Module 8: Varied modes of expression and representation

Aims of the module:

- Increase awareness of the key roles of expression and representation of ideas in inquiry-based approaches to learning
- Highlight the need for practitioners to introduce and value varied modes of expression and representation in fostering children's articulation and reflection on their developing ideas and strategies
- Enhance recognition of the importance of children's expression and representation of ideas as starting points for questioning, discussion and further investigation
- Illustrate ways in which children's expression and representation in varied ways can provide the basis for assessment (both by children and teachers) to inform future planning.
- Consider ways in which the teacher provide varied opportunities to share and represent their ideas at different phases in an investigation and encourage a classroom climate in which children are willing to offer and reflect on ideas
- Highlight ways in which sharing and discussion of ideas can foster critical reflection in science.

Links to the Content Design Principles and Outcomes

9. Teacher education should enable teachers to make best use of and assess the various modes of expression and representation of science and mathematics learning to support inquiry and the development of creativity.

9.1 Teachers should be able to recognize and value children's various forms of expression and representation of their ideas and learning in science and mathematics.

9.2 Teachers should be able to make best use of children's preferred forms of expression and representation of their science and mathematics ideas to support inquiry and their creativity development.

9.3 Teachers should be able to select and use different approaches for and forms of recording children's ideas and learning in science and mathematics at different stages of the learning process and for various purposes, including to support children's reflection and reasoning processes.

9.4 Teachers should be able to use the various modes of children's expression and representation of science and mathematics ideas (e.g. pictures, graphs, gestures, physical activities) for assessment purposes.

Rationale for the module

Perspectives on science education highlight the importance of reflection and reasoning in science learning, emphasising the importance of metacognitive processes, reflective awareness and deliberate control of cognitive activities, which may still be developing in young children but which are incorporated into early years practice, science learning and inquiry-based approaches to science education. Expressing and representing ideas and strategies have central roles in facilitating processes associated with inquiry-based education, for example in noting observations, making comparisons, examining patterns in data, making connections or offering explanations in the light of evidence.

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IBSE seeks to help children make use of their experiences, from home, school and in the wider world, as 'data'. They should reflect on this data and use reasoning to try to develop scientific theories. This is similar to the generation and evaluation of ideas in creativity. However, Metz (2004) found that children need help and encouragement to do this because they tend to just think about their evidence in terms of their existing theories. According to Goswami and Bryant (2007) young children are capable of this 'explanation-based' or causal learning but scientific reasoning tends to require dealing with multiple causal variables and this takes longer to develop. Nevertheless, there is research evidence that shows children can reason scientifically, test a hypothesis and recognise conclusive tests (Duschl, et al., 2007; Eshach and Fried, 2005).

It is possible for the teacher to scaffold this development by modelling and providing opportunities for sharing, testing and evaluating ideas. The teacher needs to provide a supportive climate that encourages questioning, attempts at explanation, debate and reflection. The teacher can model these and provide formative feedback. Wellman and Lagattuta (2004) recommended getting children to explain their reasoning and that evaluating and commenting on each other's explanations was important in developing mathematical reasoning. There have also been studies showing that children recording their reasoning in different ways can also help this development (for example Wood and Hall, 2011) Whether the reasoning is expressed through dialogue, in writing, through a diagram, by drawing, in a video or through drama, the key aspect is helping the children to think about how they think. A teacher of 6 and 7 year olds, who was doing a project on forces, focused on reflection and questioning and found that this increased the children's ability to participate in metacognitive dialogue and make creative connections (Williams and Cremin, 2008).

Providing children with opportunities to express and represent their ideas is also central in assessment in early years science (both by children and teachers). As noted in the Conceptual Framework adopted by the CEYS (Creative Little Scientists, 2012:61): Harrison and Howard (2011) highlight the key roles of feedback, sharing criteria with learners, questioning and self-assessment in promoting effective learning. The role of children in assessment is particularly significant when considering that evaluating ideas is an important learning process. This may include peer assessment as well as self-assessment, thereby contributing to community aspects of the class.

In the early years there are also arguments that a more holistic approach to assessment is important, that takes account of children's attitudes and interaction with others and with the environment in thinking (e.g. Glauert, 2009). Insights from recent research highlight the need to develop assessment approaches sensitive to the capabilities of young children (Robbins, 2005) and to afford opportunities for children to express their ideas in different ways through for example speech, gestures or visualisations (Glauert 2009).

Overview of the module

The module consists of the following activities:

1. **An introduction to the roles of expression and representation** in children's learning and in inquiry-based approaches to science education.
2. **In what ways do you encourage children to express and represent their ideas?** An activity to enable participants to reflect on ways the encourage children in their own classrooms to express and represent their ideas. In what ways do these approaches support teaching and learning?

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3. **Role of expression and recording in scientific inquiry**. This practical activity offers a context for discussing the role of expression and representation of ideas in scientific inquiry processes. Participants undertake some short inquiry-based activities. What was the role of discussion and recording in the development of their investigations? How might this have been extended?
4. **What are the roles of expression and representation in fostering 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: What approaches did children use to express/represent ideas? In what ways might the approaches identified support learning? What evidence of learning is provided – how might you build on this? What questions would you like to ask? How does the teacher support reflection and reasoning?
5. **In what ways might opportunities for expression and representation of ideas foster critical reflection or creative dispositions?** What features of inquiry-based learning can you identify in these examples? Can you identify *features of the nature of science* (drawing on Akerson et al, 2012)?
6. **What are the implications for teachers' planning?** Participants identify issues to consider in relation to the curriculum dimensions represented in the 'vulnerable spider web (van den Akker, 2007).
7. **Participants reflect on what has been gained from the module** – both content and process, in relation to the aims of the workshop. They return to their original list of classroom strategies to consider: How might the range of modes of expression and representation be extended? How might children/teachers make greater/more explicit use of expression/representation in varied modes to inform future learning and teaching?

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Module at a glance

Time	Task	Materials	Grouping
00.00	**1. Introduction: aims and rationale for the module**.	Powerpoint presentation • Aims • Links to Content Design Principles and Outcomes • Session rationale – linked to perspectives on learning and features of IBSE with brief illustrations using classroom examples. • Outline of the module	Whole group
00.10	**2. In what ways do you encourage children to express and represent their ideas?** In what ways do these approaches support learning and teaching? *In pairs* – brainstorm the different ways in which children can express and represent ideas in your classroom. Record each idea on a post it *As group of 3/4* See if you can sort these into groups – any common themes of differences • In what ways might they support children's learning? • How do they support your planning, teaching or assessment? • Identify any issues raised in your discussion. As a whole group • Collate the repertoire of approaches – any further suggestions? • Note ways in which they support learning and teaching and issues for discussion	A1 sheet for groups to share sort and comment on responses. Pens Powerpoint slide of task A1 Flip chart to record summary of whole class views Marker pens Blutak to display the chart for review at the end of the session.	Pairs Groups 3/4 Followed with feedback with whole group
00.30	**3a. Role of expression and recording in varied ways in scientific inquiry.** *Working in 3s/4s* participants undertake an investigation and keep notes of their progress. Examples could include: • How can you change the size and shape of shadows? What factors make a difference? • How is your rate of blinking affected by the activity you do? • Draw what happens to food in your body. • Can you make a spinner that falls really slowly. (These involve different kinds of investigation but can all be undertaken quickly with limited equipment) Prepare to feedback to another group who carried out a different inquiry.	Powerpoint slide of practical activities and questions to consider. Resources for each activity Paper of varied kinds, pens, measuring instruments. .	Groups of 3 or 4
1.00	**3b. Reflect on the features of scientific inquiry involved in your activity.** *In your 3s* – Review your investigation in relation to the features of inquiry on the Barrow chart • What did you discuss? • Review your recording. What evidence does	Powerpoint slides of questions for reflection Barrow chart A4 paper for participants to record their ideas.	Groups 3 Followed by whole group discussion.

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	this provide of inquiry processes? • In what ways did discussion/recording support inquiry processes – in particular reflection and reasoning? • Are there further features that could have been included? What are the implications for planning? *Whole group feedback* • Share issues regarding the role of recording • Discuss findings – making comparisons across groups – links to science concepts • Consider further questions and follow up investigations	Copy of Barrow chart. Flip chart and pens to share responses. If using several activities this could be a table to record • Responses in relation to each task. • Key findings • Further investigations and questions	
1.20	**Break**		
1.50	**4. What are the roles of expression and representation in fostering inquiry and creativity within everyday classroom activities** *In groups of 4* • Review and analyse classroom examples from with a focus on the following: • What approaches did children use to express/represent ideas? • In what ways might the approaches identified support learning? • What evidence of learning is provided – how might you build on this? • How does the teacher support reflection and reasoning? • What questions would you like to ask? *As a whole group* share and record key features of the 4 different examples.	Copies of 4 episodes or templates from CLS for example: *Selected episodes* GE Building blocks PT Sun Distance UKNI Gingerbread Man raft *Templates* UKEN Egg carrier UKEN Sound UKSC Water play Each group of 4 has copies of the different examples to share plus an A3 sheet to record their analysis. Review one example in pairs and record findings. If time swap with the other pair who add to the recording sheet. Review other 2 examples briefly. Powerpoint slides of the task and showing key details from the episodes selected to support whole group discussion.	Groups of 4 divided into 2 pairs. Suggest new groups after break. Followed by whole group discussion.
2.20	**5. How might opportunities for expression, representation and discussion of ideas foster features of inquiry or creative dispositions?** • What features of inquiry can you identify in these examples? Can you make any links to the nature of science? • *In pairs* - Annotate the sheet provided with illustrations from the classroom example you examined in detail.	Powerpoint slides of Creative dispositions Features of inquiry Nature of science (incorporated also in a handout for participants to annotate)	Pairs followed by the whole group
2.30	**6. Implications for planning** *In groups of 4* • Record general implications for planning in relation to the 'vulnerable spider web' . • Review the range of strategies for formative assessment listed on the self evaluation form developed by the TAPs project. How might these support reflection and reasoning? *In whole group* • Share suggestions • Note any issues raised.	Powerpoint slides vulnerable spider web TAPS project pyramid Copies of spider web and TAPS pyramid for participants to annotate. Flip chart and pens A1 copy of spider web for annotation	Whole group

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2.45	**Reflections on what has been gained from the module** *As an individual* • Look back at your original chart recording modes of expression and representation and ways in which they support learning and teaching. • Add any additional ideas or comments • Note 2 actions you will take building on workshop content record. • In what ways did the different activities support your developing thinking? *As a whole group* share any ideas participants are ready to offer *Individually* – complete evaluation from. How far have the aims of the session been met?	Powerpoint slides of activity and aims Add to recording from activity 2 Pens Flip chart and marker to record key suggestions Evaluation forms	Groups of 4 to reflect on initial ideas and any further suggestions. Sharing with the whole group
3.00	End		

Teacher education pedagogy

1. Introduction – aims and rationale for the module. This module draws on the definition of creativity in early years science adopted by the CEYS Project (Creative Little Scientists, 2012) 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. Examples of relevant modules and resources you might utilise are provided in the support materials below.

2. In what ways do you encourage children to express and represent their ideas? This second task encourages participants to make current practices in relation to modes of representation and expression explicit and to reflect on their roles in learning and teaching. Often too recording and expression is treated as an end point (or evidence for accountability) rather than as part of a developing process of learning and teaching. The recording sheet associated with this task and the shared reflections of participants provide important reference points to return to in reflecting on learning across the session.

3. Role of expression and recording in different ways in scientific inquiry. The practical activities for this part of the session need to be simple – but to offer sufficient scope for developing/reflecting on ideas. This can serve to highlight the key role of ongoing discussion and the evidence of learning this often provides and often the limited use made of recording spontaneously (to record plans, note data, or discuss explanations). Investigations often evolve over time. Written evidence often does not do justice to the development of children's inquiry skills and thinking. Reflection in relation to the Barrow chart often illustrates a common tendency to focus on the generation of ideas – with more limited attention to evaluation of ideas and evidence.
Part 3a: It is helpful if the groups do different activities. For example 4/5 groups doing the shadow activity and 4/5 groups the spinners activity. The groups can then be paired to feed back to each other. This can help groups to focus on how they will present their findings.
Part 3b: As part of the discussion there are opportunities to compare the results of groups that have done the same activity, drawing out similarities and differences, making links to scientific concepts and considering possible further questions and investigations.

4. What are the roles of expression and representation in fostering inquiry and creativity within everyday classroom examples? As in all modules the classroom examples have

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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 D4.3 Country Reports. The range of questions is designed to encourage participants to reflect on ways in which varied modes of expression and representation can support both learning and teaching. They are also designed to draw attention to the role of varied forms of recording/communication as part of the learning process – not as a product. They provide opportunities to gain insights into the development of skills, attitudes and concepts as well as children's reasoning and reflections on their own learning.

It is best for each pair to start by examining one example in detail recording their thoughts on the sheet provided. If there is time they could swap examples and recording sheets with the other pair in their group and *add* to their records rather than start a new record sheet (for reasons of time and attention).

5. How might opportunities for expression, representation and discussion of ideas foster scientific attitudes or creative dispositions? This activity is designed to draw attention to the key connections between scientific attitudes, creative dispositions and reflection and reasoning in science.

The links to the nature of science are intended to be brief and could be introduced by the teacher. There are strong connections between this module and module 3 that examines the nature of science in more detail.

6. Implications for planning. The spider web of curriculum dimensions provides a useful framework for drawing together implications for future practice. The self-evaluation tool from the TAPS project suggests a range of approaches for formative assessment by teachers and peer and self assessment by children. Many of the approaches suggested can help children to make their reflections and reasoning explicit to support their future learning.

8. **Reflections on what has been gained from the workshop**. The charts produced in task 2 provide a starting point for reviewing their discussions and learning across the session and the implications for practice. It is often supportive to share ideas about classroom implications. It is helpful to encourage consideration of the *processes* as well as the content of learning to feed into session evaluations.

Background reading

Potential for inquiry and creativity in early years science

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 session, with illustrations from the classroom. These documents can be found on the CLS website at http://www.creative-little-scientists.eu/content/deliverables. They also provide and overview of findings and recommendations from the project that informed the design of these teacher education modules.

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Supporting reflection and reasoning

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.
Offers a framework for developing ideas about the nature of science with young children.

Brooks, M. (2009). Drawing, visualisation and young children's exploration of 'big ideas'. *International Journal of Science Education,* 31(3), 319-431.
Argues that in the visualization of ideas, and the expression and drawing of our ideas that we can bring something more clearly into consciousness.

Ehrlen, K. (2009). Drawings as representations of children's conceptions. *International Journal of Science Education,* 31(1), 41-57.
Report of a study undertaken to gain knowledge of the relation between children's conceptions and their representation of these in drawings.

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.

Harlen, W. (2004). 'Talking and writing: have we got the balance right?' *Primary Science Review*, 83, 17–19.
Raises questions about the roles of writing in science and stresses the importance of dialogue in learning science at primary level.

South, A. (2012). 'Developing Creativity and Abstraction in Representing Data'. *Primary Science* 124, 15-18.
Andy South shares ideas concerning different ways of representing data and how they can be used to develop skills in creating and interpreting representations.

Wright, L. (2004). And then we'll write about it. *Primary Science Review* 84, 4-5.
When, why and how do recording in science? Discussion of the purposes of recording and the advantages and disadvantages of different approaches.

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
Classroom Episodes: GE building blocks, PT Sun distance, UKNI Gingerbread man raft in D4.4 Appendix Selected Episodes of Practice
Classroom Templates: UKEn Egg carrier, UKEN Sound, UKSC Water play in Addendum to D5.3.

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

Title	Age group	Country
Life cycle of the frog	4-5	England
Electricity	4-5	England
A wisp of air	7-8	Belgium
Super soup	4-6	Belgium
Oxygen	4-5	Belgium
Floating boats	5-6	Greece
Plants	4-6	Greece
Plant and Butterfly Cycles	5-6	Greece
Bees and their communities	4-5	Greece
The sounds around us	6-7	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 list of resources for Task 3a – Shadows, Spinners, Blinking, Food inside your body
- Recording sheets for the different activities:
  - Task 3b: Features of scientific inquiry involved in your activity
  - Task 4:Roles of expression and representation in fostering inquiry and creativity within everyday classroom activities
- Handouts
  - Task 3b Barrow chart
  - Task 5 Creative dispositions, Features of inquiry for annotation
  - Task 5 Characteristics of the Nature of Science
  - Task 6 Vulnerable Spider Web
  - Task 6 Teacher Assessment in Primary Science school self evaluation sheet

References

CREATIVE LITTLE SCIENTISTS (2012) *Conceptual Framework.* Deliverable D2.2. Available at: http://www.creative-little-scientists.eu/content/deliverables

Duschl, R. A., Schweingruber, H. A., and Shouse, A. W. (2007). *Taking science to school: Learning and teaching science in grades K-8*: Washington, DC: National Academy Press

Eshach, H., And Fried, M. N. (2005). Should science be taught in early childhood? *Journal of Science Education and Technology, 14*(3), 315-336.

Glauert, E. (2009). Research in early childhood science education: Issues for early childhood curriculum design and implications for primary science education. In R. Lauterbach, H. Giest And B. B. Marquardt-Mau (Eds.), *Lernen und kindliche Entwicklung: Elementarbildung und Sachunterricht* 41-56. Klinkhardt: Bad Heilbrunn.

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Goswami, U., and Bryant, P. (2007). Children's cognitive development and learning. In R.Alexander (ed.), *The Cambridge primary review research surveys* 141-169. London: Routledge.

Harrison, C., And Howard, S. (2011). Issues in primary assessment: Assessment for learning; how and why it works in primary classrooms. *Primary Science, 116*, 5-7.

Metz, K. E. (2004). Children's understanding of scientific inquiry: Their conceptualization of uncertainty in investigations of their own design. *Cognition and Instruction, 22*(2), 219-290.

Robbins, J. (2005). Brown paper packages? A sociocultural perspective on young children. *Research in Science Education*, *35,* 151-172.
Wellman, H. M., And Lagattuta, K. H. (2004). Theory of mind for learning and teaching: The nature and role of explanation. *Cognitive Development, 19*(4), 479-497.

Williams, M. and Cremin, T (2008). The force of creative and curious voices paper presented at British Educational Research Association annual conference 2009, Institute of Education, London.

Wood, E. And Hall, E. (2011). Drawings as spaces for intellectual play. International Journal of Early Years Education, 193(4), 267-281.

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