Creative Cross-Disciplinary Science & Mathematics

University of Leicester

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The structure of this session

1. What is a Cross-Disciplinary approach
2. Current experience of cross-disciplinary approaches in EU countries
3. The Pollen experience in Leicester
4. Early work in exploring links between science and mathematics in Leicester
5. Inquiry in science and mathematics
6. Fibonacci and the future implementation in schools of cross-disciplinary approach

What is Cross-Disciplinary Science?

Realistic links between science and one or more other subjects. The intention is to enhance pupils' learning of all subjects.

City of Leicester Primary teachers trialled creative cross-disciplinary investigative activities over the past 3 years.

Good links were made between

- **science and literacy**
- **history**
- **geography**
- **physical education**
- **art**

Discussion: Your experience of a Cross-Disciplinary Approach

- **What are the ways of linking different subjects?**
- **What are the advantages and disadvantages of this approach?**
- **Can you optimise the advantages and reduce the disadvantages?**
- **What is the place of ICT in a cross disciplinary approach?**

Advantages as found in the Leicester Pollen Project

- Children are taught knowledge and skills in a holistic way in a context that is meaningful to them and more memorable.
- Learning is easier because it is less disjointed and relevant.
- Children are enabled to use similar skills in different subjects. This helps to them to understand and use these skills.
- Children can appreciate the contexts of their learning and so are more able to apply learning to their lives and develop a wider interest in the world.
- Language of the context is the same in each subject, making it easier for pupils who speak English as a second language to understand skills and concepts being covered.

Issues to Solve

- **Ensuring progression and continuity of skills and knowledge in all subjects.**
- **Identifying and assessing objectives to monitor progress.**
- **Current organisational practice / timetabling may need changing.**
- **Lack of experience of teachers (and schools) in using a new pedagogy. Some are not enthusiastic. Others lack confidence and need professional development.**
- **Lack of resources (funding, equipment & time) can be limiting. 'Rethinking' and rewriting plans takes time. Achieving consistency throughout school will need training input.**
- **Once it is in place as an initiative it can become too rigid.**

Teachers' planning is important

Deciding on a planning approach:

- **Should one topic be dominant, if so which one?**
- **How many subjects can be covered in one topic?**
- **How can a lack of balance be avoided?**
- **How can quality and not contrived links be achieved?**
- **It is important not to lose 'coverage' of some subjects. Teachers may teach what they like/want to teach and miss out key objectives.**

We found linking only two subjects, with information technology used alongside if appropriate, was sensible.

The strategy for linking different subjects needed to vary.

Addressing progression in two subjects

There are problems when concept development in the two subjects is developmental. For example children need to :-

- **understand simple electrical circuits before bulbs in series and parallel (science).**
- **appreciate addition of numbers up to 10 before numbers to 100 (mathematics).**
- **learn about local geographical features before studying the wider world (geography).**

We found by focusing on the skills of one subject and the concepts of the other, good links could be made.

However linking mathematics and science was still a problem at the end of the Pollen Project.

Linking Literacy & Science Concepts

Literacy	The fiction / non-fiction can be read and analysed for language objectives		Children use their new science language or experience to write in the focus genre.
Science activities		Science session practical time optimised	

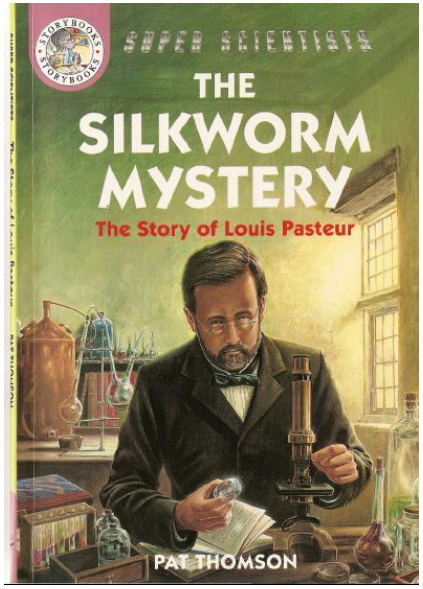
Texts chosen that relate to the science

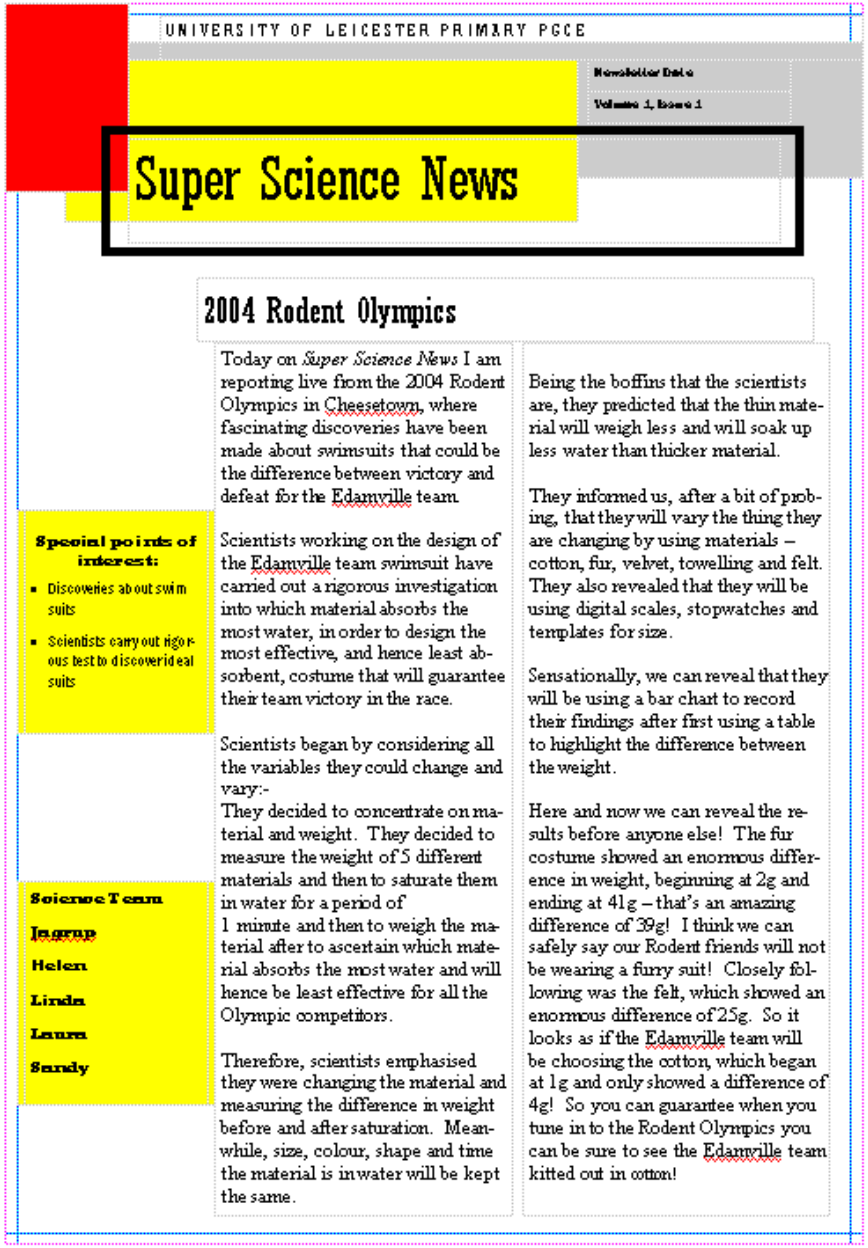
- Fiction - myths & traditional stories
- Letters, emails, fax
- Persuasive text
- Non-fiction science texts – eg reports, explanations
- Autobiographies & biographies

Little Red Riding Hood & Granny's diet

- **Letter -** Grandma 'wrote' to a class of 6-7 year olds complaining about the unhealthy food Red Riding Hood kept bringing her. She asked them to advise her granddaughter on a healthy diet.
- **Science -** Children sorted healthy and unhealthy foods into baskets. They assessed each proposed basket to choose the best basket of healthy food.
- **Letter & oral work** – They wrote to Red Riding Hood. Granny visited the class (the classroom assistant) to talk about her new basket of food as a way of consolidating the science concepts.

Investigating micro-organisms & biography of Louis Pasteur





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Newsletter Date

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Super Science News

2004 Rodent Olympics

Today on *Super Science News* I am reporting live from the 2004 Rodent Olympics in Cheesetown, where fascinating discoveries have been made about swimsuits that could be the difference between victory and defeat for the Edamville team.

Scientists working on the design of the Edamville team swimsuit have carried out a rigorous investigation into which material absorbs the most water, in order to design the most effective, and hence least absorbent, costume that will guarantee their team victory in the race.

Scientists began by considering all the variables they could change and vary:-
They decided to concentrate on material and weight. They decided to measure the weight of 5 different materials and then to saturate them in water for a period of
1 minute and then to weigh the material after to ascertain which material absorbs the most water and will hence be least effective for all the Olympic competitors.

Therefore, scientists emphasised they were changing the material and measuring the difference in weight before and after saturation. Meanwhile, size, colour, shape and time the material is in water will be kept the same.

Being the boffins that the scientists are, they predicted that the thin material will weigh less and will soak up less water than thicker material.

They informed us, after a bit of probing, that they will vary the thing they are changing by using materials – cotton, fur, velvet, towelling and felt. They also revealed that they will be using digital scales, stopwatches and templates for size.

Sensationally, we can reveal that they will be using a bar chart to record their findings after first using a table to highlight the difference between the weight.

Here and now we can reveal the results before anyone else! The fur costume showed an enormous difference in weight, beginning at 2g and ending at 41g – that's an amazing difference of 39g! I think we can safely say our Rodent friends will not be wearing a furry suit! Closely following was the felt, which showed an enormous difference of 25g. So it looks as if the Edamville team will be choosing the cotton, which began at 1g and only showed a difference of 4g! So you can guarantee when you tune in to the Rodent Olympics you can be sure to see the Edamville team kitted out in cotton!

Special points of interest:

- Discoveries about swim suits
- Scientists carry out rigorous test to discover ideal suits

Science Team

Ingrap

Helen

Linda

Laura

Sandy

Newspaper Article

Developing and applying science skills & (knowledge)

in

History
Geography
Religious Education
Physical Education
Art

History: Dyes used in the past

- During a project about the Romans – how did they colour their clothes?
- Children thought about what was available in our environment . Suggestions included blood, grass, oranges, banana skins. They were given turmeric, tea, spinach, redcurrants, red cabbage & onion skins.
- Cotton fabric was dipped into dye made from different plants to discover which plant worked.
- Further investigations such as varying dyeing time were explored.

Geography: Improving water in 3rd world countries - What is the best filter to 'clean' dirty water?

Pupils investigated the best way to filter the water mixed with mud, leaves, litter & twigs. They tried sieves, cleaning cloths, paper towels and filter papers.

Pupils discussed how many harmful bacteria cling to dirt particles. Removing the dirt removes these bacteria. They found out that by filtering water through old saris, Bangladeshi women in one community cut the incidence of cholera.

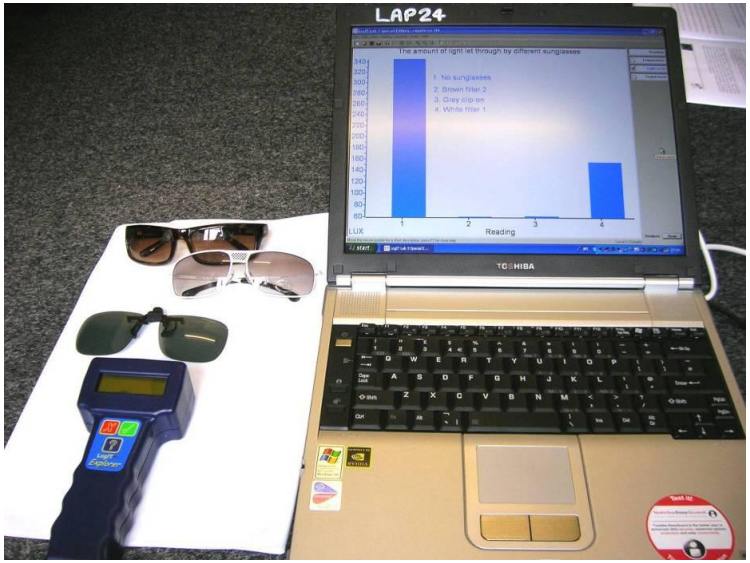
Booklets giving further examples

These booklets can be downloaded from the UK site

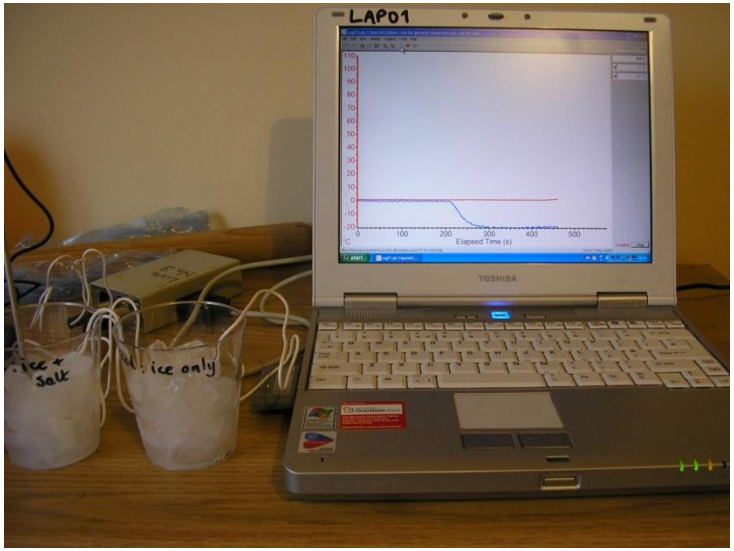
http://www.le.ac.uk/se/centres/sci/products/crosscurricular.htmlt

Using information technology as appropriate

English teachers have access to good ICT equipment such as data loggers, electronic microscopes and interactive white boards. They are expected to use them as a tool to enhance their teaching. Therefore at sometimes it is appropriate to use them and at sometimes they should not be used.



Investigating which sun glasses keep out most light.



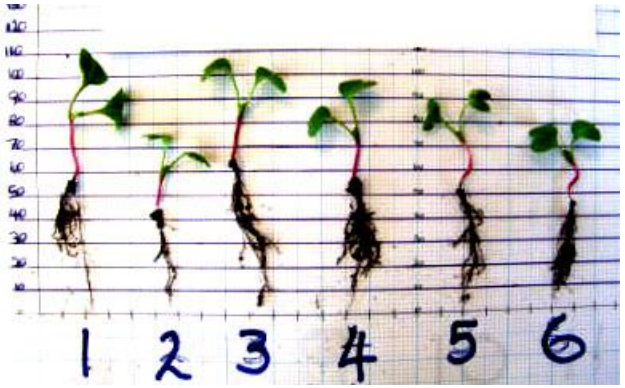
Investigating why we put salt on the roads in winter.

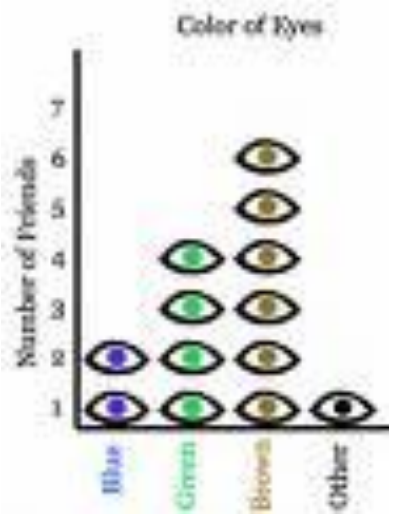
Mathematics and Science

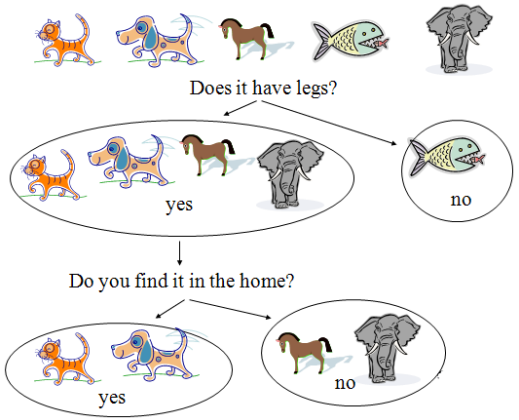
Leicester Pollen Project initial links were made between mathematics and science

1. Datahandling

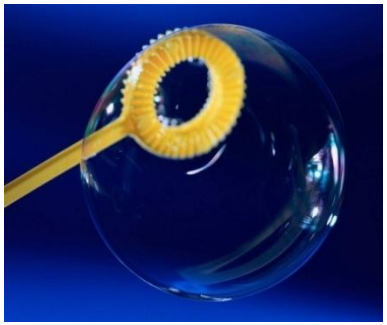
- **Science gives a purpose for data handling**
- **Charts and graphs as a way of communicating and thinking about ideas.**

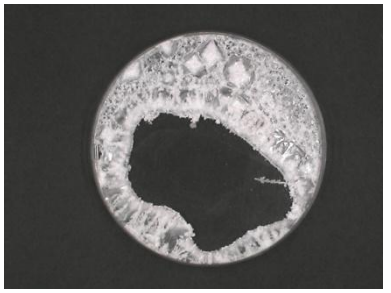






2. Identifying and explaining shape




Links between science and mathematics were relatively superficial because:-

1. **Both subjects need careful progression of concepts**
2. **There is an emphasis on manipulating numbers rather than exploring the development of mathematical ideas as part of a science activity.**
3. **Teachers and tutors have had little experience of developing both subjects together.**

Discussion

- **Your views on the Leicester Pollen experience of developing a cross-disciplinary approach.**

- **What strategies have you found to link science and mathematical investigations, concepts, skills etc?**

Our approach to planning

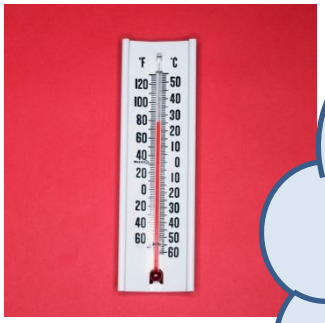
Science educators present a sequence of science activities for progression a topic

e.g.

- **Insulation and heat loss**
- **dissolving**
- **recording aspects of weather**

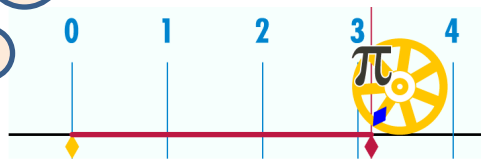
Our approach to planning

Mathematics educator looks for opportunities for mathematical ideas, and then considers appropriate progression



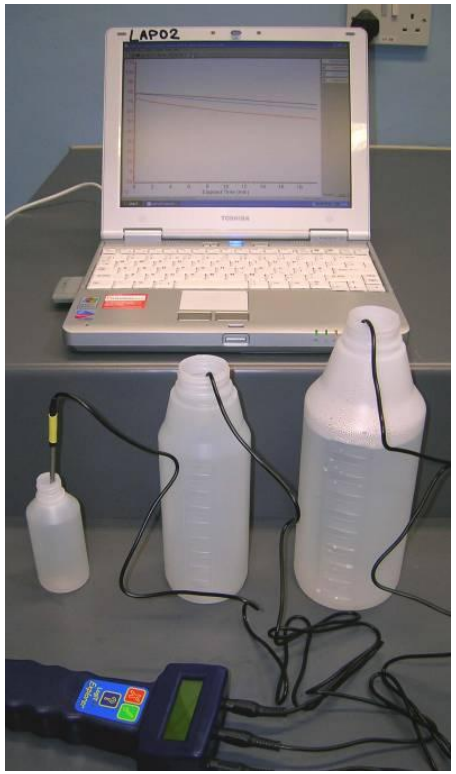
You need good number knowledge to read the scales

We need to use Pi to convert to standard measures or wind speed



Our approach to planning

Some ‘big ideas’ keep coming up



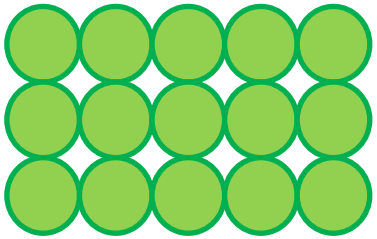
The ratio of surface area to volume affects how things cool …. and how they dissolve

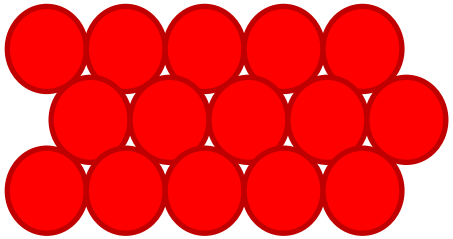
Our approach to planning

Opportunities arise in unexpected places

How do penguins huddle?

How do circles pack together?





Which way would keep penguins warmer?

How do other shapes pack together?

Why try to link mathematics and science?

Mathematical ideas play an important role in the explanatory power of models in science

‘School mathematics’ often lacks purpose: scientific inquiry is a rich source of opportunities to use mathematical ideas purposefully and understand their utility

Why try to link mathematics and science?

Data handling in primary schools is often based on artificial contexts

In scientific inquiry decisions have to be made about collecting, displaying and interpreting real, messy data

This provides rich opportunities for learning statistical ideas in meaningful ways

Discussion

- **Your views on the Leicester experience of exploring links between mathematics and science.**

Does the term 'Inquiry' create a particular problem?

- **What does the term 'inquiry' mean to different subject specialists?**
- **Does the term 'inquiry' mean the same thing in mathematics & science?**
- **Could different concepts of this term create problems?**

	Science	Mathematics	
The School curriculum	Electricity Forces Properties of materials Plants …	Counting Calculation Naming shapes Measurement …	*Teachers need the reassurance of links at this level.* *Links will be easier to make, but may be superficial and lack progression.*
'Big ideas'	Energy Particle theory Inheritance …	Pattern Proportion Equivalence Ratio…	*Links at this level are harder, but offer opportunities to develop sequential learning in both subjects.*
Inquiry	Observation, posing questions, collecting data, analysing data to draw conclusions, predicting, hypothesising, evaluating modelling, raising further questions, …		*We see strong similarities at this level which can be reinforced with different emphases.*

Discussion

- **Your views on the Leicester model for integrated planning in mathematics and science.**

- **Does the model make sense in your context?**

Implementation in schools

Changes observed in Pollen schools

Perquisite

Understanding and ability to carry out and teach pupils to carry out investigations in school

Year 1

i) Teachers replicate activities shown during in-service sessions. Children usually react with increased interest and behave well & take some independence.

ii) Teachers become more daring and take greater risks and add/develop ideas from the in-service.

Year 2

i) Teachers use proof that children can respond well to cross-disciplinary, independent work to make a case with colleagues to try this approach.

ii) Year groups and classes plan to make partial changes to include cross-disciplinary days or a cross-disciplinary topic during the year.

Year 3+

Total cross-disciplinary curricula. This takes several years as major planning is only done once a year.

Discussion

- **What support is needed to enable teachers and schools to use a cross-disciplinary approach?**

- **What general principles can be given to teachers to enable them to make creative links between subjects for themselves?**

- **What can be done to support schools and teachers in these changes?**