Materials and Energy around Us

related to the

Materials Science Project

and presented for the project

EFEU - Energy for Europe – with respect to the environment

Prof. V. Meisalo, PhD.
Dept. of Applied Sciences of Education,
University of Helsinki, Finland
at University of Patras, Greece

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Structure of the Wednesday Programme 1

The morning session has the subtitle '**Learning on Properties of Materials**' and there is an

Introductory lesson on the EU MaterialScience Project and its relation to energy problems,

- the problems of using different materials and saving or wasting energy.
- An introduction to concept maps and the use of Cmap Tools software in creating these, and

Student group-work in three groups finding information on

- 'energy with respect to environment' and
- organising the collected information in concept maps

Structure of the Wednesday Programme 2

The title of the afternoon session is '**Materials around Us**'

The session begins with *General discussion* comparing the experiences and outcomes of the three groups in the morning session.

The rest of the afternoon session is divided in two parts:

- Lesson introducing the Project's approach to the topic including the Activity-Based Site Visit Approach developed in Finland with experiences of an implementation in Greece,
- *Student group-work finding information on materials around us in the Internet and relating the collected information with personal experiences. The collected information on pros and cons for using different materials is organised in concept maps*

- Finally, there will be a discussion comparing the experiences and outcomes of the three groups and summarising the whole day's work.

Learning on Properties of Materials

Introductory lesson on the EU MaterialScience Project and its relation to energy problems, focussing more on pedagogical approaches than contents

- the problems of using different materials and
- saving or wasting energy and other resources.

An introduction to

- concept maps and the
- use of Cmap Tools software in creating these.

Student groupwork finding information on

- *'energy with respect to environment' and*
- *organising the collected information in concept maps*

EU MaterialScience Project

The piece of research reported here is a part of the *Materials Science Project* (SAS6-CT-2006-042942-Material Science 042942). This university-school partnership project is financed by the Specific Support Action of the European Union for designing and implementing research-based ICT-enhanced modules on material properties.

- Framework of the project, partners
- Goals
- In relation to designing of artefacts
- Lifecycle of artefacts and materials
- In relation to energy problems.

Framework of the project

The Project Co-ordinator is
University of Cyprus
(Costas P. Constantinou) and
the other partners besides University of Helsinki are

- University of Naples, Italy,
- Universitat Autonoma de Barcelona, Spain
- University of Western Macedonia, Greece, and
- University of Thessaloniki, Greece.

LWG in Finland

- The Finnish Local Working Group consists of
  - *six university teachers/researchers,*
  - *three school teachers,*
  - *a councillor of education (National Bureau of Education), as well as*
  - *a director (Industrial organisations, learning materials*)

Mission:
Engage Students in Material Science/Technology Learning

Pedagogical tools:

- Activate students in planning, learning and evaluating
- Emphasise constructivistic learning
- Emphasise collaboration
- Emphasise contextual learning
- Increase motivation

Aims of the Finnish Module: The students should learn about …

- Nature of material science and technology: There is an overlap between material science and technology.
- Methods of material science and technology: How materials science issues are researched and developed.
- Contents of material science and technology: **Physical and chemical properties of materials around us** and interesting properties of new materials including nanomaterials. ***How new materials are produced and where they are used. What properties different materials have, choice of materials for different purposes …***
- Careers in material science and technology: Scientists, engineers and many types of jobs in modern MS enterprises and laboratories
- ***Student interest and motivation to be enhanced through …***

EFEU & MaterialScience Project

We focus here on

- ***relation to energy problems,***
- ***And problems of saving natural resources***

We have also an introduction to

- ***concept maps and the***
- ***use of Cmap Tools software in creating these.***

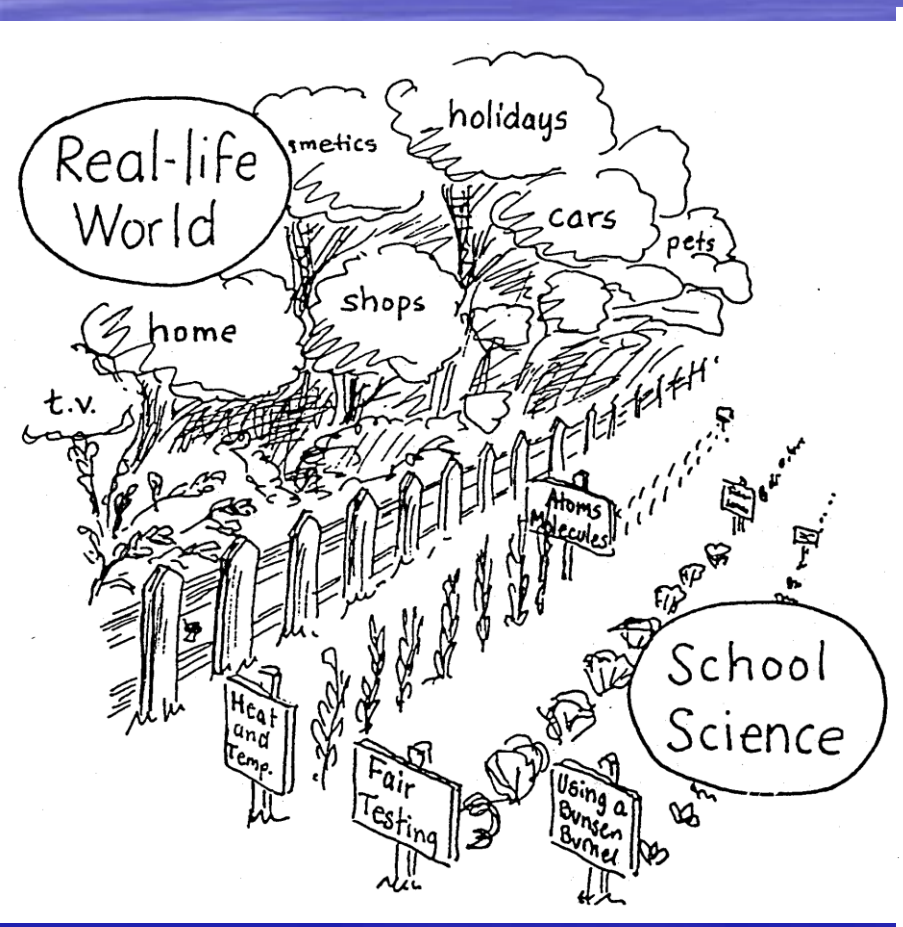
We introduce in the afternoon different pedagogical approaches including the Activity-Based Site Visit Model developed in Finland with experiences in Greece

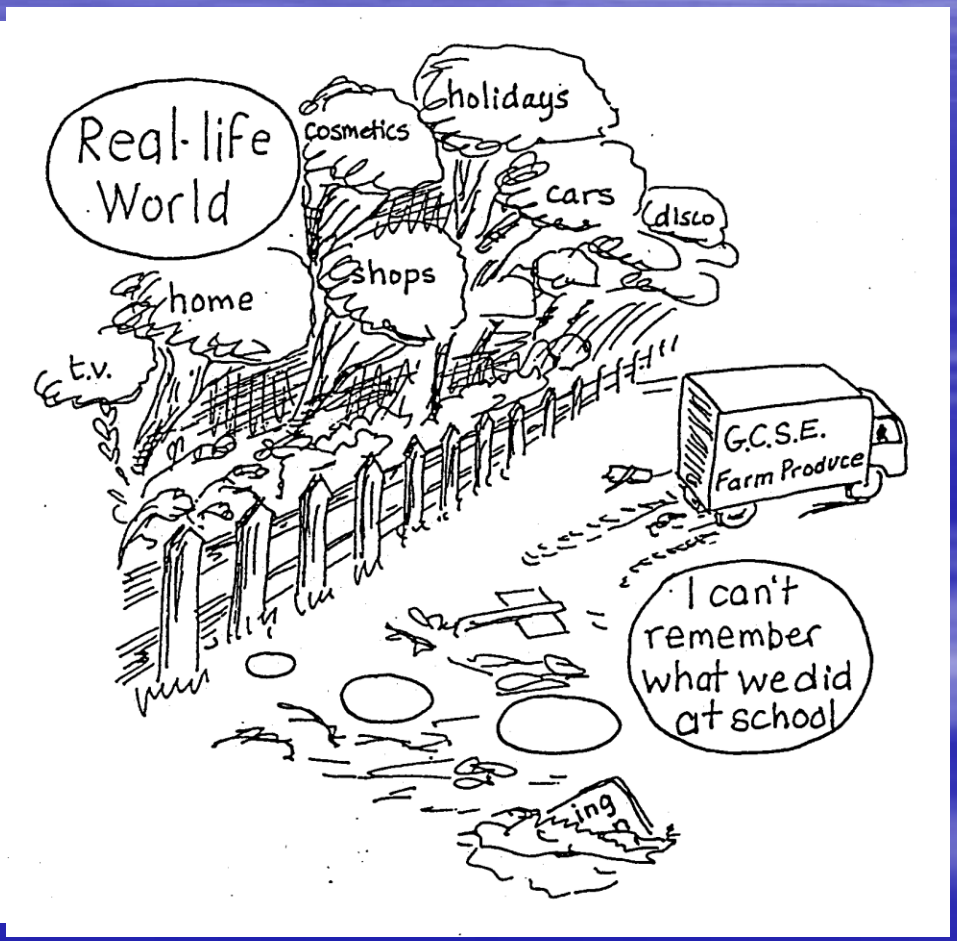
- ***As an example of out-of school learning***

We simulate student group-work finding information on

- ***'energy with respect to environment' and***
- ***organising the collected information in concept maps***

Images of Learning Science





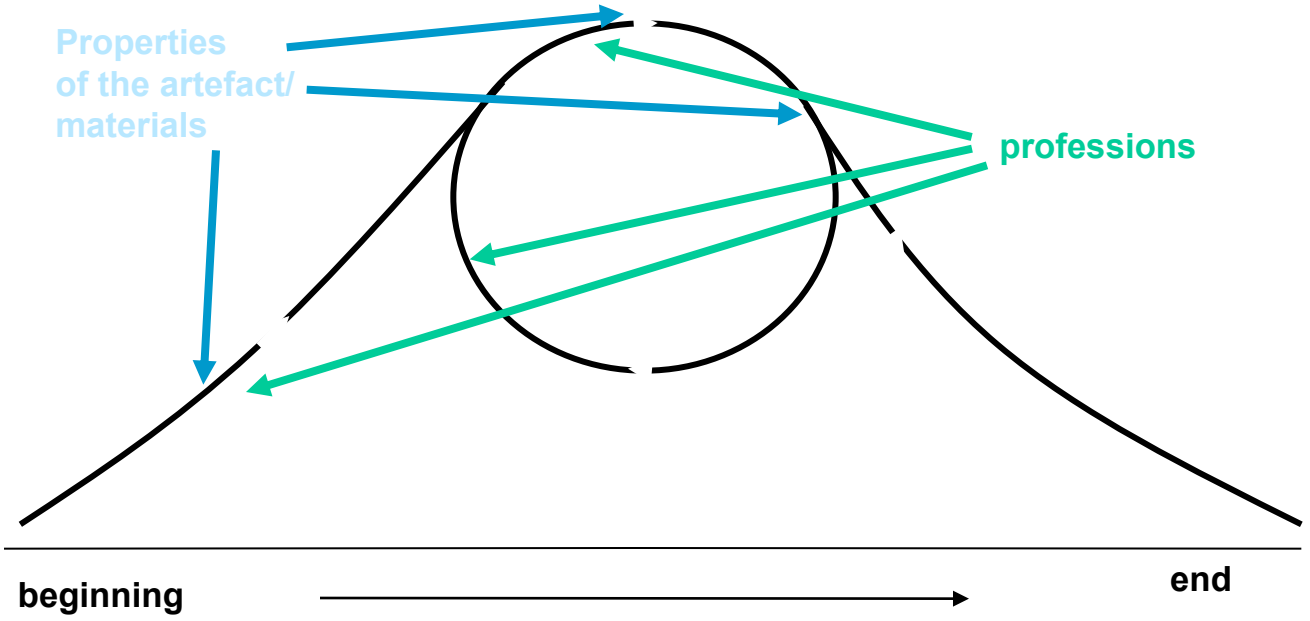
(Ross, Lakin and Callaghan, 2004)

Sub-units originally prepared in Finland

- **Materials around us as contents for grades 5-6, with modifications implemented even in upper secondary schools;**
- **Site Visit usually to an industrial plant, designed originally for upper secondary schools, but implemented down to grade 8 (6);**
- **Modern materials studied in the context of a site visit to a research laboratory, upper secondary school but even down to grade 9.**

Lifecycle of an Artefact

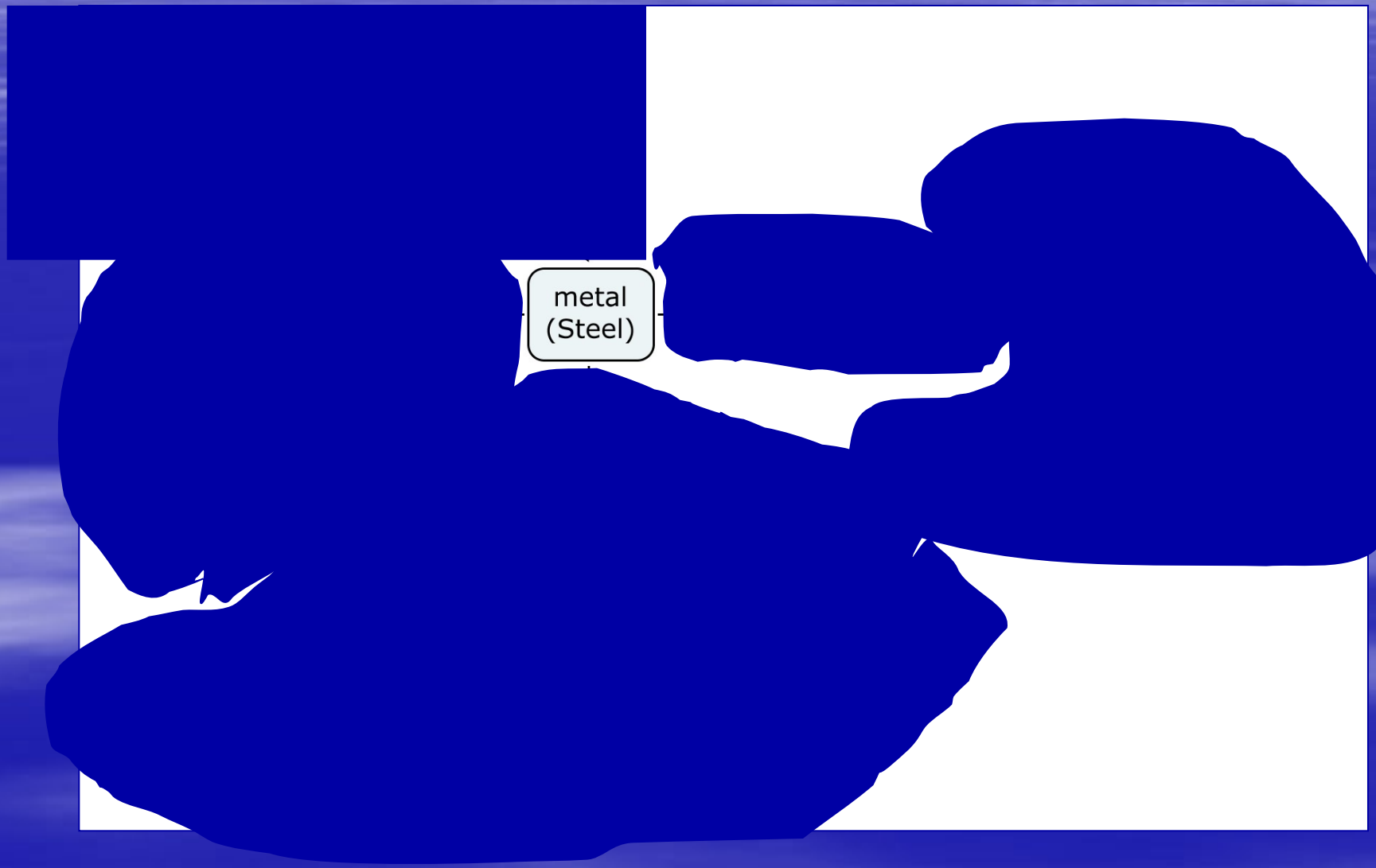
- From raw materials to waste with recycling
- Use or winning of energy at each phase?



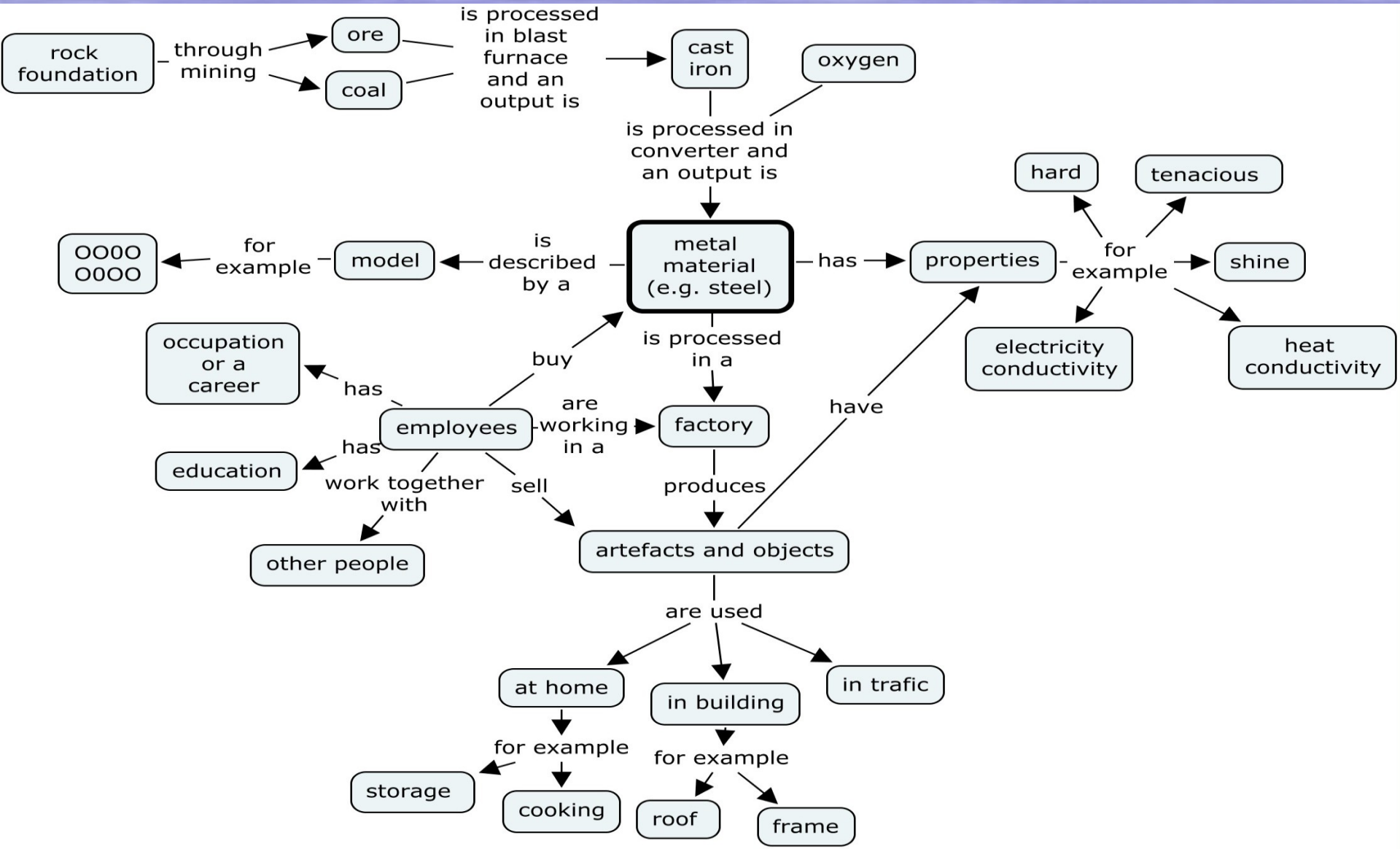
An introduction to concept maps

- What are concept maps?
- Why to use concept maps?
- How to use Cmap Tools software in creating these?

Mapping Manufacturing and the Use of Materials Around Us



Mapping Manufacturing and the Use of Materials Around Us



Use of Cmap Tools in Concept Mapping

- Bransford et al. (2000, 9) suggest:
  - experts have a rich body of knowledge about subject matter
  - content knowledge of experts in science is organised around core concepts or “big ideas” that guide their thinking
  - learning activities which help students to create a network of concepts seem to be advantageous to learning.
- Cmap Tools is an open-source software for concept and mind mapping

CmapTools 1

- CmapTools is free software
- It is very suitable for making concept maps in schools.
- It facilitates drawing and manipulation of concept maps.
- It can be downloaded from http://cmap.ihmc.us/download/.

CmapTools 2

- This website is run by IHMC, A University Affiliated Research Institute of the University of West Florida.
- More information about use of CmapTools can be found from the CmapTools help (http://cmap.ihmc.us/Support/Help/)

Discussion on Materials around Us. Morning session in Patras

- *Group discussions*

on Materials around Us based on an Internet search and individual experiences. These will be collected in concept maps, first with pen on paper. Student teachers from University of Helsinki supervise the groupwork of Internet search demonstrating the CmapTools software for concept mapping.

Thank you for your interest!

We continue with group-work in three groups…
Remember to join together for general discussion after the lunch break!

Structure of the Wednesday Programme 2

The afternoon session is on ‘Materials around Us’

- We begin with a discussion comparing the experiences and outcomes of the three groups in the morning session.

The rest of the afternoon is divided in two parts:

  - Lesson introducing out-of-school learning and the project approach to the topic including the Activity-Based Site Visit Approach developed in Finland with experiences of an implementation in Greece
  - *Student group-work finding information on materials around us in the Internet and relating the collected information with personal experiences. The collected information on pros and cons for using different materials is organised in concept maps*

- Finally, there will be a discussion comparing the experiences and outcomes of the whole day’s work.

Research on Out-of-School Learning Environments

- has a history of over 100 years (Hein & Alexander, 1998),
- focuses nowadays on learning and cognition (reviews by Dierking & Falk, 1994; Ramey-Gassert, Walberg, & Walberg, 1994; Hooper-Greenhill & Moussouri, 2003),
- has employed a wide variety of approaches and methodologies.

Contexts and opportunities for learning science outside the classroom

Environmental:

- School grounds – outside laboratory
- Field trips
- Zoos, botanical gardens, cemeteries, etc.
- Nature and other trails (e.g., rocks/chemistry, forces)
- Energy use audits (EfSD)
- Astronomy - night sky – star parties
- Residential centres and outdoor pursuits
- Recreational/sporting - e.g., sports science/physiology

Industrial and commercial:

- **Factories - manufacturing sites**
- Power stations
- Water and sewage treatment plants
- Building sites and quarries
- Small businesses e.g., farms, bakeries
- Health and veterinary centres
- Leisure and theme parks

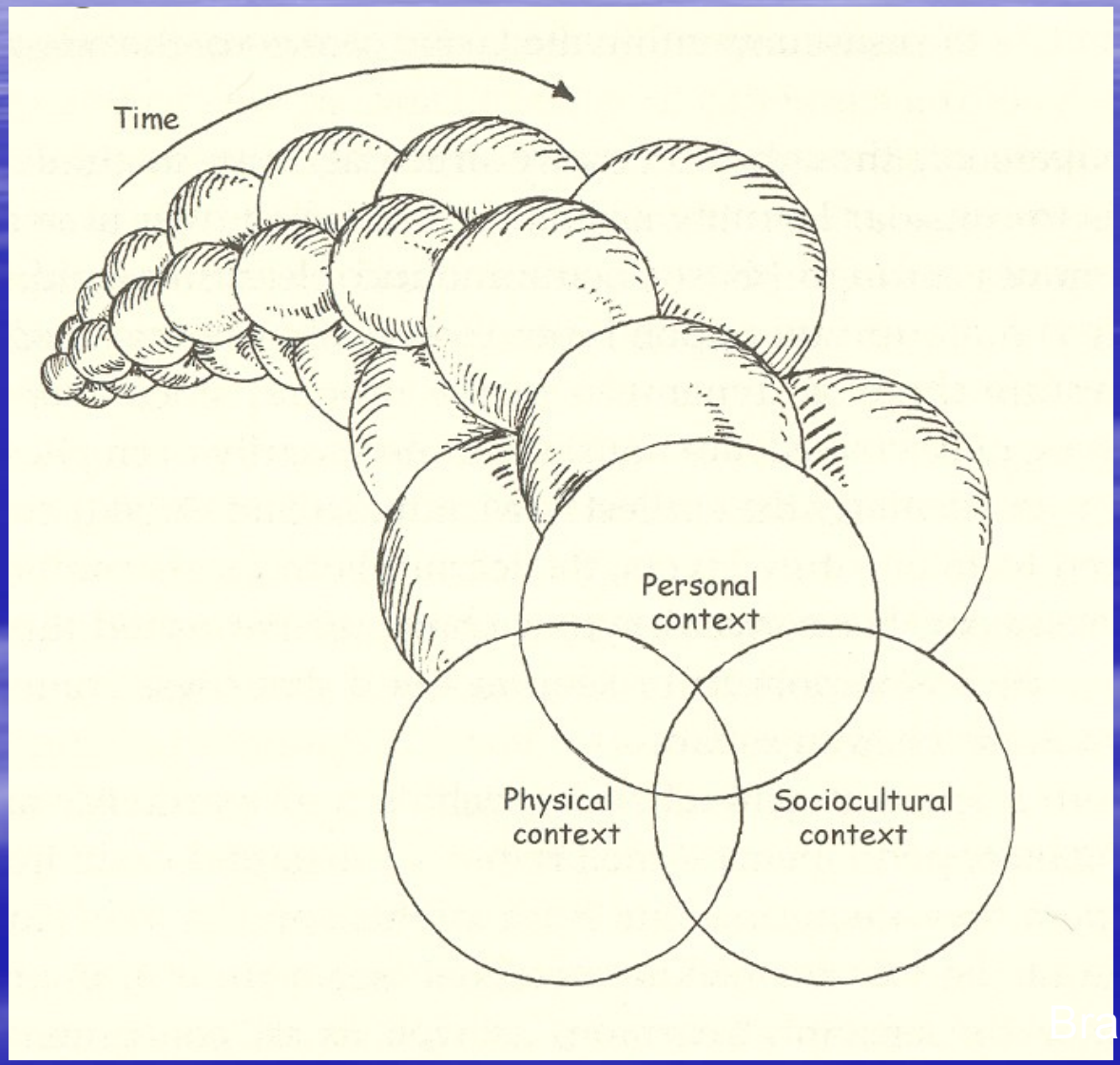
Universities, educational establishments, Museums, galleries, and 'hands-on' centres:

- National, regional, local
- Themed and specialist museums
- 'Hands-on' centres
- Interpretative centres (e.g., specific environments)
- **Special exhibitions** and galleries
- Lectures, talks, tours and special events
- Planetaria
- **University laboratories**

Home-situated learning

- ICT and the **Internet**
- Visual media: TV /film/video/DVD
- Printed media: Newspapers, magazines and books
- Conversations with family and friends
- Learning by doing when helping adults

Falk and Dierking's Contextual Model of Learning in Informal Contexts



Braund & Reiss, 2004

Background to the Finnish Site Visit Model

- Educational research on
  - site visits or in general on out-of school learning:
    - the analysis of the characteristics of out-of school learning and
    - an affect on student learning
  - Interest/motivation in science, personal development and responsibility,…
  - stimulating further learning or even a career in science and technology

    (Astin & Astin, 1992; Braund & Reiss, 2004; 2006; Anderson, Lucas, & Ginns, 2003; Falk & Storksdieck, 2005).

Objectives of the *Site Visit* (by teachers)

- Theme: Lifecycle of an artefact from the point of view of materials, their properties and professions in a site.
  - Students learn about materials that are used in the products of the company
  - ***Recyclability of materials***

- Demands to the production materials of *atmospheric observation devices* (how e.g., plastics and metals behave in different conditions)

- Students become familiar with the professions at the site. The pedagogic starting point is that science and professions related to the site are studied in the real context.

- Pupils operate in the journalist role.

Syntax of the Site Visit 1

1. Advance planning by teachers (0.5 – 2 hours):

- preliminary planning on general level,
- choosing the site to be visited,
- informing the school management team on the plans to organise a visit to get a formal permission, when needed.

2. Teacher preparatory site visit (2 – 3 hours):

- finding a contact person at the plant,
- co-planning with the contact person at the plant (discussion about the preliminary goals of the visit dealing with the materials science and technology contents and occupations, description of the student skills and abilities)

Syntax of the Site Visit 2

3. The preparation with students (1 – 2 hours):

- forming of student groups for project work (working as journalists),
- presenting preliminary goals for the visit,
- planning of the tasks and a way of reporting (preliminary questions to the contact person at the plant, structure of the report, ICT use in reporting, evaluation of the visit and the report),
- co-planning of the visit,
- groups prepare their project plans (goals, tasks, reporting plan),

Syntax of the Site Visit 3

4. Practical preparations for the visit (0.5 – 2 hours)

- Details of the visit, including the date, time, venue and programme details must to be given to all involved, including
  - the participating students
  - accompanying teachers
  - non-teacher supervisors
  - any staff at the site to be visited who will receive/work with the students
  - …

Syntax of the Site Visit 4

5. The site visit to the site (2 – 4 hours):

- introduction (plant, what they are doing, what kinds of people are working there),
- “sightseeing” around the plant,
- group work, different topics as agreed with students,

6. Student group reports (1 – 2 hours):

- students prepare the reports,
- students present their reports,
- discussing what they have learnt and what could be improved.
- Work completed by students either during or subsequent to an educational visit should be displayed publicly in the school.

Syntax of the Site Visit 5

7. Evaluation and feedback with teachers and site representatives (0.5 – 1 hours):

- evaluation of learning outcomes and student reports,
- evaluation of the ICT use during the project,
- evaluation of the overall arrangements and the practical running of the visit
- evaluation of student behaviour
- if the site-visit will be organized again, what would/should be done differently

8. Collecting ideas for planning future site visits (15 – 30 minutes).

Pedagogical Approaches and Context

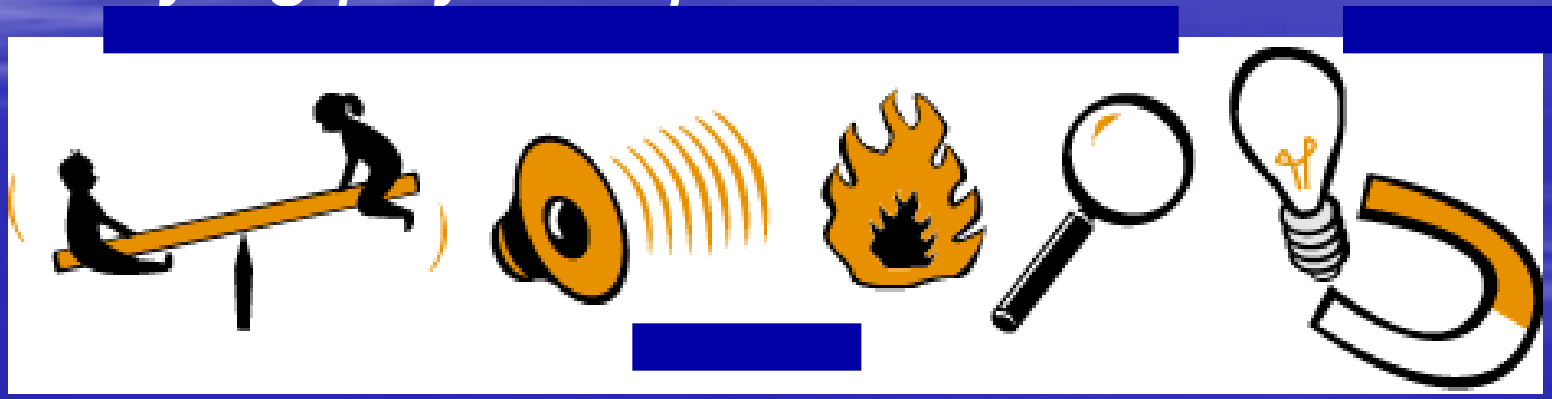
Materials around us as a content: paper and wood products, metal, plastics, ceramics, nanomaterials, …

- Learning by science inquiry, classification, POE
- Materials science related activity-based site visit: background, industry perspective, teacher perspective, student perspective, pedagogical approach (syntax) …
- Reading and writing activities: Background reading, writing plans and project documents
- ***Concept mapping: identifying conceptions, summarising learning outcomes***
- ***Identifying relation of materials to energy and environmental problems***
- Versatile ICT use

Classification as an Inquiry-Oriented Activity

Classifications in Science

- *Classifying physical phenomena*



Motion and balance

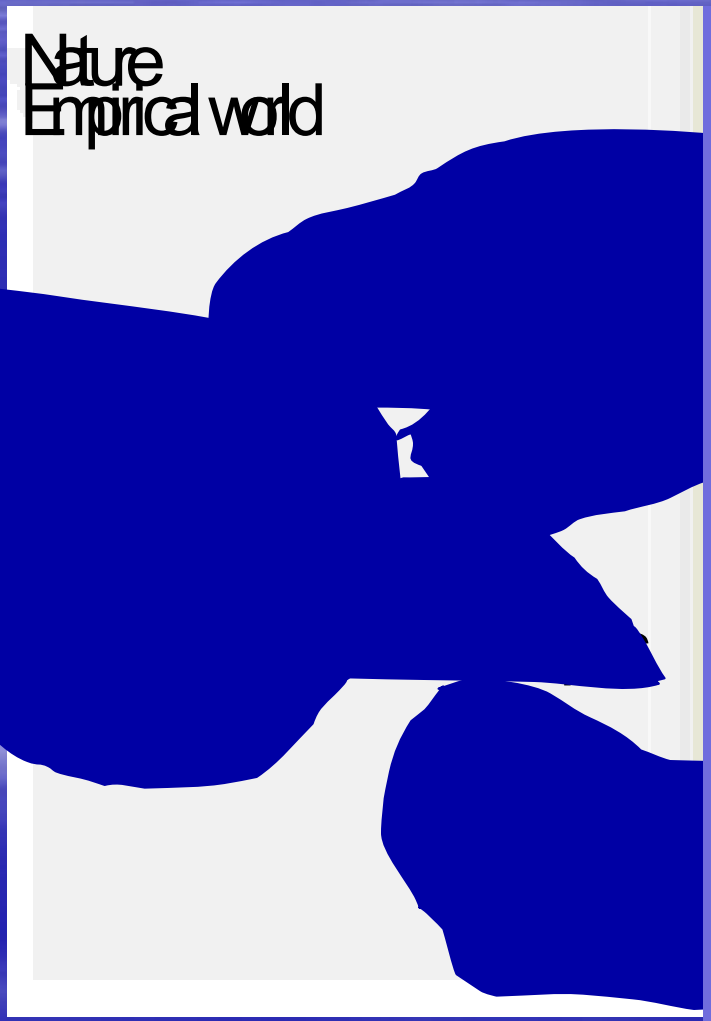
Vibration and wave motion, sound

Thermal phenomena, light

Optics

Electromagnetism, electricity and magnetism, modern physics

Classification Method

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Predict, Observe, Explain (POE) Strategy in Science Inquiry

POE Strategy in Science Inquiry

- POE is often used while the students are guided by worksheets.
- A POE activity includes the following phases:
  - **Predict**: Students are presented with a worksheet a particular set-up of equipment, and described what s/he will do. Students then make predictions about what will happen, and a brief explanation of why they think that will be the correct outcome. Several classification exercises are organised and properties of the materials discussed before making the predictions
  - **Observe**: The activity is carried out, the results are observed, and students write down their observations.
  - **Explain**: The students attempt to deconstruct the observed phenomena and explain why things happened the way they did. The idea is that the teacher plays a minimal role in a POE activity.

Characteristics of Inquiry-Based Learning and ICT Use

- Learning is an active process. Students benefit from working on complex problems, which can be approached from different perspectives.
- Learning is a co-operative process and, therefore, students should be encouraged in interaction with others.
- Conceptual understanding takes precedence over procedural efficiency.
- Teachers must be sensitive to students' previous knowledge of the phenomena under study.
- Learning activities occur in interesting contexts.
- Problems that are relevant to students' experiences outside of the school setting enable them to make connections between what they learn outside of school and in class.
- Development of metacognitive skills enables students to take responsibility for managing and monitoring their own learning activities.
- Preparing the students for lifelong learning.

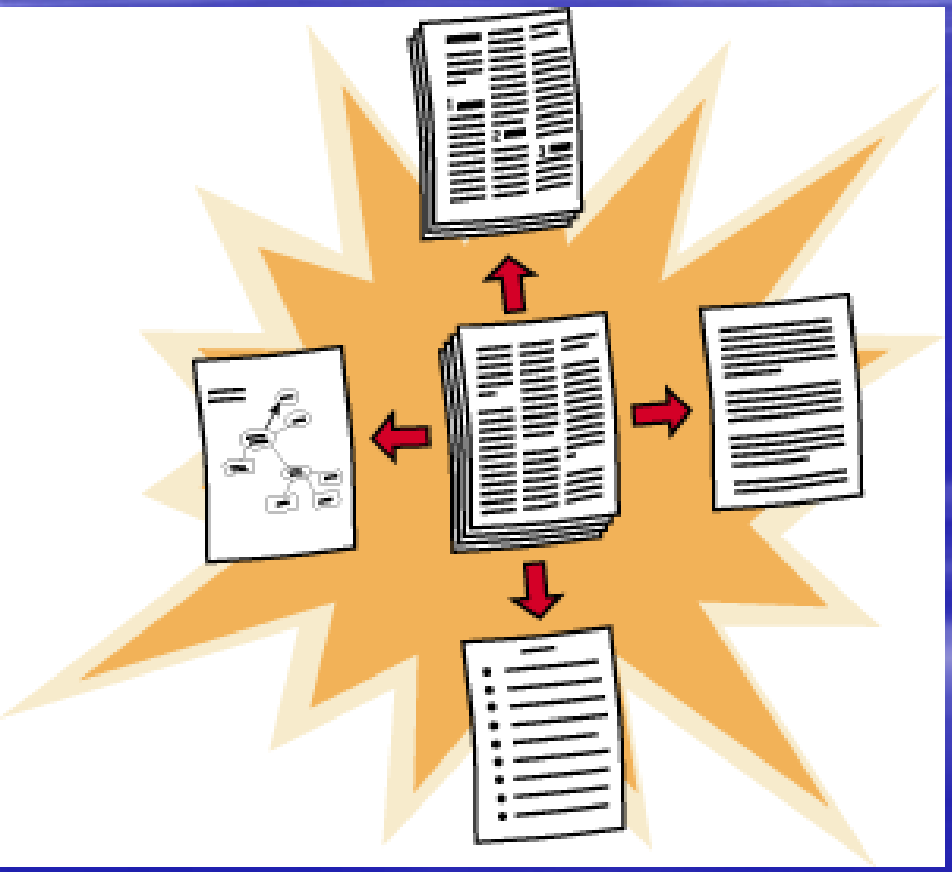
Properties of Learning when Reading and Writing are Emphasised

- Reading and writing activities in science should support learning with the following properties:
  - collaborative,
  - constructive,
  - reflective and
  - contextual

Process Writing

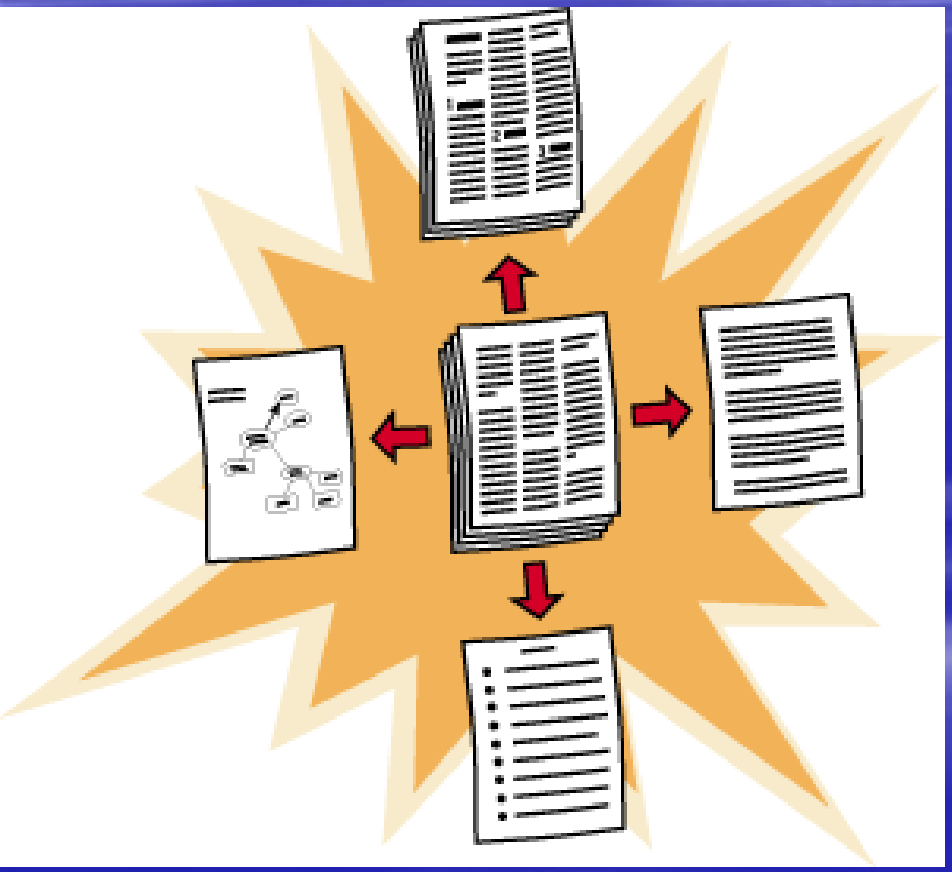
- Brainstorming and choosing the topic
- Familiarising oneself with the topic (generating and choosing ideas, facts, views, goals, and visions)
- Outlining the topic (analytic questions, mindmaps) and sketching the structure for the text
- Writing the first draft
- Feedback (one's own views, peer feedback and teacher feedback)
- Editing the text and thus creating the second draft
- Creating the final publication version (double-checking language points and headings)
- Publishing.

Reading
Supporting Independent Reading 1



When students read independently, they can be asked to write down key expressions and pose questions that come to mind when reading a given text. These questions voice points that students have not understood.

Reading
Supporting Independent Reading 2



The questions can be collected on a white board or on a transparency for everybody to reflect.

While reading, students can create a mind map on the basis of the text. This mind map serves as a visual representation on the ideas generated by the reading process and the connections between these ideas.

Exercises Using Prewritten Texts Manuals and Booklets

Create an updated and localised booklet, a basic guide for dealing with energy end environmental issues at home. First, jointly discuss which aspects need to be covered in the booklet.

After this is done, divide the students into groups and allocate each group an area of responsibility.

Thank you!

You have been a wonderful audience!

Now again team work in three groups before the final discussion!