Using outdoor physics activities and web-site support to stimulate inquiry-based learning in science teacher education in Sweden and Russia

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- **Petrozavodsk**

This is Umeå University

Inaugurated 1965

4,246 employees

28 football fields

28,000 students

1,400 postgraduate students

272 professorships

58 departments (equivalent)

24 centres

5 faculties

2,900 millions SEK in annual turnover 2004

Project background

Our previous research shows:

- Low students' motivation for study physics, it is perceived as difficult and boring subject (applied mathematics) with limited connection to everyday life.
- Teachers and teacher students have limited knowledge about and skills of teaching physics outdoors even if they value and like to be in nature/outdoors

Main action

- Development of inquiry-based methods of teaching physics based on practical students' activities outdoors supported by website with examples (cases) of such activities, interactive computer visualisations (ICVs) and use of personal technologies (PDAs)

Scientific inquiry

- inquiry refers to the work that scientists do when studying the natural world i.e. posing questions, gathering evidence and making explanations of natural phenomena.

Skills of scientific inquiry

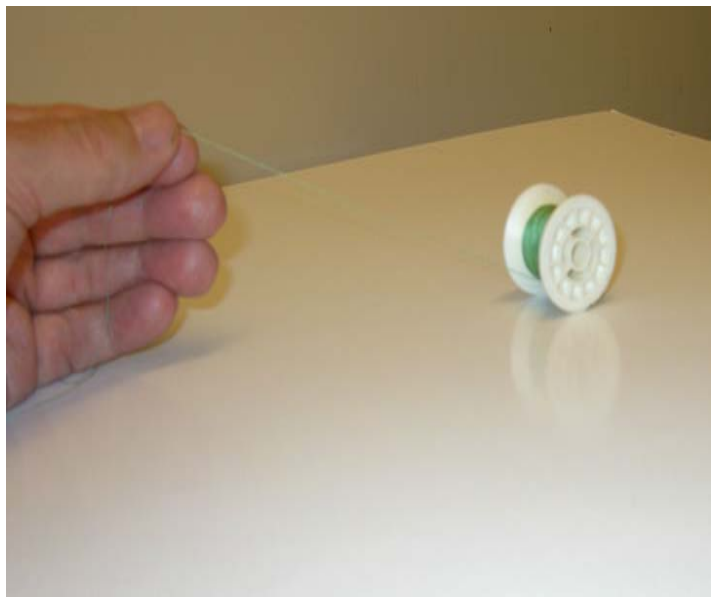
- Recognising scientifically investigable questions;
- Identifying evidence needed in a scientific investigation;
- Drawing up or evaluating conclusions;
- Communicating valid conclusions. *OECD (2003)*

Pedagogical methods

- Play and learn in the open air (PLOA)
- Predict - observe - control - explain (POCE)
- Prove through action and construction (PAC)
- Exploring Authentic Problems (EAP)

Pedagogical hypothesis:

Size does matter!



Place does matter!

Group work is must!

- Most of the activities is simply impossible to do alone.

Work outdoors provides for strong ‘Historical dimension’

Many discoveries in physics were done outdoors and could be easily reproduced:

- Eratosthenes – measurement the size of the Earth
- Gallieo – free fall law
- Pascal – demonstration of atmospheric pressure,
- Herschel – discovery of the infrared radiation

Principles for selection of cases:

- Relevance to the socio-cultural context
- Can be done **only** outdoors: launch a rocket, count snowflakes, make explosions, etc.
- Can be **more effectively** done outdoors: speed of water flow, ‘temperature wave’ in the soil.

Target group

- Teacher educators;
- Prospective primary and secondary science teachers;
- Science teachers;

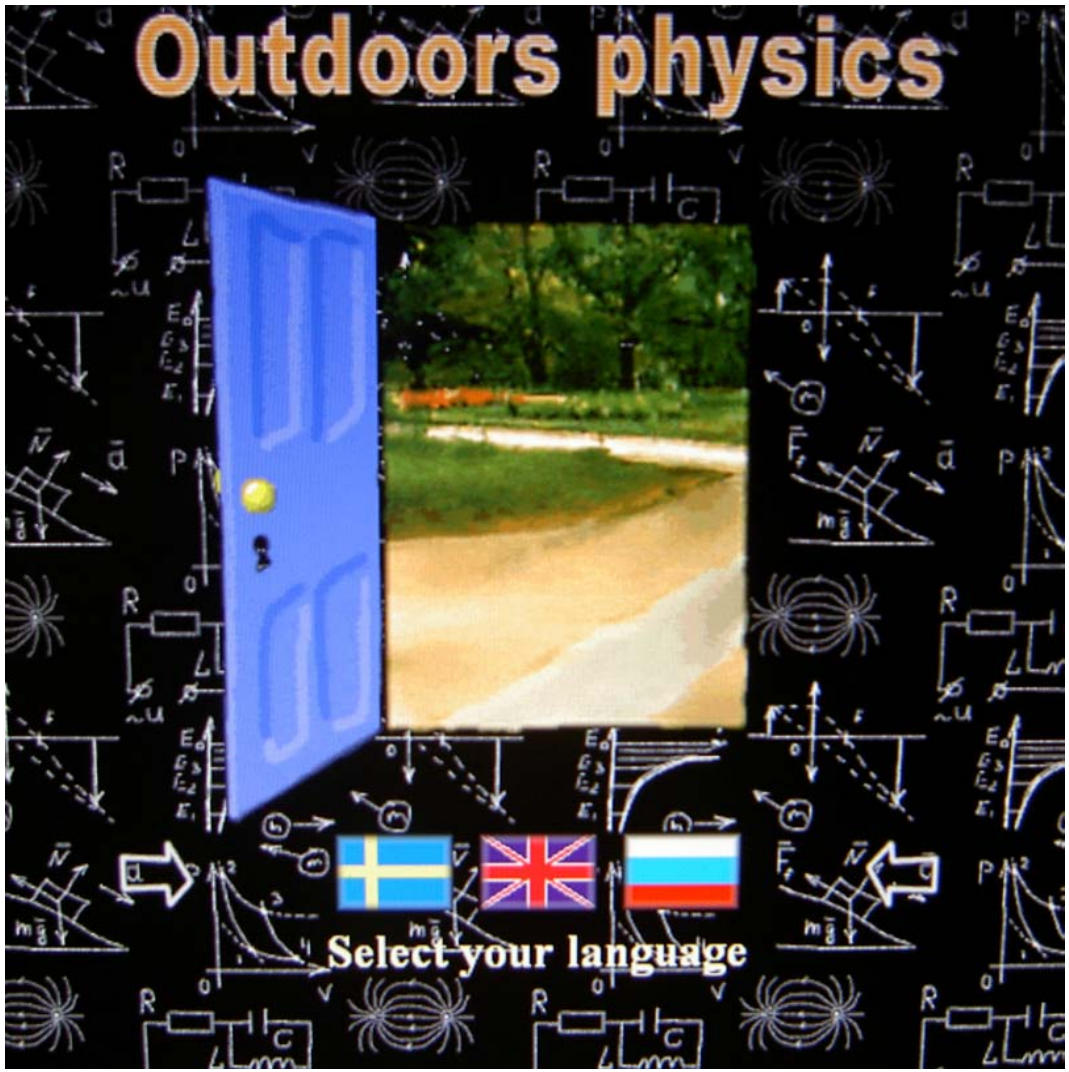
Outdoor activities in Umea University

- The prospective teachers work with physics activities outdoors in different forms and occasions, such as science course assignments, school practice, diploma/examination work and master courses.

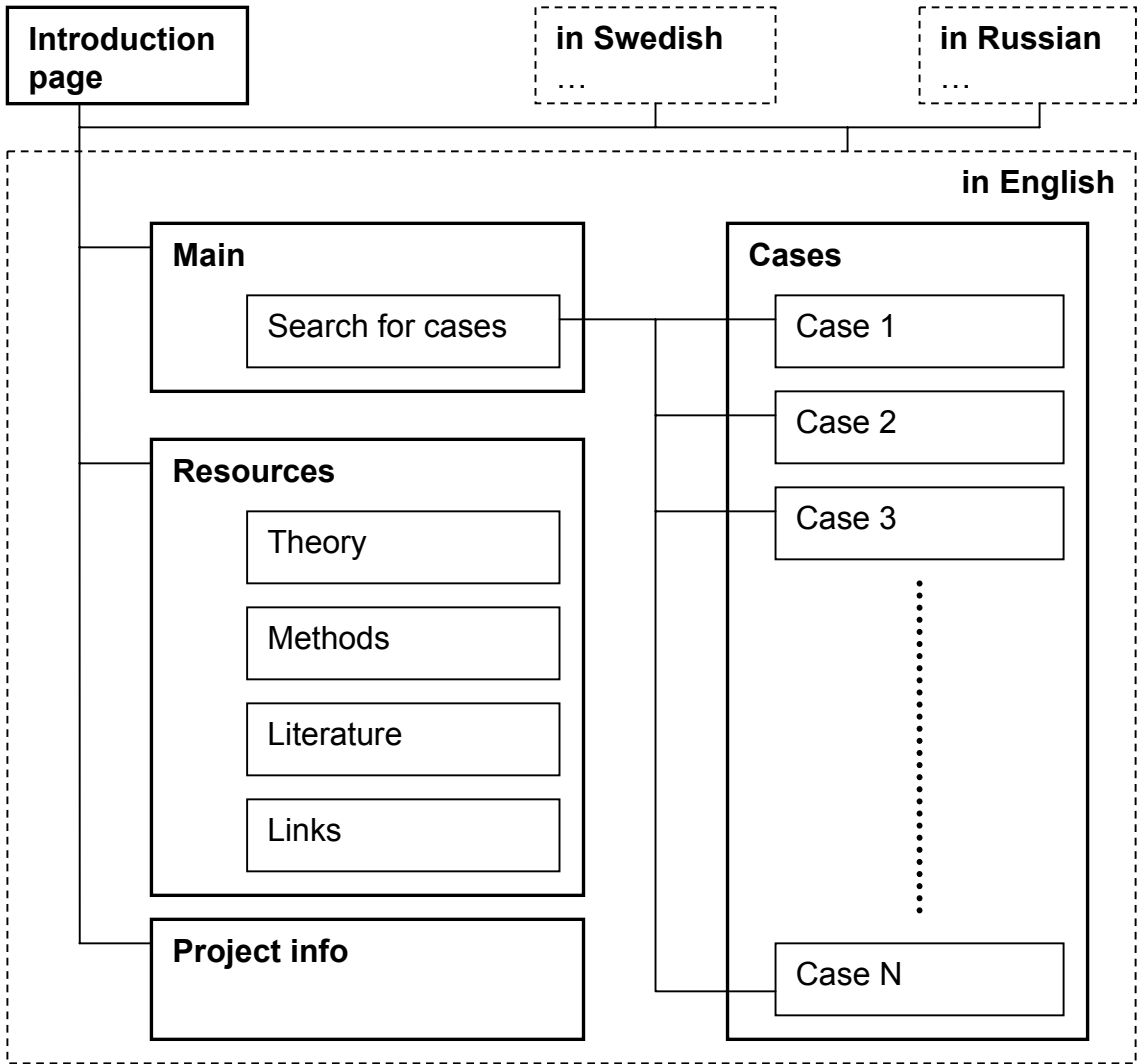
Outdoor activities in Russian Karelia

- Outdoors approach changed the design of the introductory physics course. It transform the curricular priorities from focus on strictly prescribed practical work towards more open inquiry work of forming general research skills and competencies.

Entrance – outdoors physics website



Structure of the website



Three levels of cases

Initial level

- Base on students' practical experiences of dealing with everyday problems without preliminary physics knowledge

Medium level

- Conceptual physics without or with very simple formulae like $v = s / t$. Work form is from guided to open inquiry.

High level

- Activities are more advanced and complex. Use of formulae is often required. Cases are based on creative problem solving, move takes place towards more open inquiry.

Interactive computer visualisations (ICVs)

- ICVs were used for illustration and analysis of observed phenomena and/or experiments conducted outdoors in order to make its physics more explicit and understandable

Pedagogical use of PDAs in teaching physics outdoors

- data logging tools (Flash Logger interface with a set of sensors) for data capture, to record, monitor and measure events and phenomena;
- spreadsheets and graphing tools for data handling and analysis of data drawn from practical activities and experiments;
- simulations and modeling tools, including animations and virtual environments;
- information resources, to search for and retrieve information and instructions.

Example:
Thermal properties of soil

Task:

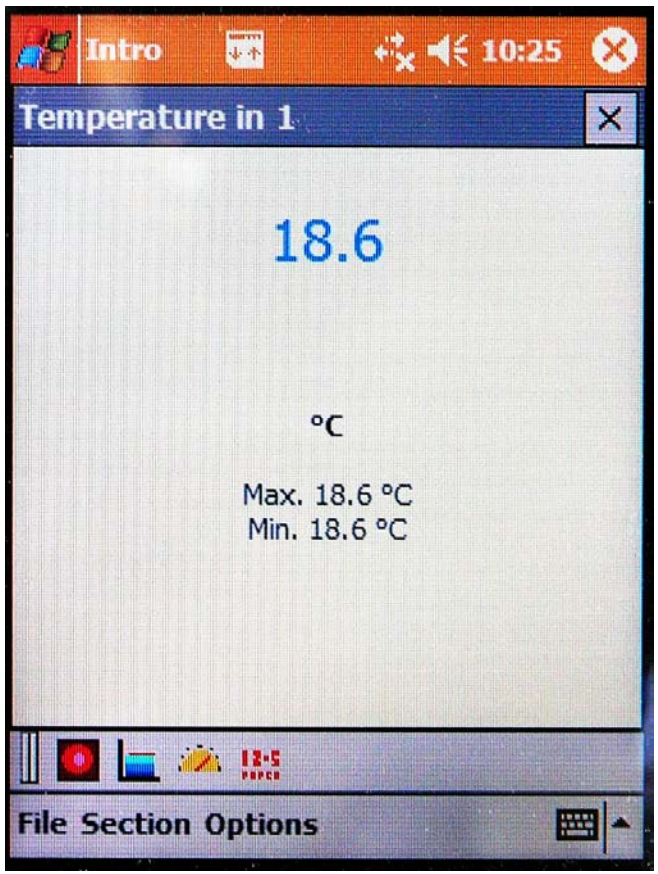
- Investigate how temperature changes with depth in the surface layer of soil.

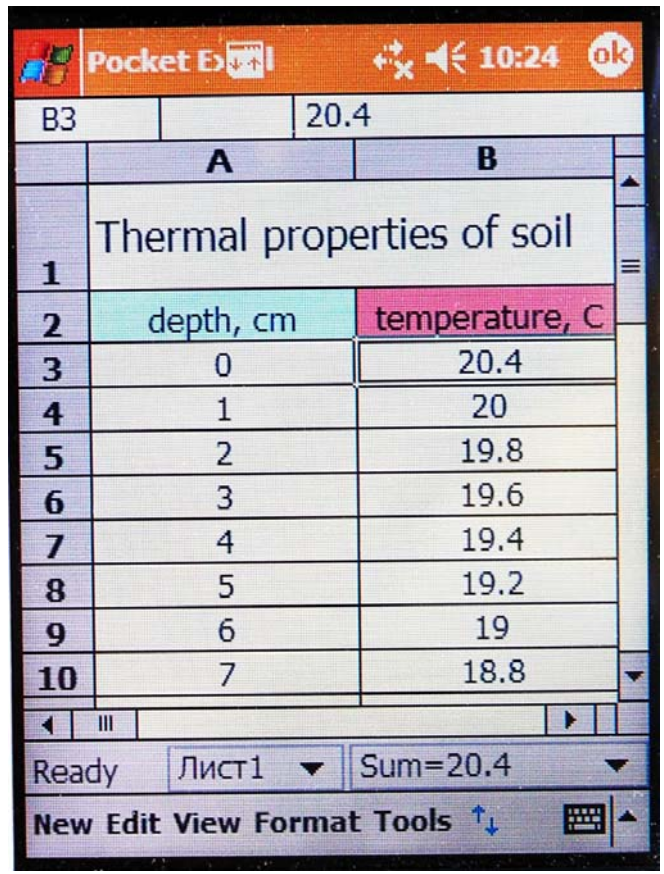
Actions:

- Collect and visualise data
- Analyse a computer simulation.

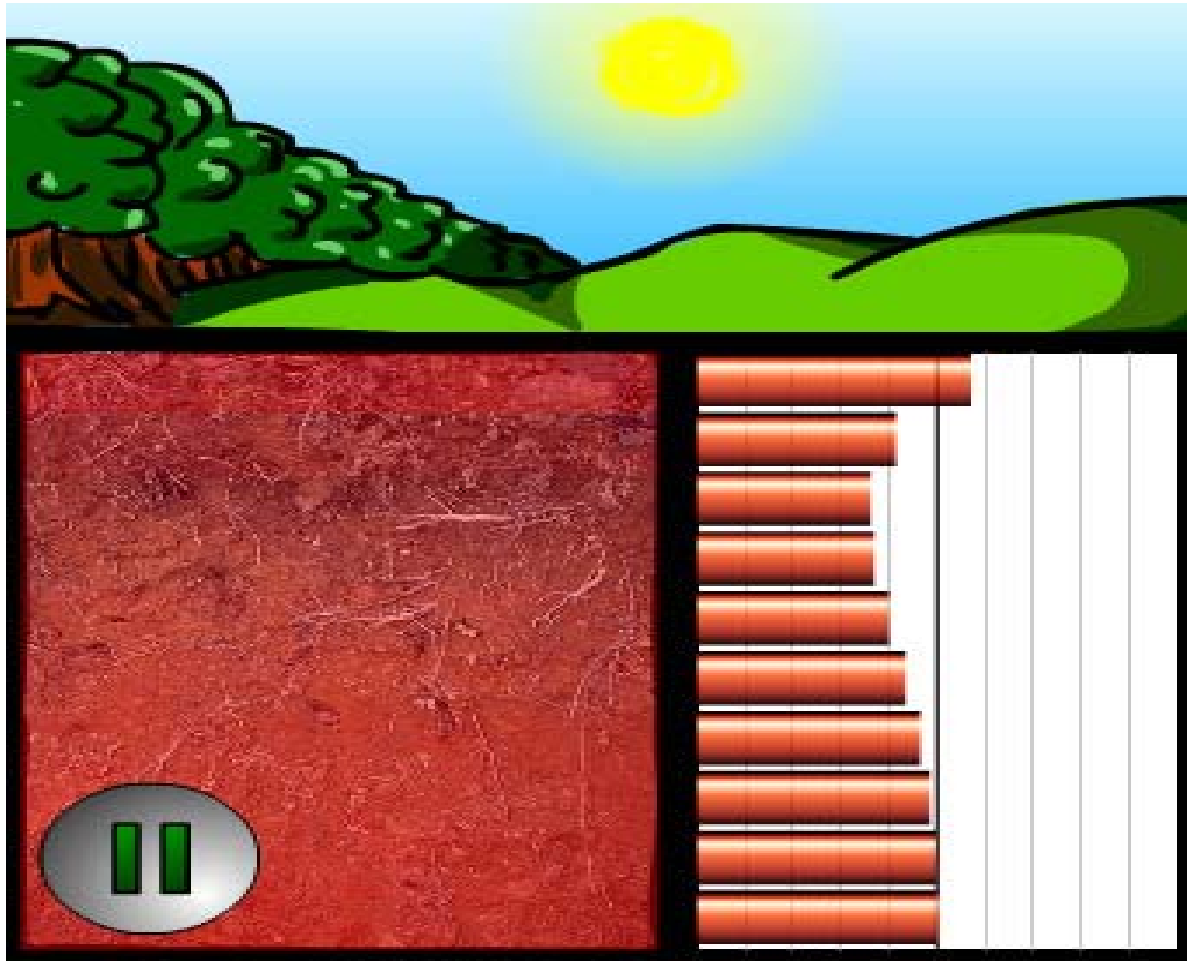
PDA with Flash Logger interface and temperature sensor

Collecting and registering data





Computer simulation



Pedagogical advantages of using PDAs

- PDAs can be easily taken to outdoors. They allow studying physical phenomena directly in the real life context.
- Students can make different measurements and data analysis directly “just-on-time and place” basis.
- Modeling capacity of PDA allows visualization of the complex phenomena to make it more transparent and understandable.
- Data logging with help of PDAs assures rigorous scientific quality of physics investigations even in the outdoors.

Discussion of outdoors

- Demand extra risk assessment
- Can take more time
- Not as comfortable as indoors
- Innovative work is always challenging and demands more “psychological energy”
- “weather could be better”
- Needs more administration effort

Conclusions

- Students show interest in inquiry based outdoor physics.
- They have possibility to acquire more confidence to teach physics.
- Interactive website and PDAs have powerful potential for physics learning.

Perspectives

- This work will be a part of European Comenius project called OutLab – “Outdoor Laboratory” for innovative Science Teacher Education.
- Cooperation in the “Outdoor physics” area continues with the Pedagogical University in the twin city of Umeå – Petrozavodsk – in the Russia Karelia