# Module 3: Focus on the nature of science

## Aims of the module:

- Introduce participants to current perspectives on the nature of science
- Examine arguments for the relevance of the nature of science in early years science education
- Explore ways in which teachers can support children's developing understanding of the nature of science and challenge stereotypical images of science and scientists
- Discuss the importance of teachers' views of the nature of science and ways in which they can influence opportunities for children's creativity and inquiry in their science learning

## Links to the Content Design Principles and Outcomes

3. Teacher education should advance teachers' understandings about the nature of science and how scientists work, confronting stereotypical images of science and scientists.

3.1 Teachers should be able to advance children's understanding about the nature of science and how scientists work, confronting stereotypical images of science and scientists.

3.2 Teachers should be able to recognize young children's capabilities to engage with processes associated with the evaluation as well as generation of ideas in science and mathematics, since these processes are also important for the development of learner creativity.

3.3 Teachers should be able to foster the processes of imagination, reflection and consideration of alternative ideas in supporting children's understanding of scientific ideas and procedures and development of creativity.

## Rationale for the module

*What has led to increasing emphasis in science education internationally on developing children's understanding of the nature of science?*

There has been considerable debate in recent years about the importance and purposes science education, reflected in documentation at EU level and in discussions in science education community internationally that has contributed to growing emphasis on the nature of science. Common themes include:

- *Economic imperatives*- both or the supply of future scientists and a technically skilled workforce, and to complete globally - the need for individuals who have the skills and competencies to apply knowledge in innovative ways. This is in the context also of concerns about lack of take up of science and declining attitudes to science across the primary school.
- *Growing emphasis on scientific literacy for citizens* – importance of science and mathematics education not just for future jobs and the needs of the economy – but for all as an individual and as part of a community as an active responsible citizen. The need to develop an appreciation of the nature of science to participate in democratic processes and to make decisions in the context of access to vast quantities of information and in using new technologies. The need also to develop skills and dispositions for 21st century when futures are uncertain and knowledge changing rapidly.

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- *Technological developments* – offer new opportunities not just for assessing learning but shaping learning processes – debate about how to take advantage of these new opportunities (especially in relation to capturing sharing and discussing ideas), as well as considering their limitations.

These issues are explored further in the Conceptual Framework adopted by the CEYS project (Creative Little Scientists, 2012, 27-32).

In addition changes in society's perception of science have led to changing perceptions of how it should be taught in schools. This includes emphasis on children understanding the nature of science, its social and cultural aspects; the notion of science as a human construction building on evidence and involving argumentation within a community. There is greater acknowledgement of the need to foster positive attitudes to science and involve children in debate around contemporary issues.

Science should not be presented to children as something divorced from their everyday lives, rather the importance of helping children draw personal meaning, promoting the role of inquiry and creativity in questioning and interpreting the world around them.

As noted the Conceptual Framework adopted by the CEYS Project (Creative Little Scientists, 2012), the concern to include understanding of the nature of science in the curriculum is reflected in the following comment, from the EU report *Increasing Human Resources for Science and Technology in Europe*.

> The 'nature of science' has become an important concern in the curriculum. This often means the rejection of the stereotypical and false image of science as a simple search for objective and final truths based on unproblematic observations. The recent emphasis on understanding the nature of science is related to the attempt to give more attention to its social, cultural and human aspects. Science is now to be presented as knowledge that is built on evidence as well as upon arguments deployed in a creative search for meaning and explanation (Gago et al., 2004: 138).

*What are the issues for teachers?*

- What features are emphasised in current perspectives on the nature of science?
- What is the relevance of nature of science to early years science education?
- What kinds of teaching and learning approaches might be appropriate to support children's developing understanding of the nature of science?
- Why is it important for teachers to reflect on their views of the nature of science?

## Overview of the module

The workshop consists of the following activities:

1. Introduction to the module - consideration of the rationale for science education and reasons for growing attention to the nature of science.
2. Activity Mystery Boxes developed by the London Science Museum designed to highlight features of the Nature of Science.
3. Introduction to a framework for representing some key features of the nature of science developed by Akerson et al (2011) - exploring potential connections to everyday life and classroom experiences.
4. Discussion of classroom examples to examine - What aspects of the nature of science are evident in the classroom examples? What makes you think this? Which aspects are discussed with children and made explicit by the teacher and how?
5. Developing ideas about ways in which teachers might draw attention to the nature of science: in planning a scheme of work, and in their classroom interactions. How

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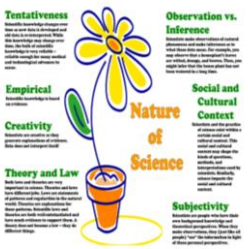
might this help to foster creativity and inquiry in early years science. What impact might this have on attitudes to science?

6. How might you apply these ideas in your classroom? Select a recent science topic or project you have undertaken. How might you have extended opportunities for consideration of the nature of science? Consider for example the range of experiences provided, issues you might discuss, how you might model key features. What links can be identified to curriculum requirements in your settings?
7. Reflection on workshop content and approaches: views about the nature of science and why it matters; thoughts provoked by the module (both discussion activities and classroom examples). Complete module evaluation.

## Module at a glance

| Time | Task | Materials | Grouping |
|---|---|---|---|
| 00.00 | **1. Introduction to the module** - factors that have influenced growing attention to the nature of science in science education. | Powerpoint presentation<br>• Aims<br>• Links to Content Design Principles and Outcomes<br>• Session rationale<br>• Outline of the session | Whole group |
| 00.15 | **2. Mystery boxes**<br>Work in 6 groups of 4/5<br>There are 6 sealed Mystery Boxes and it is the task of each group to try to work out what is inside.<br>Each group is given one box and has about 5 minutes to record their observations and conclusions on a recording sheet.<br>Then they pass the boxes round in turn so each group records their ideas about each box.<br>This is followed by a group discussion of skills and processes used and a science conference to share ideas.<br>See powerpoint slides and activity instructions for further details. | Powerpoint slides for Mystery Boxes from the London Science Museum (with instructions)<br>Mystery boxes<br>Recording sheets for each group<br>Sheet for sharing ideas about what is in each box.<br>Link to video on you tube of scientists discussing Mystery Boxes. | Groups of 4/5<br><br>Followed with feedback with whole group |
| 1.00 | **3. Introduction and discussion of characteristics of the nature of science in the Akerson poster**<br>• *As a whole group* - examine and clarify the different characteristics<br>• Can participants identify links to the previous activity?<br>• *As an individual* Identify examples to illustrate the nature of science from a) your everyday life b) your own school experiences of science education c) science in your classroom. Record each idea on a post it.<br>• *In a group of 4/5* pool your ideas in each category, placing them in groups on the A1 sheet provided. Annotate to indicate explicit links the Akerson poster.<br>• Consider any common themes or differences in view<br>• *Feedback* as a whole group - share links made in each context, characteristics of the NoS that are easier/harder to illustrate.<br>• What images of science were presented in your own school experience of science? | Powerpoints slides<br>Akerson poster<br>  <br><br>Group task<br><br>Copy of Akerson poster for each group 4/5<br>Post its and pens<br>A1 sheet of paper<br>Marker pens | Whole group<br><br>Individual work<br><br>Groups 4/5 |
| 1.30 | **Break** | | |

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| 1.45 | **4. Discussion of classroom examples**. Questions to consider:<br>• Which aspects of the Nature of Science are evident in the examples offered?<br>• What makes you think this?<br>• What aspects are discussed with the children and made explicit by the teacher - and how?<br>• *Working in a group of 4/5*<br>• *In sub- group of 2/3* start with one of the examples allocated to your table.<br>• Annotate your copy of the Akerson poster to indicate the links with your example.<br>• Then swap your example with the other 2/3 and swap posters. Add additional comments to their poster - note any questions for clarification.<br>• Brief feedback with whole group – opportunities within each episode - note key points.<br>• Keep and display participants' record sheets for reference later in the session. | Copies of 4 episodes or templates from CLS for example:<br>Selected episodes<br>FR Magnetic Attraction, UKSc Day and Night<br>Templates<br>RO Float and Sink (IBSE) (276-278) and NoS (294-298)<br>UKEN Waterproofing (378-379)<br>*For each group*<br>1/2 copies of each example (depending on group size)<br>2 copies of A3 Akerson poster for annotation<br>Flip chart and pens<br>Powerpoint slides of task, examples and of Akerson poster | Groups 4/5<br>Work in 2/3 to discuss one example. (If time swap to discuss second example and add to the recording sheet of the other 2/3.)<br><br>Feedback with whole group |
| 2.15 | **5. How might teachers draw attention to the nature of science?** What are the implications for the curriculum - learning, teaching and assessment?<br>*Work in a group of 4/5*<br>How might you build this into your planning?<br>What are the implications for example for<br>• learning objectives<br>• contexts you choose for science<br>• ways of organising the class<br>• the nature of activities<br>• questions you ask<br>• children's reporting and recording<br>• assessment?<br>• Any other dimensions?<br>•<br>*Whole group feedback*<br>Note common ideas<br>Share ideas for questioning to support reflection from the Akerson article<br>Why does this matter?<br><br>Note connections to conceptual framework for the CEYS project in particular creative dispositions and the definition of creativity in science.<br><br>How might the approaches you suggest impact on children's attitudes to science? | Powerpoint slide of task<br>Recording sheet to annotate<br>Powerpoint slide of Akerson questions:<br>What do we already know?<br>How might we find out?<br>Are there any other suggestions?<br>What have you observed?<br>Have you noticed any patterns?<br>How could you explain this?<br>Are there any alternatives?<br>How have your ideas changed? Why?<br>In what ways are we acting like scientists?<br>*Use of evidence, creativity in design and interpretation, influence of background knowledge, tentative – change in ideas.*<br>Supported by working in teams, reflective notebooks, peer assessment<br>Powerpoint slides of creative dispositions<br>CEYS definition of creativity in science and scientific attitudes. | Group of 4/5<br><br>Whole group for feedback and to share Akerson questions |
| 2.30 | **6. Application to classroom planning** - what would your suggestions mean in specific terms?<br>*In groups 2/3*<br>• Select a recent/common science topic you have taught.<br>• How might the experiences have been extended to enhance consideration of the nature of science?<br>*Whole group* - brief feedback of anychanges/additions - 1 from each group<br>What would you say to convince a colleague of the | Powerpoint slides of task | Groups 2/3<br><br>Whole group |

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|---|---|---|---|
| | relevance of the nature of science in primary science?<br>How might this link to your curriculum context? | | |
| 2.45 | **7. Reflections on what has been gained from the module.**<br>• In original groups of Look back at your original poster of post its as a group – anything you might add? Add in any additional comments or issues in another colour (pen/post it).<br>• Note 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 module been met? | Powerpoint slides of activity and aims<br><br>Collect posters from activity 2 and return to the groups<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

This module draws on the work of Valarie Akerson and her colleagues over many years in exploring ways in which ideas about the nature of science can be integrated into classroom experiences in primary school. You may find it useful to read her article that introduces the poster used in the session and indicates classroom applications with children in the early years of primary school. Details are given in the list of background material below.

**1. Introduction to the module**. This is designed to begin to provide a rationale for attention to the nature of science. It is useful to return to participants' views of why this might matter at the end of the session.

**2. Mystery boxes.** The London Science Museum has an activity called Mystery Boxes to be found at http://www.sciencemuseum.org.uk/educators/teaching_resources/activities.aspx that takes a practical approach to drawing out features of the nature of science. The site provides clear instructions about how to carry out the activity and a video of scientists conducting the task and making links to the nature of science. The instructions are also provided in the materials for this module. It is very helpful if you ask someone else to make up the boxes so that you genuinely do not know what is inside each box. Do not be tempted to open them yourself. Participants are often frustrated by not knowing what is inside, but the video helps to illustrate why this feature of the activity is vital. Also in our experience, not knowing the answer makes the activity very memorable and adds to its impact.

**3. Characteristics of the nature of science.** This part of the session provides an introduction to Akerson's model of the Nature of Science that highlights the following features:

- Empirical – based on evidence
- Tentative – changes in light of new data/ interpretations of data
- Creative – involves imagination and creativity
- Subjective – influenced by knowledge and perspectives
- Social and cultural context – influences both practices of science and impact
- Law (pattern/regularity) and Theory (explanation)

The accompanying tasks are designed to help participants to become more familiar with the different dimensions that may at first seem difficult to grasp. It can be useful to reflect on the nature of participants' own school experience of science and the images of science they conveyed.

It is useful to display the posters produced and allow time for discussion during the break. You could start the next part of the session by asking if there is anything that has struck participants so far.

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**4. Discussion of classroom examples.** 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 at http://www.creative-little-scientists.eu/content/deliverables, under deliverables D4.3 Country Reports. The use of the Akerson poster to guide analysis helps focus discussion and allows further opportunities to reflect on its application to the classroom. It is important that participants have the opportunity to examine one example in detail. If there is time to review the second example on their table they can swap examples and annotated flower poster with the other pair and just add to the comments already made.

**5. How might teachers' draw attention to the nature of science?** This activity is designed to encourage participants to think about ways in which views of the nature of science might be reflected in all aspects of classroom practice - the wider environment as well as classroom activities and interactions. Here it is useful to make connections with key features of the Conceptual Framework adopted by the CEYS project- the definition of creativity, creative dispositions and features of inquiry. The approaches suggested have the potential to have an impact on children's attitudes to science – participants could be encouraged to reflect on children's current views about science and the challenges and opportunities presented.

**6. Applications to classroom planning.** The intention is to encourage participants to be specific about what they might do in relation to a particular topic. Here it can be useful to make links with national/local curriculum requirements. This can provide a helpful stimulus for the final task in the module.

**7. Reflections on what has been gained from the module.** The posters produced in task 2, and other recording completed during the session, are designed to provide participants with a starting point for reviewing their discussions and learning across the session and the implications for practice. They encourage consideration of the processes as well as the content of learning to feed into an evaluation of the module.

## Background reading

### *Introducing the nature of science*

This module draws on the work of Valarie Akerson and her colleagues over many years in exploring ways in which ideas about the nature of science can be integrated into classroom experiences in primary school.

Akerson, V., Weiland, I., Pongsanon, K. & Nargund, V. (2011)
Evidence-based strategies for teaching Nature of Science to young children. *Journal of Kirsehir Education*, 11(4): 61-78.

There are a number of activities devised to introduce teachers to the nature of science at their own level in Abd- El- Khalick, F., & Lederman, N.G. (1998). Avoiding de-natured science: Activities that promote understanding of the nature of science. In W. McComas (Ed.) *The nature of science in science education: Rationales and strategies* (pp. 83-126). Dordrecht, the Netherlands: Kluwer Academic Publishers.

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### *Making links across features of the conceptual framework developed by the Creative Little Scientists Project*

It is important to highlight connections between characteristics of the nature of science and characteristics of creativity and inquiry in early years science at the heart of the Creative Little Scientists project.

The executive summaries of the Final Reports of the Creative little Scientists project

- D6.5 Final Report on Creativity and Science and Mathematics Education for Young Children EXECUTIVE SUMMARY
- D6.6 Recommendations to Policy Makers and Stakeholders on Creativity and Early Years Science EXECUTIVE SUMMARY

provide an accessible introduction to the definitions of creativity and inquiry used during the the project, with illustrations from the classroom. These documents can be found on the CLS website at http://www.creative-little-scientists.eu/content/deliverables.

### *Supporting scientific reasoning*

The articles below indicate approaches that might be adopted to foster children's scientific reasoning and appreciation of the nature of science.

Mercer, N. et al (2004). Reasoning as a scientist: ways of helping children to use language to learn science. *British Educational Research Journal*, 30(3), 359-377.
Reports on findings from an experimental teaching programme designed to enable children in primary schools to talk and reason together and apply these skills in their study of science.

Siry, C. & Lang, D. (2010). Creating participatory discourse for teaching and research in early childhood science. *Journal of Science Teacher Education,* 21(2), pp149-160.
This study examined the possibilities for engaging children in critical discourse about their classroom science experiences.

## 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*: FR Magnetic Attraction, UKSc Day and Night in D4.4 Appendix Selected Episodes of Practice
*Classroom Templates*: RO Float and Sink (IBSE) (276-278) and NoS (294-298)
UKEN Waterproofing (378-379) 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 |
|---|---|---|
| Skeletons | 7-8 | England |
| Plants | 4-6 | 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
- Practical activities with resources and instructions – Mystery boxes

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- Handouts
    - Sheet showing definitions of creativity in early years science and Features of inquiry and creative dispositions - for reference during the session
    - Task 2 Mystery boxes recording sheet for recording observations and conclusions
    - A4 version of the Akerson poster that can be enlarged for use with groups across the session for reference and for recording in Task 4
    - Task 5 Recording sheet to support discussion of implications for planning.



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