# Module 4: Focus on Inquiry-based Science – link with creativity

## Aims of the module

- Introduce participants to characteristics of inquiry-based approaches to science education
- Explore opportunities for creativity within scientific inquiry
- Examine connections between inquiry-based and creative approaches to learning and teaching
- Consider ways in which practitioners can promote children's decision making and creativity in science building on their own ideas and questions
- Enable participants to reflect on opportunities for fostering inquiry-based and creative approaches to science, within both policy and practice, in their own educational settings.

## Links to the Content Design Principles and Outcomes

6. Teacher education should provide pedagogical content knowledge to stimulate inquiry and problem solving in science and mathematics education.

6.2 Teachers should be able to open up everyday learning activities to allow greater opportunities for inquiry, problem solving and scope for creativity.

6.3 Teachers should be able to recognise the key roles of children's questioning and existing ideas (both implicit and explicit) of science and mathematics.

6.4 Teachers should be able to use a variety of strategies for eliciting and building on children's questions and ideas during inquiry processes (before, during and after explorations and investigations).

6.5 Teachers should be able to foster opportunities for children's agency and creativity in learning in inquiry and problem solving – in particular the importance of children making their own decisions during inquiry processes, making their own connections between questions, planning and evaluating evidence, and reflecting on outcomes.

## Rationale for the module

*What has led to the focus on Inquiry-based science?*

In recent years there has been growing emphasis in policy on scientific literacy as an aim of science education. Scientific literacy was defined by the OECD as:

> The capacity to use scientific knowledge, to identify questions and draw evidence-based conclusions in order to understand and make decisions about the natural world and make changes to it through human activity. (Harlen, 2001)

This trend is reflected internationally through the inclusion of the development of scientific inquiry skills and understanding of scientific ways of working within curriculum requirements for science education.

There is widespread recognition of the central role of inquiry processes in young children's learning in fostering the skills and understandings and associated with scientific inquiry, alongside the development of scientific concepts.

For example as noted in the Conceptual Framework adopted by the CEYS Project (Creative Little Scientists, 2012: 32):

> Young children's experiences, both informal experiences and those nurtured in the classroom, provide them with 'data' with which to generate and evaluate different ideas in collaboration with adults and peers. As argued by Drayton and Falk (2001) an inquiry-based approach to learning is

The project CREATIVITY IN EARLY YEARS SCIENCE EDUCATION has received funding from the European Union Erasmus+ Programme (2014-2017) under Grant Agreement n0 2014-1-EL01-KA201-001644.

not only a means of fostering understandings and skills associated with scientific procedures, but is a means of learning content. Greater procedural knowledge may be informed by, and in turn inform, conceptual understanding (Rittle-Johnson, Siegler and Alibali, 1999); knowledge of content can provide the context for developing process skills, which in turn can help learners develop further concepts (Harlen and Qualter, 2004).

There is increasing evidence that positive attitudes to science, and scientific attitudes such as curiosity or respect for evidence, are fostered through practical inquiry and opportunities for children to explore their own ideas and questions. Affective factors play a significant role in learning. As argued by Perrier and Sendiyumva (2003: 1124), "The affective dimension is not just a simple catalyst, but a necessary condition for learning to occur".

There is growing attention to the role of creativity in the development of scientific ideas and strategies, both in science and in science education. This can be seen in recent publications and projects concerning research, policy and practice in science education. However as highlighted in the Final Reports of the Creative Little Scientists project (Creative Little Scientists, 2014) further work is needed to illustrate and explore how creativity might be recognized and promoted in everyday classroom experiences of science.

*What are the issues for practitioners?*
Key questions in developing creative, inquiry-based approaches to science include:

- What do we mean by inquiry-based science education? A variety of definitions are offered– what are some of the common characteristics of inquiry-based approaches?
- What are the connections with creativity? Creativity is often referred to in policy in rather general terms. What might this look like in the classroom?
- How might children's inquiry and creativity be recognized and fostered in everyday classroom activities?
- What factors are influential in opening up opportunities for children to build on their own ideas and questions and make decisions during inquiry processes?

## Overview of the module

The module consists of the following activities:

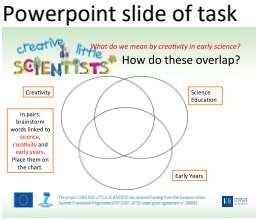
1. **Introduction** - Why the focus on inquiry and creativity in early years science?
2. **What characteristics do you associate with creativity, science and learning and in the early years?** How are they related? Participants are encouraged to share their initial ideas. This provides a starting point for an introduction to *key features of the definition of creativity* adopted by the CEYS Project.
3. **How would you recognise creativity in examples of learning and teaching?** Participants discuss examples of lessons that undergraduate teachers in training identified as creative.
4. **Introduction to the definition of creativity in science** adopted by the CEYS Project
5. **What is meant by scientific inquiry?** Participants engage in practical activities designed to facilitate reflection on features of inquiry. Which features of inquiry did they engage in spontaneously? What aspects might need further support or encouragement? Participants then consider the opportunities this activity offered for decision making drawing on the framework *Essential features of classroom inquiry and their variations* (Barrow, 2010). Finally they reflect on the ideas and questions they generated through their activity and consider how their inquiry could be extended.
6. **What might be the advantages and disadvantages of open, guided and structured approaches to investigation?** Participants discuss the strengths and weaknesses of different approaches to examples of everyday classroom investigations (either an

The project CREATIVITY IN EARLY YEARS SCIENCE EDUCATION has received funding from the European Union Erasmus+ Programme (2014-2017) under Grant Agreement n0 2014-1-EL01-KA201-001644.

example from their own school, or the fliers example provided as a handout.) It is not intended that they carry out the investigations but reflect on

7. **What is the potential for inquiry and creativity within everyday classroom activities?** Participants review and analyse classroom examples from the Creative Little Scientists Project with a focus on the following: Which features of can you identify? What are the opportunities for children's decision-making and creativity? Do you think this is an open, guided or structured inquiry?
8. **What are the roles of the teacher in fostering inquiry and creativity in children's learning?** In what ways did the teacher foster children's independence and inquiry? What opportunities can you identify for assessment and for extending learning? Participants examine these questions in relation to two further features of the CLS Conceptual Framework: The synergies between creative and inquiry based approaches to science education and the pedagogical model *Pedagogical interventions in context* (Siraj-Blatchford et al, 2002).
9. **What are the implications for planning?** Participants reflect on how opportunities for inquiry and creativity might be extended in their own settings.
10. **Reflection**. Participants reflect on what has been gained from the module – both content and process, in relation to the aims of the workshop.

## Module at a glance

| Time | Task | Materials | Grouping |
|---|---|---|---|
| 00.00 | **1. Introduction**: aims and rationale for the module. Why the focus on inquiry and creativity in early years science? | Powerpoint presentation<br>• Aims<br>• Links to Content Design Principles and Outcomes<br>• Session rationale – making links to research and policy developments in the field<br>• Outline of the session | Whole group |
| 00.10 | **2. What characteristics do you associate with creativity, science and learning in the early years?** How might they be inter-related?<br>• *In groups of 2 or 3*– brainstorm three or four characteristics you associate each of the words - *science, creativity* and *early learning*. Write each characteristic that comes to mind on an individual post it and place in the relevant section of the chart provided (avoiding overlapping sections).<br>• Then consider which characteristics might be shared by science, creativity and early years. Place these in the central area of the chart.<br>• Which are <u>not</u> shared? What makes you think this?<br>• *As a whole group* – share and record ideas about common characteristics including common skills, processes and dispositions.<br>• Discuss areas of disagreement and characteristics that might not be shared. | Powerpoint slide of task<br>  <br><br>Small thin post-its (page markers) and pens<br>A4 recording sheets for groups to share and sort responses.<br><br>A1 Flip chart of Venn diagram to record summary of views<br>Marker pens<br>Blutak to display the chart for review at the end of the session. | Groups of 2/3<br><br>Followed with feedback with whole group |
| 00.20 | 3. **How would you recognise creativity in examples of science learning and teaching?**<br>• *In 2s/3s* Discuss examples of lessons taught by undergraduate teacher training students, which they identified as creative.<br>• Which examples do you think show the greatest potential for creativity and why? | Powerpoint slide of classroom examples<br><br>A4 sheets with examples given by trainee teachers.<br><br>A1 flip chart and pens for | Groups 2/3<br><br>Followed by whole group |

The project CREATIVITY IN EARLY YEARS SCIENCE EDUCATION has received funding from the European Union Erasmus+ Programme (2014-2017) under Grant Agreement n0 2014-1-EL01-KA201-001644.

| | | | |
|---|---|---|---|
| | • Which do you consider are less creative and why?<br>• *As a whole group* - share views<br>• Highlight common characteristics of creative examples<br>• Discuss areas of disagreement (related to conceptions of creativity or nature of science)<br>• Consider distinctions between creative teaching (*teacher* creativity) and teaching for *children' s* creativity. | recording characteristics of creative examples. | |
| 00.30 | **4. Introducing definitions of creativity in learning and teaching** from the conceptual framework adopted by the CEYS project.<br>Note comparisons with ideas shared so far and displayed on the initial Venn diagram of participants' ideas. | Power point slides<br>Comparing IBSE and CA<br>Definitions of creativity<br>Creative dispositions | Whole group |
| 00.40 | **5. What is meant by scientific inquiry?** What are the key features?<br>*In groups of 3/4* - Try out one of the practical activities provided.<br>1. List inquiry skills and processes you used.<br>• Which did you engage in spontaneously?<br>• Which might need further support/encouragement?<br>• What is the scope for creativity?<br>2. What opportunities did you have for decision making?<br>• Locate yourself on the Barrow Chart. Did this change over time?<br>3. What ideas and questions did you generate?<br>• How might your inquiry be extended?<br>• What are the implications?<br><br>*As a whole group* share experiences<br>Identify aspects of inquiry that might need particular support. | Powerpoint slides of task and of Barrow chart.<br>Activity sheets and resources for short practical activities.<br>Copies of Barrow chart.<br>There are useful examples on the London Science Museum website for example Rocket Mice or Ear Gongs (www.science museum.org.uk/educators)<br>   <br>(These provide clear instructions, require limited equipment, can carried out quickly with rich opportunities for extension and fun!) | Groups 4 |
| 1.10 | **6. What might be the advantages and disadvantages of open, guided or structured inquiry?**<br>• *In pairs* discuss the 3 different approaches to the fliers activity shown on the sheet provided (or another common classroom investigation).<br>• List the advantages and disadvantages of each approach.<br>• *As a whole group* record advantages and disadvantages of each approach on a flip chart.<br>• Consider links to your previous activity.<br>• Do different types of inquiry have an impact on opportunities for creativity? | 3 sets of instructions (open, guided, structured) for the flier activity for participants to discuss (or another common classroom activity).<br><br>A1 chart for recording feedback of advantages and disadvantages of each approach.<br><br>Powerpoint slide of the task | Pairs<br>Then the whole group |
| 1.20 | Break | | |
| 1.50 | **7. What is the potential for inquiry and creativity within everyday classroom examples?**<br>• *In 4s* consider opportunities for *children's* inquiry and creativity in each example.<br>• Which features of the inquiry process are the focus of activity in each example? (For example: questioning, designing or planning investigations, gathering evidence, making connections, explaining evidence, | Powerpoint slides of :<br>the task, key details from the episodes selected, the Barrow chart, creative dispositions to support whole group discussion.<br><br>Copies of 4 episodes or templates from CLS for | Groups of 4 divided into 2 pairs.<br><br>Followed by whole class discussion. |

The project CREATIVITY IN EARLY YEARS SCIENCE EDUCATION has received funding from the European Union Erasmus+ Programme (2014-2017) under Grant Agreement n0 2014-1-EL01-KA201-001644.

| | | | |
|---|---|---|---|
| | communicating and reflecting on explanations)?<br>• What are the opportunities for *children's* decision-making linked to the Barrow chart?<br>• Do you think this is an example of an open, guided or structured inquiry? Why?<br>• What evidence can you identify of children's creativity?<br>• How could the activity be extended?<br>• *As a whole group* share key features of the 4 different examples. | example:<br>*Selected episodes*<br>GR Ice Balloons<br>RO Float and Sink<br>BE Colouring<br>UKSC Forest School<br>*Templates*<br>BE The Wind<br>UKNI Gloop<br>Each group of 4 has 2 copies of 2 different examples to share<br>AA3 worksheets with prompts to record their analysis. | |
| | **8. What are the roles of the teacher?**<br>• *In groups of 4* examine of the role of the teacher<br>• In what ways do you think the teacher fostered children's creativity and inquiry?<br>• How was support provided for children's decision making in each case?<br>• *Whole Group discussion*<br>• Share and record teacher approaches that fostered creativity – consider connections to the synergies between inquiry-based and creative approaches?<br>• Highlight importance of classroom context – both pedagogical framing and pedagogical interactions. | Powerpoint slides of: the task, *Pedagogical model* (Siraj-Blatchford et al 2002), *pedagogical synergies* between IBSE and CA.<br><br>Flip and pens to record responses | |
| 2.30 | **9. Implications for planning**<br>• Take a favourite science activity you carry out in your setting. How could opportunities for creativity be extended?<br>• What could you feed back to colleagues: What does it mean to teach science creatively? Why does it matter?<br>• What are the implications for addressing curriculum requirements in your setting? | Powerpoint slides of activity<br>Flip chart and pens to record feedback | Individual reflection followed by Whole group |
| 2.45 | **10. Reflections on what has been gained from the workshop.**<br>• *In groups 2/3s* Look back at your original ideas about connections between science/creativity/ early. Anything you might add or change? Add in any additional comments or issues in another colour (pen/post it).<br>• Note and record 2 actions you will take building on workshop content.<br>• In what ways did the different activities support your developing thinking?<br>• How far have the aims of the session been met?<br>• Complete module evaluation | Powerpoint slides of activity and aims<br><br>Original recording<br><br>Pens, post its<br>Flip chart<br><br>Evaluation form | Groups of 4/5<br>For activities<br>Sharing with the whole group |
| 3.00 | **End** | | |

## Teacher education pedagogy

The introductory activities are designed to encourage participants to reflect on initial ideas about inquiry and creativity. Recording these processes helps to provide a starting point for introducing features of the Conceptual Framework adopted by the CEYS project and a reference point for review at the end of the session. It is important in each activity to

The project CREATIVITY IN EARLY YEARS SCIENCE EDUCATION has received funding from the European Union Erasmus+ Programme (2014-2017) under Grant Agreement n0 2014-1-EL01-KA201-001644.

encourage participants to offer reasons for their views and to foster exchange of alternative views. Common areas for discussion include:

- General association of creativity with creative arts activities, whether developing knowledge and understanding in science involves creativity. Use of post-its encourages discussion of choices of where to place characteristics – allows flexibility in comparison to immediate positioning on the record sheet.
- Need to make a distinction between *teacher* creativity (often involving choice of motivating contexts and resources) and teaching for *children's* creativity (for example: opportunities for children's decision making, building on children's ideas and questions, safe climate that encourages risk taking).

**1. Introduction** - this indicates the aims of the session and outlines factors that have led to an increased emphasis on inquiry-based science.

**2. Characteristics of creativity, science and learning in the early years.** This activity is designed to encourage participants to reflect on their ideas about the characteristics of creativity, science and learning - often not made explicit. This provides a useful starting point for discussion across the session, as well as a reference point for reflection at the end.

**3. How would you recognise creativity in examples of science learning and teaching?** Discussing classroom examples is often helpful in clarifying teachers' thoughts and ideas about creativity in science might look like.

**4. Introducing definitions of creativity in learning and teaching** from the CEYS conceptual framework. Here it is useful to make with participants' responses to activities 1 and 2 and to encourage them to reflect on similarities and differences in their views – and any new perspectives the framework offers.

**5. What is meant by scientific inquiry?** Undertaking practical tasks can help teachers to appreciate features of inquiry at first hand. The examples from the London Science Museum are just examples. A wide range of investigations could be used here – they need to engage participants quickly and be simple to resource. These have the benefit of ready-made instructions, accessible resources and appeal to adults as well as children. They are also practical for use in shorter staff training or workshop sessions.

**6. What might be the advantages and disadvantages of open, guided and structured approaches to inquiry?** Again there are many possible examples that could be used for this activity. The flier example is easy to imagine and discuss and it is not intended that participants undertake this activity. However, if you have the time they could try out the different approaches to the flier activity themselves. The issues involved could be explored in detail through the workshop *Comparing Approaches to Hands-On Science* developed by the Institute of Inquiry that can be found on http://www.exploratorium.edu/ifi.

**7. What is the potential for inquiry and creativity within everyday classroom examples?** It is important to emphasise that the focus of this task is on evidence of *children's* inquiry and creativity. The classroom examples have considerable potential to foster interest and encourage debate. However participants may need support initially in engaging with the evidence shown in the episodes and templates. It is helpful if the module facilitators are familiar with the background to the episodes/templates selected and provide a brief introduction to each one at the start of the activity. Details can be found in the relevant Country Reports found on the CLS website http://www.creative-little-scientists.eu/content/deliverables under deliverables D4.3 Country Reports. Use of a recording sheet with key questions helps focus discussion explicitly on key features of inquiry and creativity and provides a basis for sharing analyses with others.

The project CREATIVITY IN EARLY YEARS SCIENCE EDUCATION has received funding from the European Union Erasmus+ Programme (2014-2017) under Grant Agreement n0 2014-1-EL01-KA201-001644.

**8. What are the roles of the teacher?** The discussion of the role of the teacher provides a valuable starting point for introducing both the pedagogical synergies between inquiry-based and creative approaches and the pedagogical model (Siraj-Blatchford et al 2002) - both part of the conceptual framework adopted by the CEYS project (Creative Little Scientists, 2012). It is helpful here to encourage participants to focus on *positive* features of teachers' practice and then share and discuss possible alternative practices and extensions. This reflects an important principle of the CEYS project – identification of potential in often challenging circumstances, and recognition of the complexity of factors that influence practices in real contexts. For all teachers the challenge is to find ways to make steps forward by identifying opportunities for opening up practice starting from current policy and practice. This activity provides a useful foundation for the final parts of the session focusing on implications and evaluation.

**9. Implications for planning.** This activity is designed to encourage participants to reflect on the implications of module content for their own contexts by reflecting on a practical example.

**10. Reflection**. A reminder of the aims and structure of the workshop and reflection on initial ideas provide helpful starting points for evaluation. It is valuable if you have the time to encourage participants not just to reflect on content but on workshop *processes*.

## Background reading

### *Defining creativity in early years science*

D6.6 Recommendations to Policy Makers and Stakeholders on Creativity and Early Years Science EXECUTIVE SUMMARY

This module draws on both the definition of creativity in early years science developed in the Creative Little Scientists project and adopted by the CEYS project and key features of inquiry -based approaches to science education. You may find it useful to provide opportunities for participants to become familiar with these prior to the workshop. This report from the Creative little Scientists project provides accessible introductions to the definitions of creativity and inquiry used during the session, with illustrations from the classroom. It can be found on the CLS website at http://www.creative-little-scientists.eu/content/deliverables.

Cremin, T. et al (2015) Creative Little Scientists: exploring pedagogical synergies between inquiry-based and creative approaches in early years science. *Education 3-13*, *43*(4), 404-419.

This article built on the work of the Creative Little Scientists Project provides a useful introduction to the pedagogical synergies identified by the project between IBSE and CA to science learning and teaching.

Newton, D. P. and Newton L. D. (2009) Some student teachers' conceptions of creativity in school science, *Research in Science & Technological Education*, 27(1), pp 45-60.

This article by Newton and Newton reports findings from their study of teachers' view of creativity in science and highlights common issues and challenges.

### *The nature of inquiry-based approaches to science education.*

The articles below give a flavour of key features of inquiry based-approaches and current areas of debate.

Asay, L. D., & Orgill, M. K. (2010). Analysis of essential features of inquiry found in articles published in The Science Teacher, 1998-2007. *Journal of Science Teacher Education,* 21(1), 57-79.

In order to provide a picture of how inquiry is practised in everyday science classrooms, the authors analysed articles published in The Science Teacher from 1998 – 2007 for explicit evidence of features of inquiry.

The project CREATIVITY IN EARLY YEARS SCIENCE EDUCATION has received funding from the European Union Erasmus+ Programme (2014-2017) under Grant Agreement n0 2014-1-EL01-KA201-001644.

Barrow, L. H. (2010). Encouraging creativity with scientific inquiry. Creative Education, 1(1), 3.
This provides a useful framework for assessing opportunities for children's decision making and creativity in scientific inquiry.

Fibonnaci Project (2012) has a number of *resources* on the project website http://www.fibonacci-project.eu to support inquiry-based approaches to science teaching including:
Learning Through Inquiry - a very accessible guide to inquiry-based approaches in science
Tools for Enhancing Inquiry in Science Education - The "self-reflection tool for teachers" in this document provides a valuable framework for reflecting on features of inquiry in a classroom session with prompts in relation to both teaching and learning (both as an individual and in groups).

Minner, D.D. et al (2010). Inquiry-based instruction – what is it and why does it matter? Results from a research synthesis years 1984-2002. *Journal of Research in Science Teaching*. 47 (4), 474-96.
This article is based on a sysnthesis of research carried out between 1984 – 2002. Findings indicate a clear, positive trend favouring inquiry- based instructional practices, particularly instruction that emphasizes students' active thinking and drawing conclusions from data.

Wellcome Trust (2011) Perspectives on Education: Inquiry-based learning. London. Wellcome Trust.
This report was produced to contribute to debate about what is meant by inquiry- based education and its role in inspiring science education.

## Suggested classroom examples for use during the module

The following classroom examples would act as useful starting points for discussion.

From the *Creative Little Scientists* project at http://www.creative-little-scientists.eu/content/deliverables.
*Selected Classroom Episodes:* GR Ice Balloons, RO Float and Sink, BE Colouring, UKSC Forest School in D4.4 Appendix Selected Episodes of Practice
*Classroom Templates:* BE The Wind, UKNI Gloop in Addendum to D5.3.

From the *Creativity in Early Years Science Project at* http://www.ceys-project.eu
Curriculum Materials

| Title | Age group | Country |
|---|---|---|
| Everyday materials | 5-6 | England |
| An icy adventure | 3-4 | England |
| Water resistance | 5-6 | Belgium |
| Oxygen | 4-5 | Belgium |
| Germination and growth | 5-6 | Romania |
| Plant and Butterfly Cycles | 5-6 | Greece |

However it is important to review and select examples appropriate to your context and audience. Other examples can be found on the CLS and CEYS websites.

## Module resources

The following documents are provided as separate files in the Module folder for adaptation and use as appropriate during the module:

- Powerpoint presentation
- Task 5 Practical activities, Resources and Guidance – Rocket Mice and Ear Gongs
- Recording sheets for the different activities:
  - Task 2 recording sheet - What characteristics do you associate with science, creativity and early years? How might they be inter-related?

The project CREATIVITY IN EARLY YEARS SCIENCE EDUCATION has received funding from the European Union Erasmus+ Programme (2014-2017) under Grant Agreement n0 2014-1-EL01-KA201-001644.

- Task 6 Recording sheet: Open, guided and structured approaches
- Task 7 Recording sheet: Discussion of classroom examples: Evidence of children's inquiry and creativity. This can be reproduced as an A3 sheet for participants to record responses to task 7.

- Handouts
  - Handout showing definitions of creativity in early years science and Features of inquiry and creative dispositions - for reference during the session
  - Task 3 Handout Examples of lessons taught by trainee teachers that they thought were creative.
  - Task 6 Handout Open, Guided or Structured Inquiry? Written examples of different approaches to the flier investigation that can be used as a starting point for discussion.
  - Task 7 Handout Barrow chart of opportunities for children's decision-making within scientific inquiry

## References


Drayton, B. And Falk, J. (2001). Tell-tale signs of the inquiry-oriented classroom. *NASSP Bulletin*, 85(623), 24-34

Harlen, W. and Qualter, A. (2004). *The teaching of science in primary schools* London: David Fulton.

Harlen, W. (2001) The Assessment of Scientific Literacy in the OECD/PISA Project. *Studies in Science Education*, 36 (1), 79-104.

Perrier, F. and Nsengiyumva, J. B. (2003). Active science as a contribution to the trauma recovery process: Preliminary indications with orphans from the 1994 genocide in Rwanda. *International Journal of Science Education,* 25(9), 1111-1128.

Rittle-Johnson, B., Siegler, R. S., And Alibali, M. W. (1999). Conceptual and procedural knowledge of mathematics: Does one lead to the other? *Journal of Educational Psychology*, 91(1), 175-189.





The project CREATIVITY IN EARLY YEARS SCIENCE EDUCATION has received funding from the European Union Erasmus+ Programme (2014-2017) under Grant Agreement n0 2014-1-EL01-KA201-001644.