Creativity in Elementary Science

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Research in the School – seven groups:

- assessment and evaluation
- curriculum and pedagogy
- language & intercultural education
- new technologies and education
- SMT Ed (science/mathematics/design technology)
- philosophy and ethics in education
- psychology of education & inclusion
- sociology and the arts
The Curriculum and Pedagogy Research Group: Creativity across the Curriculum

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Creativity in Science Education

Creativity in the science classroom

Pre-service Teachers’ Conceptions

Assessing Scientific Creativity

Experienced Teachers’ Conceptions
Creativity

Mental activity intent on producing something new, novel

appropriate, plausible, functional

ethical

elegant
Creativity in Science (Field 1)

Making sense of the world

More or less speculative descriptions
- e.g. Imagine life on Mars
- Pumice is like cinder toffee

More or less speculative explanations
- e.g. Of the image in a mirror
- Why a large object tends to make a low note
Creativity in Science (Field 2)

Collecting and evaluating scientific evidence

Of a descriptive nature
- e.g. Does sound travel through water? Which shoe has the best grip?

Of an explanatory nature
- e.g. Is roughness the cause of friction? Is ‘light for its size’ what matters when floating in water?
Creativity in ‘Science’ (Field 3)

Technology: Applying science

Make a waterproof roof for your house
Pre-Service Teachers

How do pre-service teachers think of creativity in science?

Do they see science as being creative?

How well do their conceptions match the three categories of creativity in science?
What we did

A structured questionnaire

Semi-structured interviews

Phenomenographic analysis of responses to identify categories of conceptions (Marton, 1981)
Pre-Service Teachers Involved

16 final year undergraduate students taking a primary science leadership module.

All completed the questionnaire.

All were interviewed.
The Questionnaire (1)

General information about conceptions, for example ...

2. Which subjects offer more opportunities for creative thought than science? (Select from this list and tick)
   English  Drama  MFL  Maths  RE
   History  Geography  Music  Art  PE
   ICT  D&T  Any other subject? (Please specify)

3. What makes these have more opportunities?
The Questionnaire (2)

About teaching Science, for example ....

9. Which topic would you like to teach or enjoy teaching in science?
   Suppose you taught this topic. Are there opportunities for scientific creativity in it?

10. If so, what are they?

11. Please state what is creative about them.
15. Here is a list of aspects of science. Which of them do you see as offering the best opportunities for scientific creativity?

- Ourselves and other living things
- Variety of life
- Materials and their properties
- The Earth beneath our feet
- Electricity
- Sound
- The Earth in space
- Keeping healthy
- Environments
- Changing materials
- Magnetism
- Light
- Forces
The Interviews

Individual interviews

Duration 20 - 30 minutes

To clarify, extend and supplement the responses to the questionnaire

e.g. what was seen as meriting high (or low) marks for creativity in the lessons described.
Some pre-service teachers’ conceptions of creativity in elementary science lessons

1.1 Construct descriptions

1.2 Construct explanations

2.1 Construct tests of facts

2.2 Construct tests of explanations

3.1 Use science knowledge to solve a practical problem (applied science/technology)

4. Making things and science lessons which excite
Category 1

1a  Children experience the world and generate explanations.

1b  Children experience the world, generate explanations and test them.
Pre-service teachers’ conceptions of creativity of a scientific nature

Category 2

2 Children imagine using information.
Pre-service teachers’ conceptions of creativity of a scientific nature

Category 3

3a Children do fact-finding investigations.
3b Children apply scientific knowledge.
3c Children do fact-finding investigations and apply what they find.
Pre-service teachers’ conceptions of creativity of a scientific nature

Category 4

4 Children’s positive feelings about science are aroused by the lesson.
Pre-service teachers’ conceptions of creativity of a scientific nature

Category 5

5 Children make or do things in science.
So what does this tell us?

Pre-service teachers held narrow views of creativity in science.

Some had misconceptions.

The focus was on creativity in devising experiments to find facts.

Science was seen as offering fewer opportunities than some other subjects.

The pre-service teachers had little or no grasp of assessing creativity.
Experienced Teachers’ Conceptions

How do experienced teachers think of creativity in science?

Do they see science as being creative?

How well do their conceptions match the three categories of creativity in science?
What we did

Three instruments:
1. Earth, Space and Gravity
2. Electricity
3. Plants and Animals

Each comprised 12 episodes from the science classroom, e.g. ‘The children see the dents that marbles make in a sand pit and are asked to explain the craters on the Moon.’

Given to 23 experienced teachers.
e.g. *Electricity, Episode 15*:

‘Following instructions in a book, the children use torch bulbs and batteries to make a set of lights to decorate a small cardboard tree.’

0 1 2 3 4

(REP/F3)

e.g. *Plants and Animals, episode 29*:

‘After hearing what hibernation is, the children think about how they will test places to find the best one for a hedgehog [ein igel; un hérisson] to spend the winter.’

0 1 2 3 4

(CR/Des/F2)
Some experienced teachers’ conceptions of creativity in elementary science lessons
So what does this tell us?

Experienced teachers could distinguish between incidents that favour scientific creative thought and those favouring reproductive thought.

They generally favoured fact-seeking practical activity and the application of such information to solve practical problems as opportunities for creative thought.

The same pattern of judgement was found in all topics, it was more marked in some topics than others.

They had little or no grasp of assessing creativity.
Pre-service and Practising Teachers Compared

<table>
<thead>
<tr>
<th>Pre-service teachers:</th>
<th>Experienced teachers:</th>
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<tbody>
<tr>
<td>- narrow views of opportunities for creativity in science</td>
<td>- generally, broader view of opportunities for creativity in science</td>
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Little or no grasp of assessing creativity.
Assessing Creativity in the Science Classroom

Little or no grasp of how to assess creativity.

Assessing creativity – is it difficult?
Some argue that it is easy if done intuitively and holistically.
They find a high level of agreement between assessors.

0 0.8 1.0 (max)

Is this true for the science classroom?
What we did

We used five sets of explanations representing five different science classroom contexts.

Each set of explanations was assessed by ranking them for creativity.

12 pre-service teachers completed the task for each set.

We found very different results – low level of agreement.
Why did the assessment fail?

Novel                      Appropriate              Elegant
Functional

Art

Architecture
Why did the assessment fail? Reason 1

Novel  Plausible  Elegant

Art

Science

Architecture
Why did the assessment fail? Reason 2

Novel to the CHILD
Plausible to the CHILD

Not necessarily to the teacher

The children’s world
Some conclusions

Teacher trainers should expect narrow views and misconceptions.

The popular association of creativity with the arts may limit or misdirect thinking in this context.

Thinking in terms of ‘productive thought’ may be helpful.
Where to from here?

- Extend study to include other trainee teachers;
- Explore extent to which trainees have greater difficulty thinking of creativity in different areas of science (Biology, Chemistry, Physics);
- Determine the prevalence of the categories amongst teachers generally;
- Review of science education training programme to incorporate a more explicit focus on creativity in science lessons;
- Specific training for science education tutors.
References


Newton, L.D. & Newton, D.P. (2009), *What teachers see as creative incidents in elementary science lessons*, International Journal of Science Education,
Thank you all for listening – any questions?