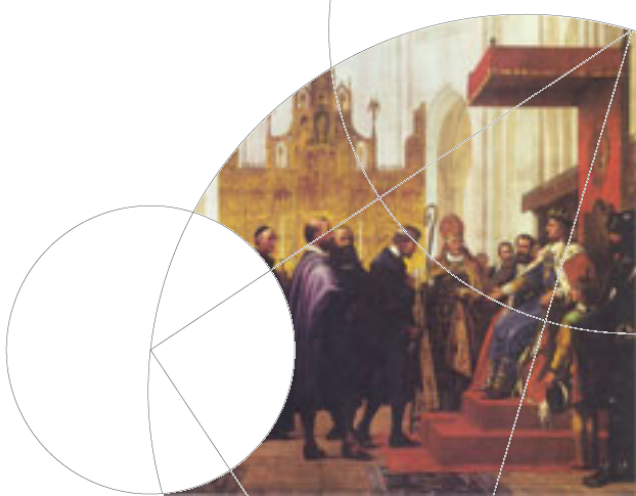
Using problems to structure curriculum

IUP



The epistemological hypothesis in didactics

Knowledge is created in specific circumstances in specific contexts

In the course of scientific development knowledge is "de-contextualised"

In teaching a "re-contextualisation" must be made if the students are to learn the intended knowledge

The institutionalisation phase is a "re-de-contextualisation".

Phases in teaching

Devolution	**What/how much information is needed to get students started working on problem?**
Action	**Spend substantial amount time on these phases…**
Formulation	
Validation	
Institutionalization	**…then this phase need not be very long (but should be there!)**

Koekoppe-Indpodnings-Attest.

Meta Elisabeth Charlotte Amalia Wismann

fød i Ribe og boende i Ribe, 14 Aar gammel, er af ~~mig underskrevne~~, Aar 1836 den 5te April indpodet med Koekopper. Ved nøiagtigt Eftersyn imellem den 7de og 9de Dag efter Indpodningen ~~har jeg~~ fundet alle de Tegn, som vise dem at være de ægte Koekopper: de vare nemlig hele og ubeskadigede, opfyldte med en klar Vædske, i Midten nedtrykkede, og omgivne med en rød Kreds; hvilket herved, paa Ære og Samvittighed, bevidnes af

Ribe den 4 Novbr. Aar 1845.

[illegible]
Distriktslæge.

Cowpox Inoculation Certificate

Meta Elisabeth Charlotte Amalie Wismann

Born in *Ribe* and living in *Ribe. 14* years of age, has been ~~by me the undersigned~~, year *1836* the *5th of April* inoculated with cowpox.

By meticulous examination between the 7th and the 9th day after the inoculation is found all the signs, which show them to be real cowpox: They were indeed whole and undamaged, filled with a clear liquid, in the middle depressed, and enclosed by a red circle – which is hereby, on honour and conscience, certified by

Ribe the *4th of Nov,* Year *1845 (Unreadable signature)*

Questions arising from the certificate

- What is the cowpox virus?
- What is the principle of smallpox vaccine?
- (How serious was the smallpox virus)?
- When did they approximately start the state initiated vaccination programs?
- When did they approximately terminate the cowpox program (when were last cases of wild smallpox eradicated)?
- …

Edward Jenner – inventor 1796

Smallpox vaccine scar

ILOs

Students should be able to:

- Distinguish between different types of poxvirus
- Explain the basic principle of smallpox vaccine
- Determine the approximate start of state initiated vaccination programs
- Determine the approximate termination of the cowpox program and the last cases of wild smallpox
- Explain the origin and etymology of the term “vaccine”

Deductive and inductive teaching

Deductive teaching:

Proceed from general principles to application

(From the general to the specific)

Inductive teaching:

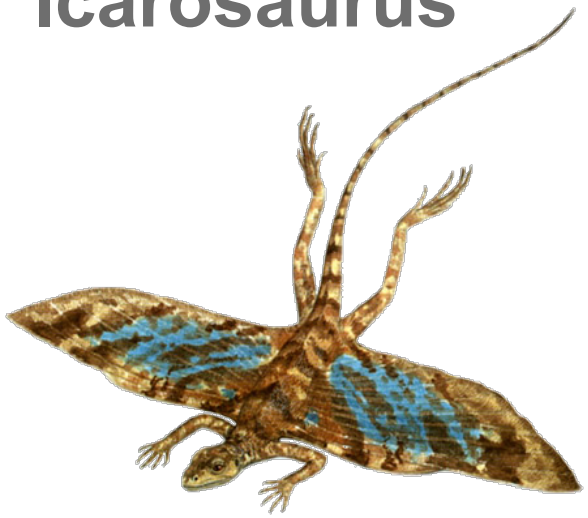
Proceed from examples to general principles

(from the specific to the general)

Problem orientation is a good way of organizing inductive teaching.

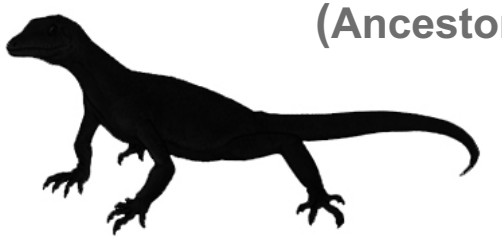
Theropod

Icarosaurus

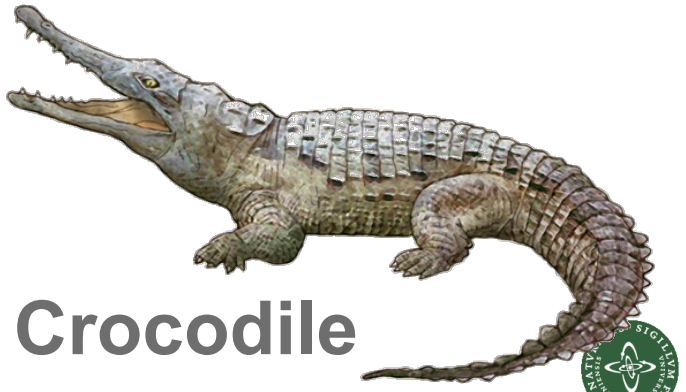


Archosaur

(Ancestor)



Bird



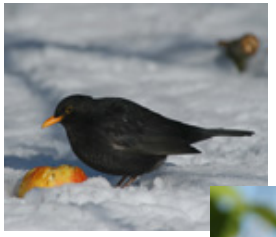
Crocodile

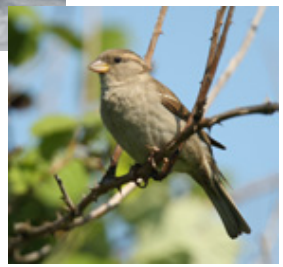
Where in education are we organizing curriculum around problems?

- Is it inductive teaching or deductive teaching?

Why is it a good idea to structure teaching around (initial) problems? – What justifications can we provide?

Cognitive indicators: prototype theory





Justifications for using problems to structure curriculum

- **Learning function**
  - We remember when we see connections in content matter
  - Motivation: Problems engage people
- **Competency function**
  - Generic skills
- **Selection function**
  - Helps the teacher select relevant contet
- **Structuring function**
  - Provides student's work with structure and a clear "next step"

Identify a problem in your lesson

In planning groups:

Use 5 minutes individually on finding one or two problems which may serve as the basis for your lesson.

Discuss your different proposals for problems

Return here after 20 minutes.

Types of problems

Ill-structured and well-structured problems

”In general, the problems presented to problem solvers by the world are best regarded as ISPs [Ill-structured problems]. They become WSPs [well-structured problems] only in the process of being prepared for the problem solvers. It is not exaggerating too much to say that there are no WSPs, only ISPs that have been formalized for problem solvers”

(Herbert Simon, 1973, ’On the structure of ill-structured problems’, Artificial Intelligence, vol. 4, pp. 181-203).

Problem types

A typology of problems in science education	**Problem formulation CLOSED**	**Problem formulation OPEN**
Problem solution space: CLOSED	**P_{11}** Closed problems	**P_{21}** Vague problems
Problem solution space: OPEN	**P_{12}** Design problems	**P_{22}** Open problems

A P_{11} version of the same problem

We wish to determine the ratio of power consumption for a freezer when it is placed in the kitchen compared to if it is placed in the garage. The temperature difference during winter is about 40K if the freezer is placed in the kitchen and about 20K if it is placed in the garage. The work done per unit time by a water pump in the freezer is *A*. This process removes the heat *Qi* per unit time from the interior of the freezer of (absolute) temperature *Ti* and adds the heat *Qs* per unit time to the surroundings of (absolute) temperature *Ts*. The temperature of the freezer is kept constant.

1. *What is A in terms of Qi and Qs?*

The largest efficiency of the heat pump corresponds to a situation where the entropy removed from the freezer's interior is as large as the entropy added to the surroundings per unit time.

2. *What is Qs in terms of Qi, Ti and Ts in this limiting case?*
3. *What is A in terms of Qi, Ti and Ts in this limiting case?*

The amount of heat needed to be removed from the freezer's interior per unit time is equal to the heat that diffuses from the surroundings through the insulation into the freezer per unit time. We assume that this quantity is given by *K(Ts – Ti)*, i.e. is proportional to the temperature difference between the interior and the surroundings. The constant *K* depends on the freezer's insulation.

4. *What isin terms of K, Ti and Ts?*
5. *What is the ratio of "the consumption of electricity," i.e., A for the two placements of the freezer?*