Create engagement in science learning

Viikki Teacher Training School
of University of Helsinki

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Content of the lecture

- What is Viikki Teacher Training School of University of Finland?
- What is science learning in Finland in high school? Subject-based, experiences from Biology and Chemistry
- Finnish (teacher) education
- Research-based (teacher) education?
- Inquiry-based science education?
- **What is the EAGER/PIRE –project**
- What we mean by **engagement**?

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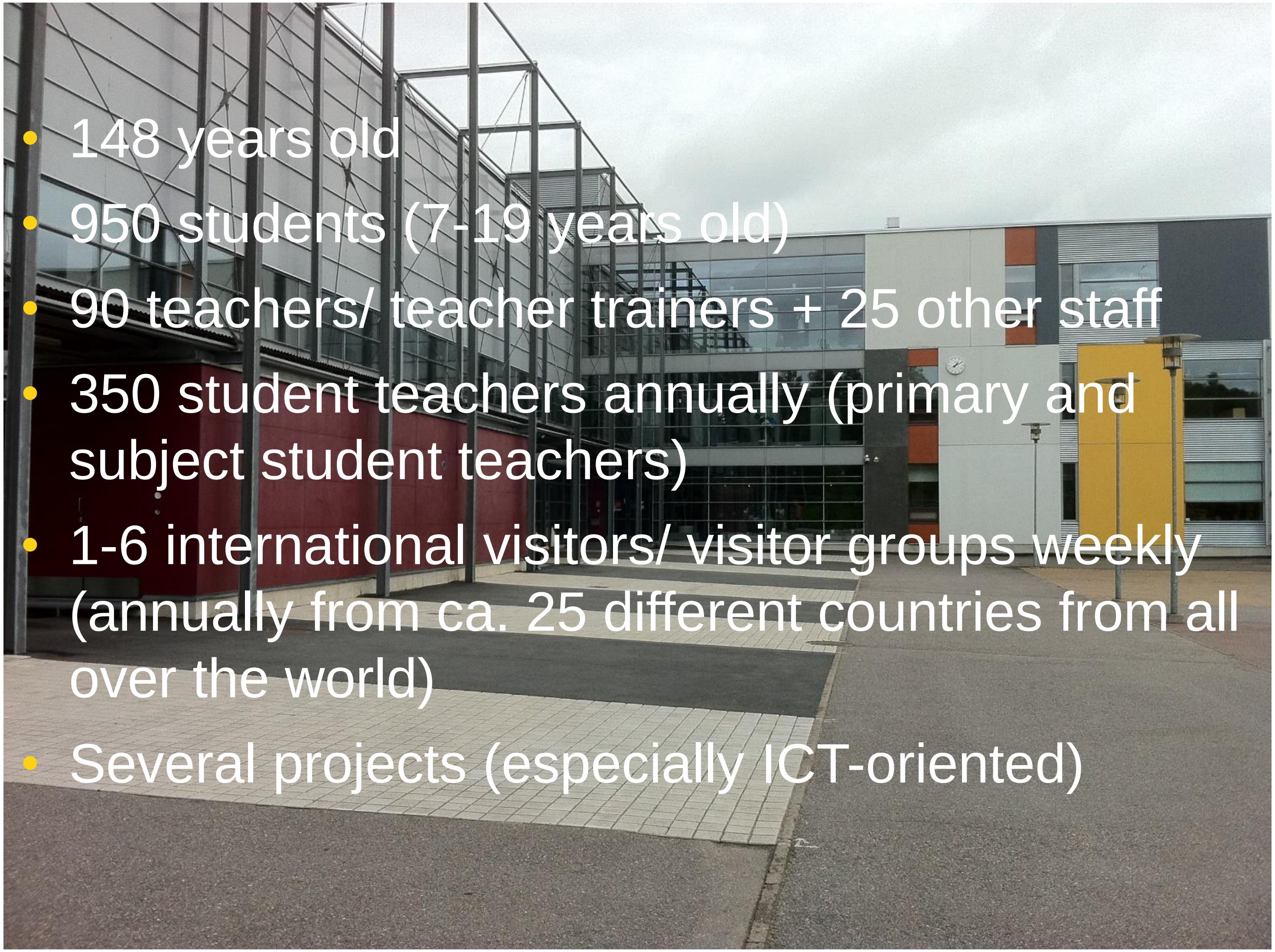
Viikki Teacher Training School in a nutshell



- 148 years old
- 950 students (7-19 years old)
- 90 teachers/ teacher trainers + 25 other staff
- 350 student teachers annually (primary and subject student teachers)
- 1-6 international visitors/ visitor groups weekly (annually from ca. 25 different countries from all over the world)
- Several projects (especially ICT-oriented)

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Finnish education and teacher education – ”principals”

more ...		less ...
professionalism	–	bureaucracy
clear, shared and long term vision based on **research outcomes and brainstorming**	–	ad hoc ideas coming from the politicians
decentralization, decision making, assessment and quality culture at the local level	–	standardization, **inspection, testing and heavy quality control**
trust based responsibility (self-evaluations, listening of students and municipality people / parents voice)	–	test and inspection based accountability
collaboration, networking and partnerships	–	**competition and rankings**

Main actions for the development of teacher education – research!

1. **Holistic view to teacher education**
2. **Selection and anticipation**
3. **Supporting the development of competences needed in generating novel ideas and innovations**
4. **Collaboration culture and networks**
5. **Supportive leadership**
6. **Research based teacher education**
   - training programs and teaching/learning **practices are based on research**
   - **student teachers learn**
     1) research skills and research orientation,
     2) assess their practices,
     3) reflect alone and in a group

Inquiry-Based Learning

- We conceptualize the different phases of IBL using the inquiry cycle formulated by Pedaste et al. (2015) through a systematic review of the existing literature on IBL.
- The cycle consists of five phases:
  1. stimulating interest (Orientation),
  2. stating theory-based questions and/or hypotheses (Conceptualization),
  3. planning and carrying out investigations (Investigation), drawing conclusions based the data (Conclusion) and
  4. communicating the findings of a particular inquiry phase or the whole cycle to others and reflecting on one's own actions (Discussion).

- The discussion phase can be a separate part of the cycle, or it can follow a particular phase of the cycle.

What is science learning in Finland in high school? **Subject-based**, experiences from Biology and Chemistry

Distribution of courses sample of subjects

Subject	Compulsory courses	Specialisation courses
Mother tongue & literature	6	3
A-language	6	2
B-language	5	2
Other languages		8+8
Mathematics	6-10	2-3
Environment & science	5	16
Humanities & social sciences	11	14
Arts, crafts & sports	4-6	7

Biology
Chemistry
Geography
Physics

PIRE-project

Michigan State University

University of Helsinki

This study contributes to the **research on student engagement** in three ways:

1. by combining questionnaire and situational measures of engagement using the Experience Sampling Method (ESM)
2. by applying a demands-resources model to describe the positive and negative aspects of student engagement,
3. by adopting a person-oriented approach to describe subgroups of students with different profiles of engagement and burnout symptoms.

Two studies were conducted among US and Finnish high school students about the engagement using mobile phones (ESM)

Engagement → the definition according this project

- **Student engagement** is a multifaceted construct that describes malleable aspects of motivation and behavior that are beneficial for learning and adjustment in the school context.
- This **broad concept** comprises
  - emotional,
  - cognitive and
  - behavioral aspects.

Science Practices

The multiple ways of knowing and doing that scientists use to study the natural world and design world.

1. **Asking questions and defining problems**
2. **Developing and using models**
3. **Planning and carrying out investigations and designing solutions**
4. **Analyzing and interpreting data**
5. **Using mathematics and computational thinking**
6. **Constructing explanations and designing solutions**
7. **Engaging in argument from evidence**
8. **Obtaining, evaluating, and communicating information**

The practices work together – they are not separated!

Our Challenge – to fulfil also our curriculums

Build learning environments that:

- Foster **deep and integrated understanding** of important ideas
- Engage students, i.e., **create optimal learning environments**, in learning science
- Support students in **developing important scientific practices and 21st century competencies**
- Support students to **solve problems, make decisions and think innovatively**

Asking questions and defining problems
DRIVING QUESTION (Bio):

- What will happen in human body when we run stairs up and down until we are tired?
- How we can measure the changes that we recognise in our body?
- What conclusions we can draw based on the findings? How do we explain the results?

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Science Practices

Case BIO

The multiple ways of knowing and doing that scientists use to study the natural world and design world.

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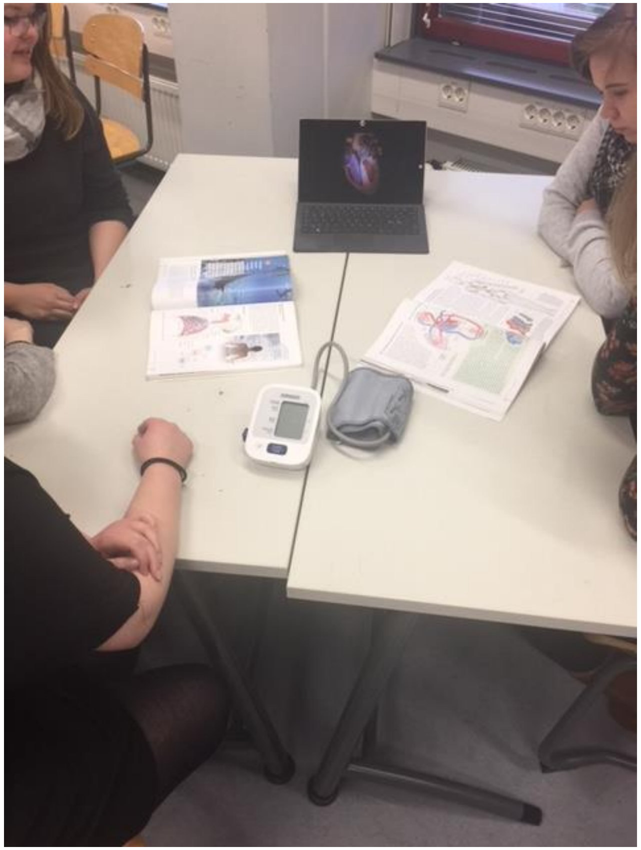
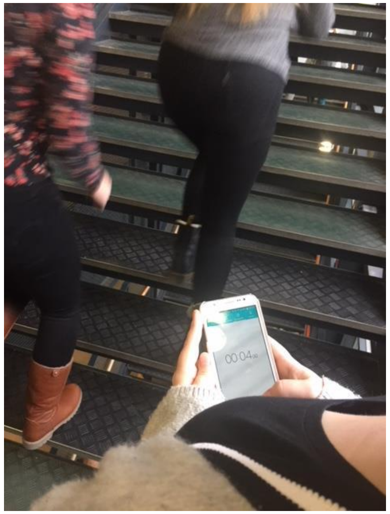
Developing and using models



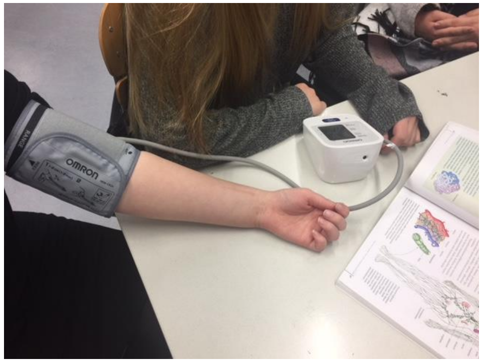
Students planed the paraments that they wanted to research and chose the equipment's that they used for measurements.

Planning and carrying out investigations and designing solutions

- Students worked in small groups
- One or two paraments per group
- Data was collected in the beginning (before running), in the end of the running and after recovery.



Student investigated:
- Heartbeat
- Respiratory rate
- Blood pressure
- Sweating

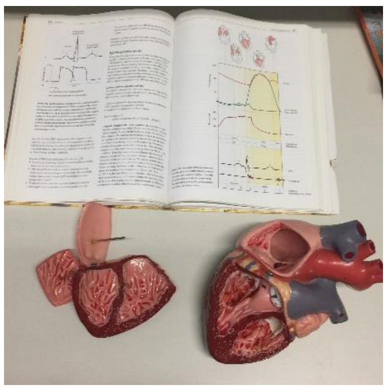


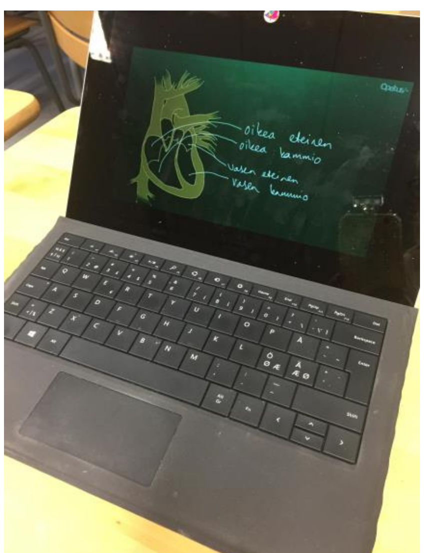
Analyzing and interpreting data, Constructing explanations and designing solutions

- Students analyzed the collected data in small groups
- They made the conclusions by comparing the data to the literature.
- In the reports students showed how the collected data was explained by using scientific literature.

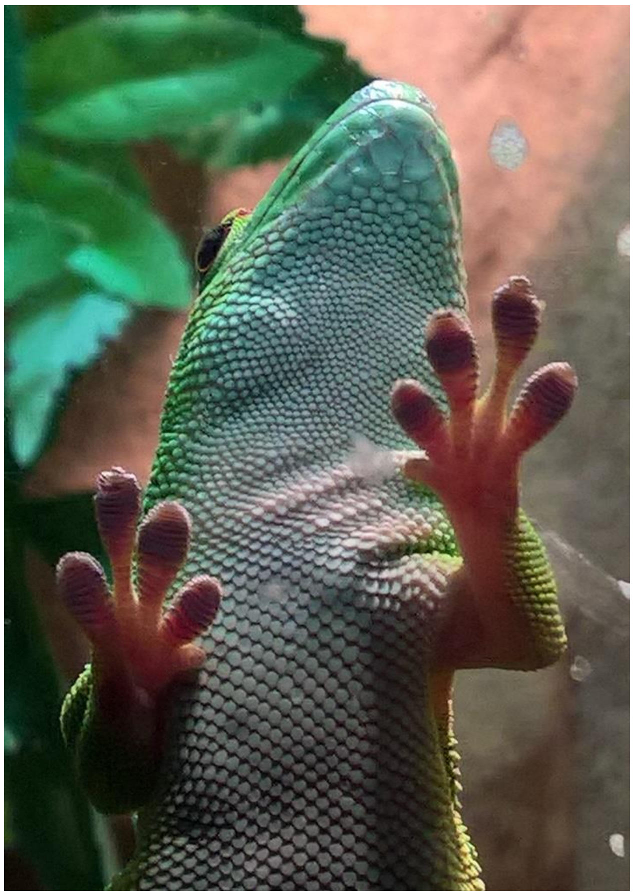
Engaging in argument from evidence Obtaining, evaluating, and communicating information

- Students made the reports about the findings and explanations and presented those to the others.
- Students considered what was the aim and purpose of this investigation.
- Students shared the presentations to each other`s.





Asking questions and defining problems
DRIVING QUESTIONS (Chem):



- **Why do Gecko lizard stick to the window or wall**? See explanation
- Why metalls conduct electricity and sugar or salt don´t? And why water don´t conduct electricity (so well) but water with salt do?
- Why different elements and compounds has different melting and boiling points?

Science Practices

Case CHEM

The multiple ways of knowing and doing that scientists use to study the natural world and design world.

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations and designing solutions
4. Analyzing and interpreting data
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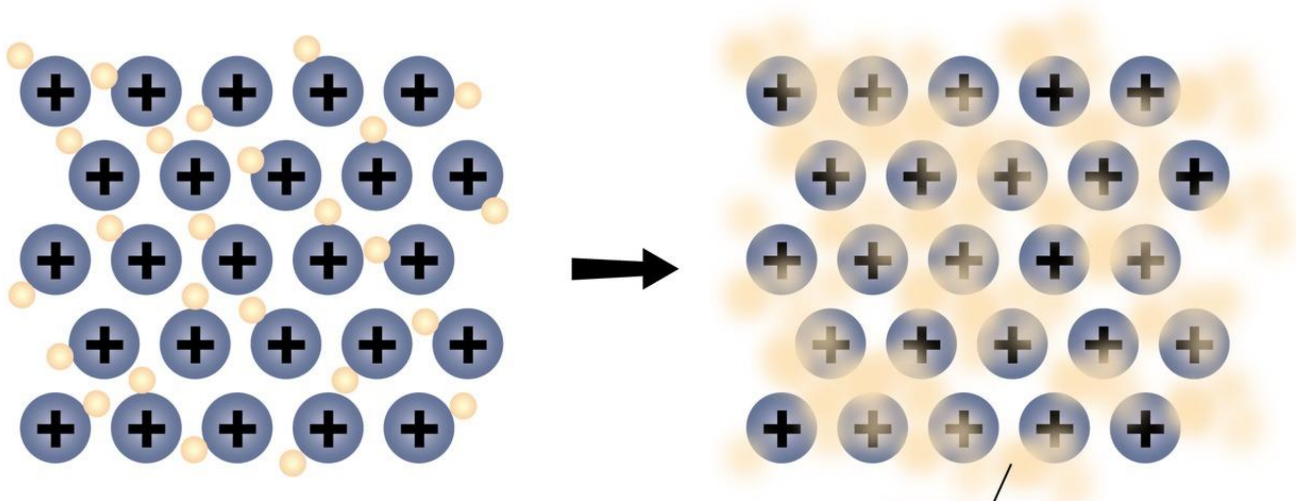
The practices work together – they are not separated!

Developing and using models

- How and why metall conduct electricity? And have higher melting points?
- What is electricity?
- **How we could build a model to explain this**?



Electron ocean / cloud / clue

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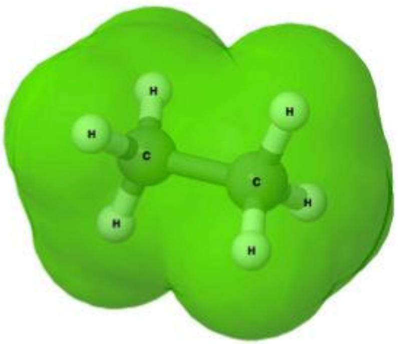
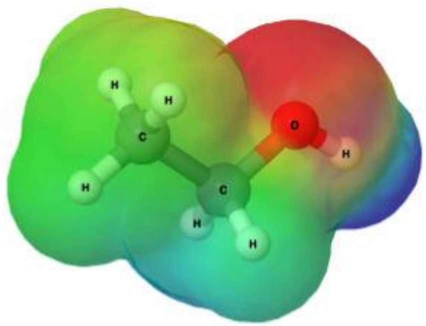
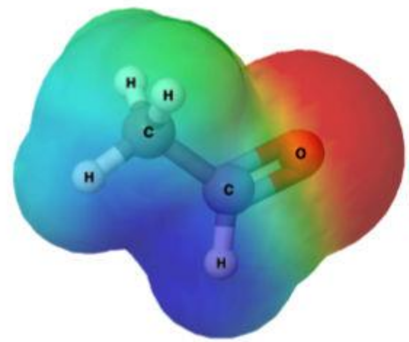
Using 3D-modeling programs – Electronegativity?



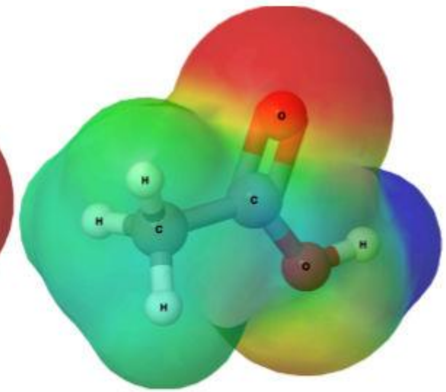
Ethane



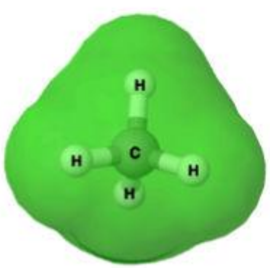
Ethanol



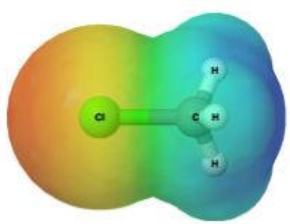
Ethanal

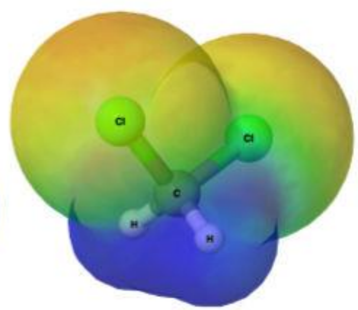


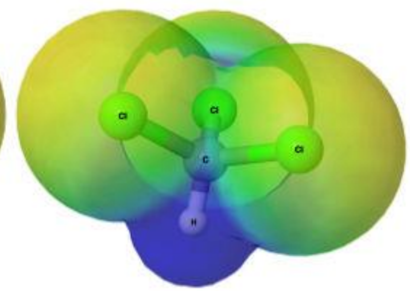
Ethan acid

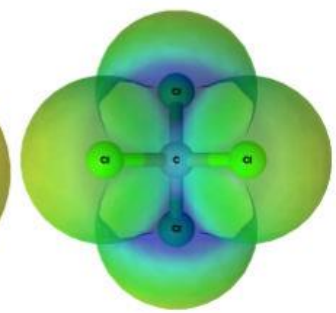


Methane









Tetracloromethane

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Planning and carrying out investigations and designing solutions

- **Four different transparent liquids?**
- Demostration shows that all liquids burns – one with blue flame – and the reaction products are water H_2O and carbon dioxide CO_2
- What are they?

- **Plan the experiments:** You can carry out two experiments – plan the experiment and ask for tools when needed.

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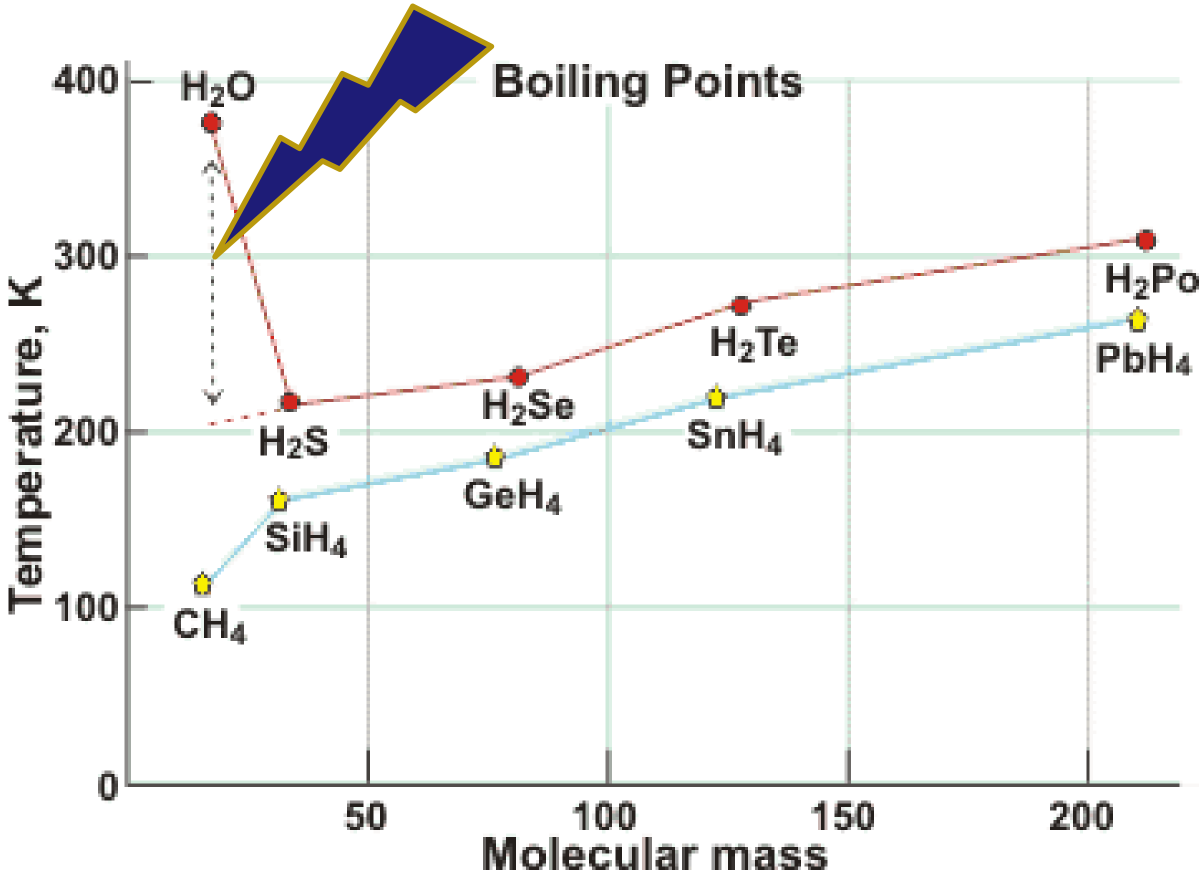
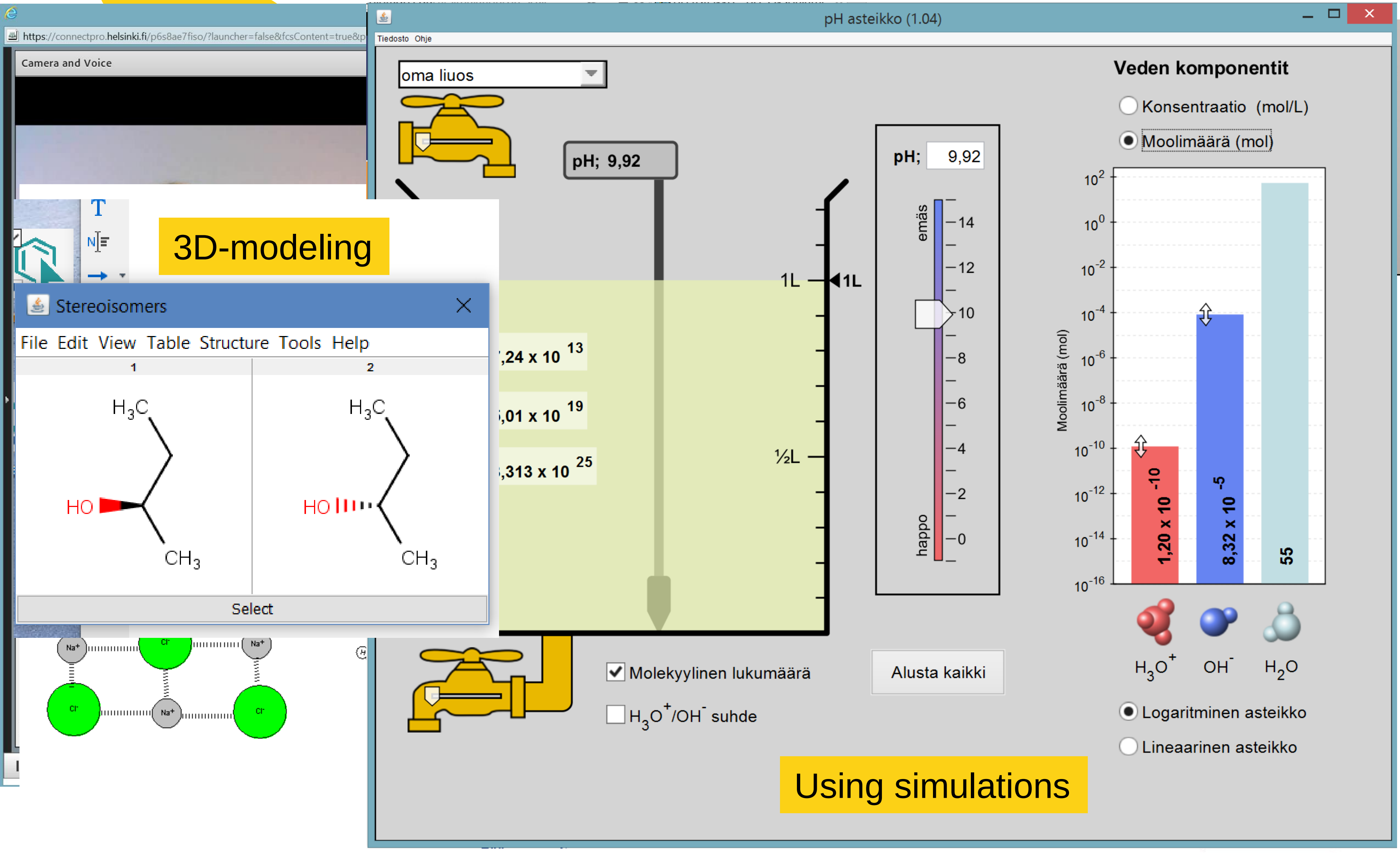
Analyzing and interpreting data



- Different Compunds with hydrogen
- Different boiling points and huge exceptions of water molecule
- **Explain the data?**

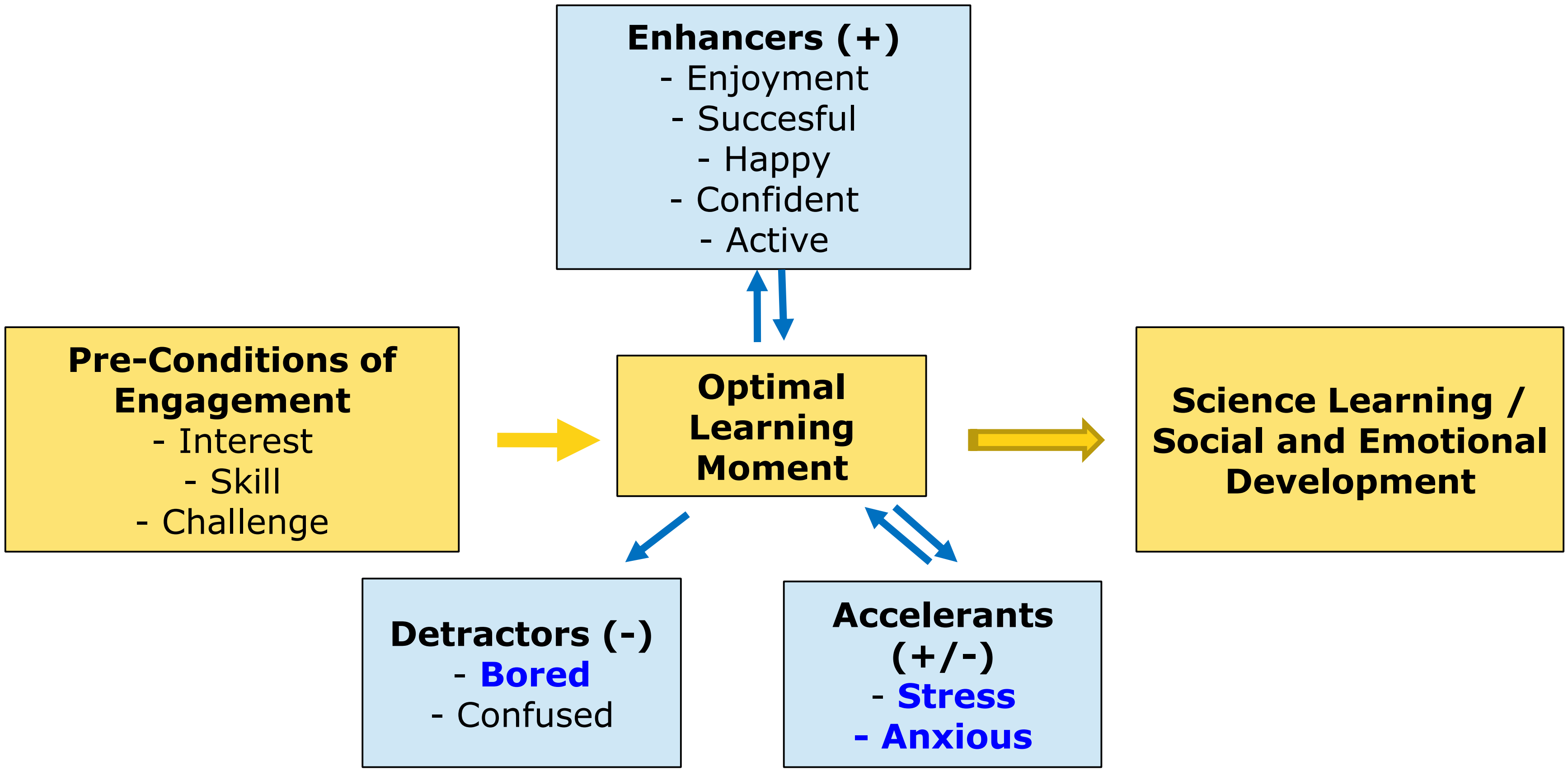
Learning by using ICT and cognitive tools



Observations

- **Driving question** is crucial – should be integrated to the curriculum (of course)
- What is the “model” (**modeling**) we are trying to great
- **Reasoning!** Not just explaining results (the phenomena in other words)
- **Experimental works** are common in Finland and students are motivated to do – BUT how to **construct explanations**, what you are doing and why, and then comparing the theory and actual finding and from the collected data (and the process) is hard
- **Groupworks** helps to **share knowledge** and **create more understanding** about the phenomena (or studied concept or matter/thing/organ/artefact)
- Is the hard **to create new** by force, how to let that happen in a creative and open way

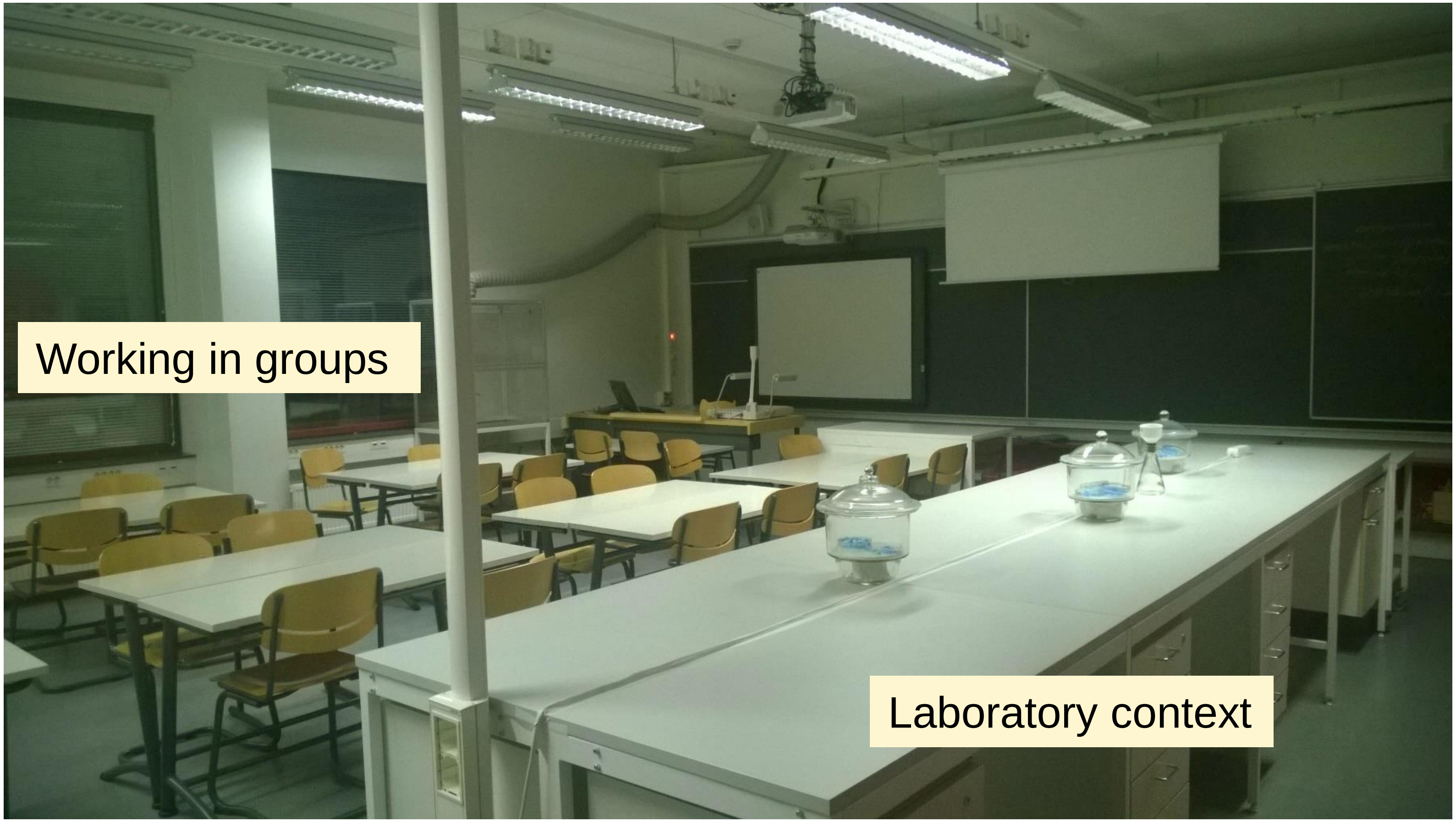
Optimal Learning Moments - Engagement



A Conseptual framework for optimal leaning moments

Working environment is crucial – chemistry classroom is not a lecture room

Working environment is crucial – chemistry classroom is not a lecture room



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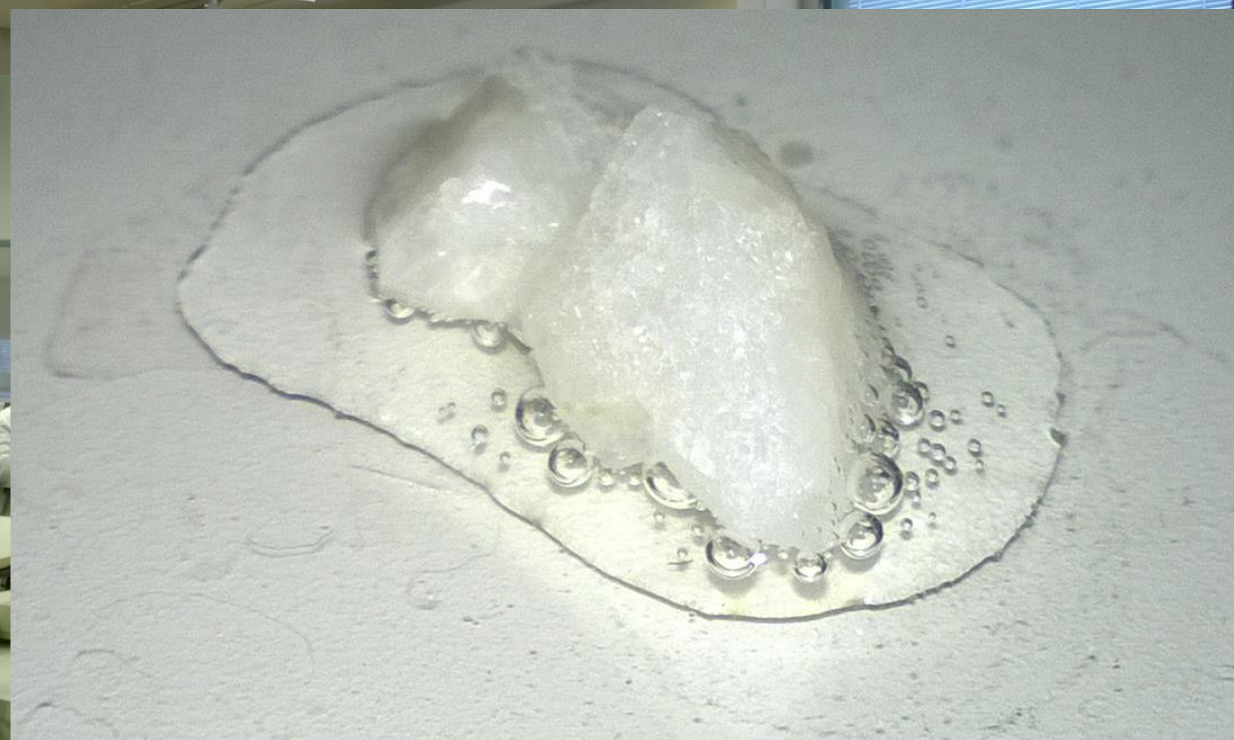
Experimental work

Marmor after acid rain → What is happening here?



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What makes a good driving question?

A driving question is a well- designed question used in project- based science that is elaborated, explored, and answered by students and the teacher.

- **Feasible -** Students should be able to design and perform investigations to answer the question and explain phenomena.
- **Worthwhile -** Questions should deal with rich content and practices.
- **Sustainable** - Questions should sustain students' interest for weeks as they find solutions to the driving questions.
- **Meaningful** - Questions should be interesting and valuable to learners.
- **Ethical** - Exploring the question should not lead to harm of the environment or and living creatures.

Scientific Practises vs. Inquiry-based learning

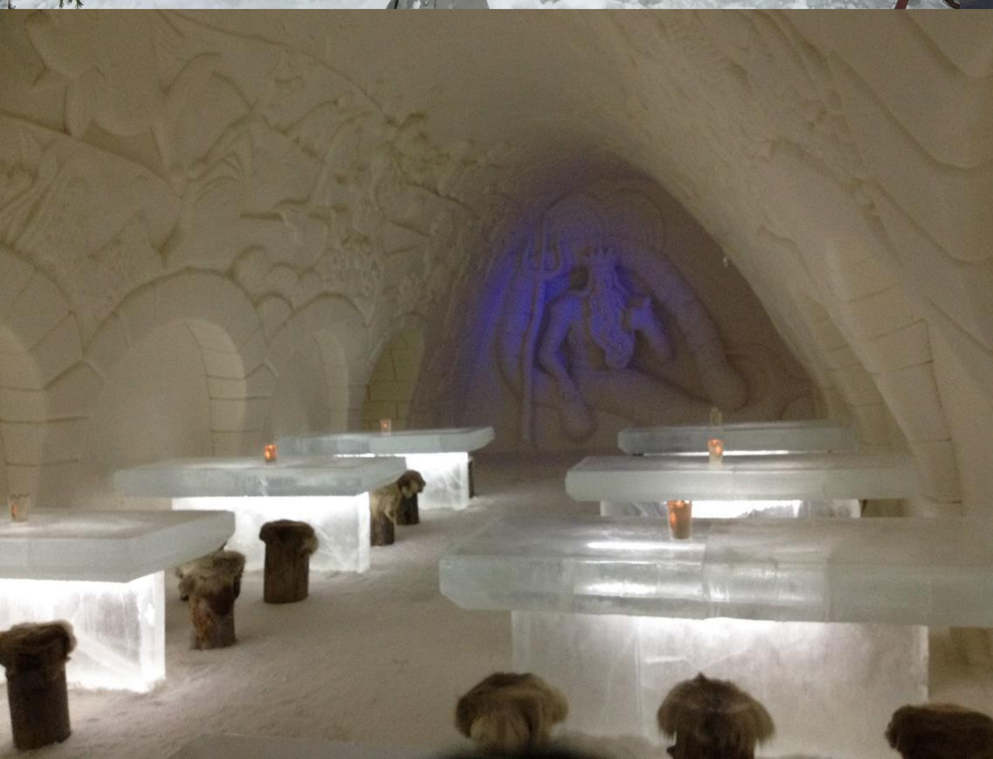
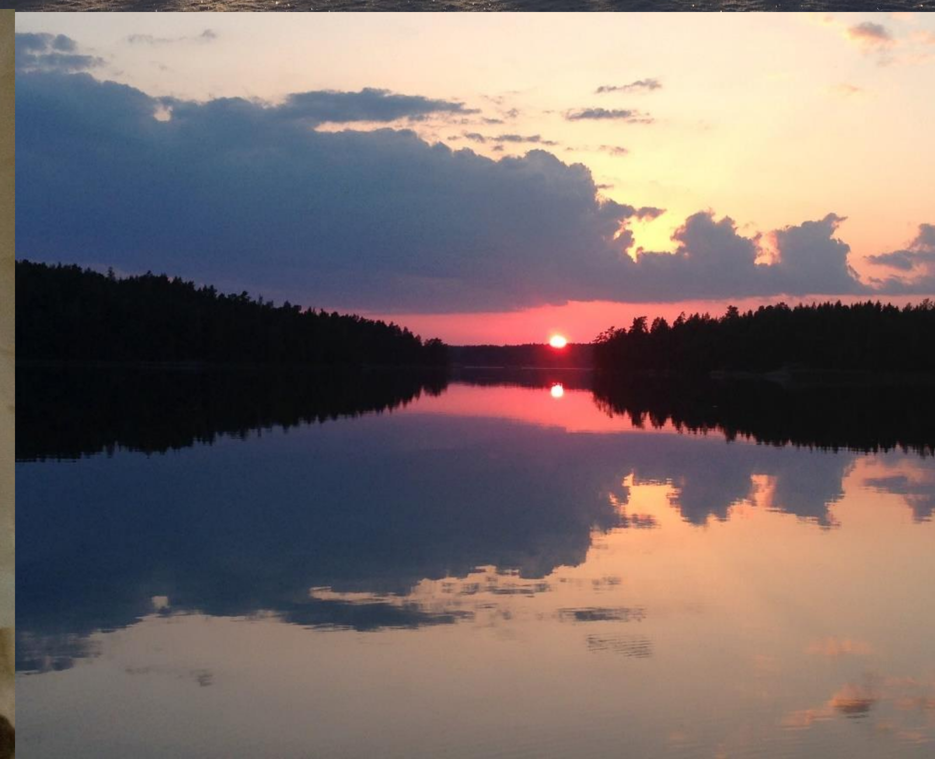
Student:

- **asks** research questions or define the aim
- **uses** a model and developes the model for the actual situation
- **plans and executes** the research
- **analyzes and interpretes** the data
- **uses** mathematic model or computational method to study the situation
- **creates** explanation of the actual phenomena
- **argues** based on his own data and based on existing knowledge
- **collects, evaluates and shares** information

Student:

- **define** research aim before or should be otherwise clear
- **uses** a model for the actual situation and analysis
- **plans and executes** the research (the same)
- **analyzes and interpretes** the data (the same)
- **uses** mathematic .. (not normally)
- **creates** explanation of the actual phenomena (the same)
- **argues** (no) instead analysing and discussing possible margins of errors
- **shares** information (**project report**)



Co-operation between teachers

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