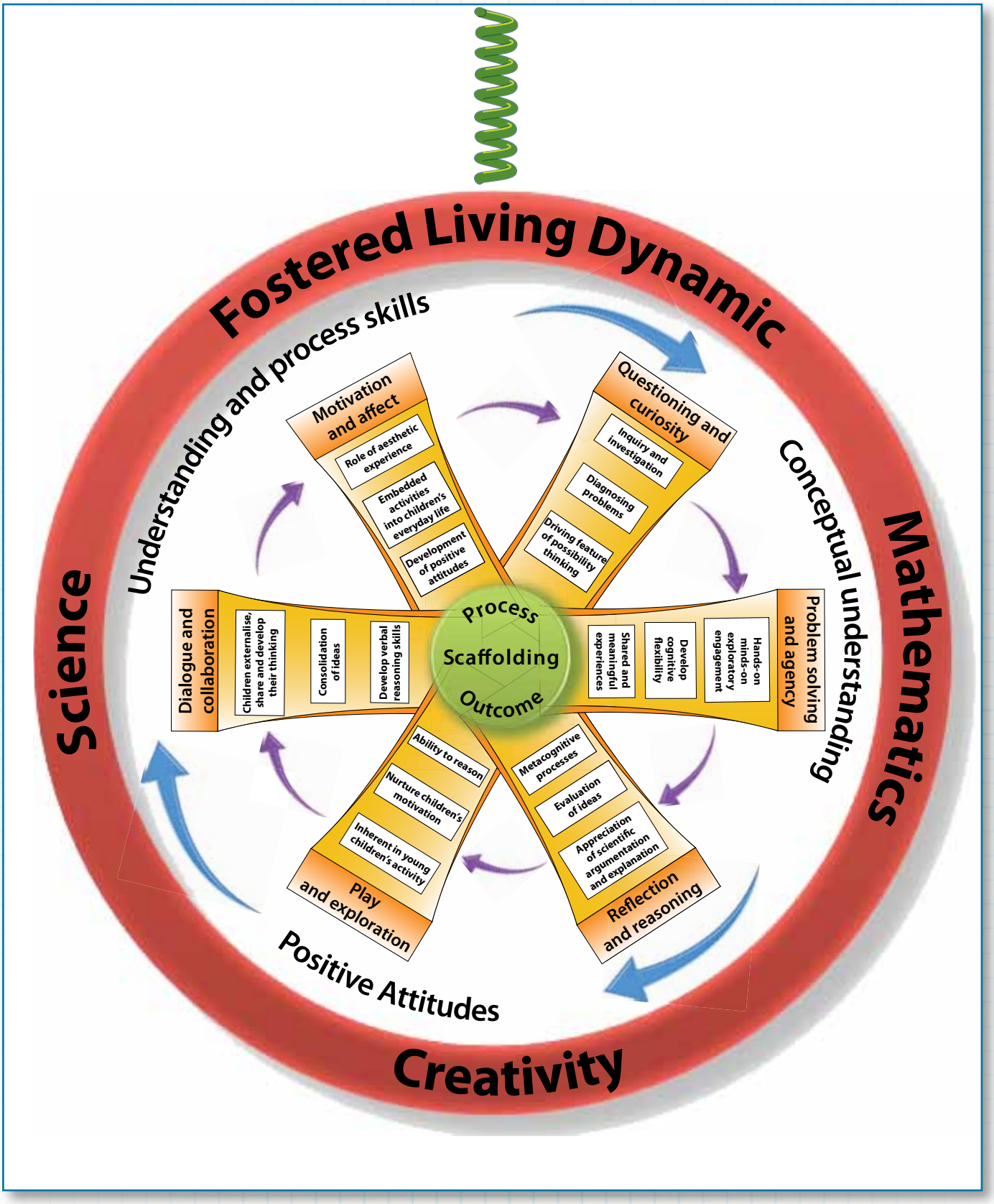
Visual model of the fostered living dynamics amongst science, mathematics, and creativity depicting the synergies between IBSE and CA approaches



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Associating policy and practice

Educational policy can shape practice by emphasising values and by indicating both content and pedagogy through frameworks, outcomes and assessment approaches. However, the degree of regulation and the official status of documents varies across countries and phases of education. There is widespread emphasis on active learning and building on children's existing knowledge and experience and interests, although few explicit references were found in policy documents of inquiry based approaches, and mention of creativity in the science and mathematics' curricula was limited in many countries. In contrast to the emphasis on science and mathematics in the early years across Europe, creativity is less evenly highlighted, perhaps reflecting the perceived lack of a relationship between creativity and economic or technological imperatives or the development of the individual as a successful citizen.

As part of the policy survey contextual reports were synthesised highlighting commonalities and differences between countries, and issues and tensions within science and mathematics education.

Findings from our international policy review

Partners in each of the Creative Little Scientists countries analysed their national educational policies with reference to creativity and science and mathematics education, as well as between preschool and primary school. Issues explored were:

- The purposes and rationale of early years science and mathematics education
- The aims and objectives of early years science and mathematics education
- The content of curricular documents from each country
- Where children are learning (for example the use of classroom space or outdoor learning)
- The particular learning activities that children were undertaking
- The role of the teacher in early years education
- Guidance on pedagogy, such as the use of materials and resources, grouping of children in lessons or time allocation in mathematics and science education
- Assessment in early years science and mathematics education
- The processes of teacher education, including both initial teacher education and continuing professional development

Many differences could be seen in factors such as curriculum content, the contexts in which children were learning, and guidance on pedagogy. A significant difference between policy documents is the extent to which they make explicit reference to science in the early years. Both at pre-school and in primary school, some curricula refer to science education and outcomes explicitly, while others place it within the context of more general educational aims or skills.

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Differences could also be seen across partner countries in the structure and organisation of schooling, with various definitions of preschool, primary, and secondary education and the associated curriculum structure, the age of compulsory education, and requirements of staffing qualifications Similarities could also be seen across partner countries in several areas. For example the purposes/or rationale of curricula, where performance in national and international tests was having an increasing impact on policy development and construction across partner countries. In many of the partner countries new policies are being developed and introduced – often associated with increasingly centralised steering of education systems. Linked to this is the gap between policy and practice – another common theme across the reports.

One of the recurring features that arose was considering assessment. While many of the countries had different approaches to assessment, there were challenges in general of assessment related to inquiry and creativity, often with a tendency to focus on products rather than processes in assessments. This is particularly interesting for the project given the approach taken by the Creative Little Scientists consortium to creativity, where the definition of creativity is firmly on the processes relative to the individual, rather than necessarily on any outcome.

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Evolving prototypical design principles for teacher development

One of the key objectives of the Creative Little Scientists project is to propose a set of curriculum design principles as concrete guidelines for European initial teacher education and continuous professional development programmes. These are aimed at helping enable creativity-based approaches to science and mathematics learning in preschool and the first years of primary education. The principles will be accompanied by illustrative teacher training materials aiming to clarify their applicability in complex and varied European educational contexts, thus facilitating implementation, evaluation and further development across Europe.

To design the principles 10 components are being used: the rationale or vision of the curriculum, aims and objectives, content, learning activities, teacher role, materials and resources, grouping location, time and assessment. The draft design principles will be evaluated and further adjusted through iterative cycles of development. The iterative process, as of September still in its early stages, has highlighted the importance of competences, expectations, beliefs, attitudes towards science and mathematics and prior experiences and prior knowledge of the teacher, as a gap needing investigation. The project has made evident some general differences between the starting situation of teachers in different countries, between early childhood teachers and primary teachers.
In addition, the project will be making recommendations about the methodology of 'curriculum design research' offering a new model based on four phases – analytical, prototyping and assessment, and on the characteristics of curriculum design research.

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- University of Malta
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Find out more

To keep up to date with the project's outputs, visit the website.

Existing and upcoming deliverables can be found here:
http://www.creative-little-scientists.eu/content/deliverables

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