Modelling Instruction in Physics Education - online course for physics teachers

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Abstract:
We would like to present the online course called "Modeling Instruction in Physics Education", developed at the Online Learning Laboratory, Charles University Prague, Czech Republic. The online course is focused on the professional development of physics teachers, mainly at the secondary school level.
The presentation reflects our several years experience from face to face seminars for University students and In-service physics teachers and related ideas, which brought us to this solution.
The presented parts of the course, focused on Electricity and Magnetism, give teachers some basic ideas, examples of use (audio/video records, etc.) useful hints and methodological processes.
Some statistical data, sustainability and the main problems and obstacles for larger (and international) use will be discussed and partially compared to similar situation and activities offered to an analogous target group by different European and North American Universities.

1. Introduction to the Modelling Instruction:

Different physics teachers and physicists understand the concepts of Modelling and Modelling Instruction in different ways. In this paper we mainly draw on the *Modelling Theory of Physics Instruction,* the focus of educational research by **David Hestenes** and his collaborators since 1980. The new curriculum design and teaching methodology, based on the theory, is available on the so called modelling home page (http://modeling.asu.edu/). The projection of the modelling program to High Schools Physics (Modelling Instruction in High School Physics) and to University Physic teaching (Remodelling University Physics) is also published there.
The Modelling home page documents the success of the workshops and the enthusiastic response of the teachers, which has stimulated institutionalisation, and expansion of the program through increased involvement of university physics departments.

2. Modelling instruction - what is it?

Conventional instruction seems to be based on following assumption:
"Students have the same mental models the instructor does, to effectively interpret what they hear and see". (according to Stith James, H.: Inquiry Based Teaching and Learning: How effective? http://perlnet.umephy.maine.edu/oldperl/modelingWS/WW8.html). That is why the conventional instruction recommends us: Tell the students as much as you can. Show the students as much as you can.
The modelling method on the other hand represents different views (according Stith, J.H. and Hestenes, D.):

- Physics is coherent / as opposed to the view that physics consists of a set of loosely related concepts and problems.
- Learning occurs through actively seeking understanding /As opposed to the view that learning consists of taking notes, listening to the teacher or memorizing facts and formulas, what happens more frequently, then we suppose.

The Hestenes team and professor Hestenes himself are focused primarily on mechanics (see the Force Concept Inventory and other tools).
There is a very little materials about electricity and magnetism on the web, except of Conceptual Survey of Electricity and Magnetism (CSEM) developed by the authors Maloney, O'Kuma and others, (see http://tycphysics.org/CSEM_5_2.htm).

3. "Modelling Instruction in Electricity and Magnetism" course - our own experience

Inspired by this we decided to implement (at least the basic ideas to our course) the course Electricity and Magnetism for future teachers in the second semester.
We applied the following:

Classroom equipment and arrangement of students:

- Quite small student groups (up to 12) divide into sub-groups of three, based on their own decision (some recommendation from teacher´ s side allowed)
- Non formal room equipped with at least one computer connected to the Internet and equipped with MBL system (for proving hypotheses, making numerical calculation, etc.), LCD projector
- Whiteboards and markers for each group

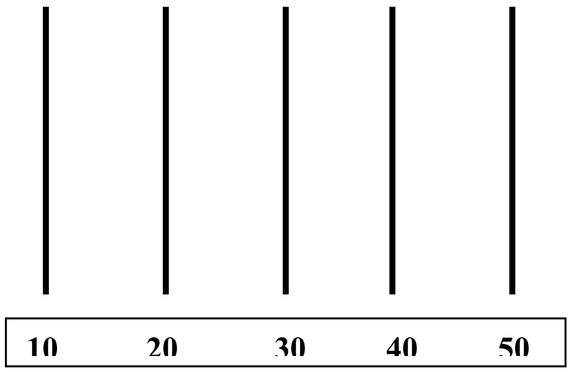
Teachers approach:

- Students-centred, comparing to the traditional one, which is more teacher-centred.
- Students are active during the whole class
- Emphasis on cognitive skills development more than on knowledge transfer (we combined traditional lectures with seminars based on modelling approach)
- Students construct and evaluate arguments instead of looking for the right answer
- Teacher is not the main authority (more a guide), for evaluation of different hypotheses we use experiment (if possible), MBL, or numeric calculations on PC

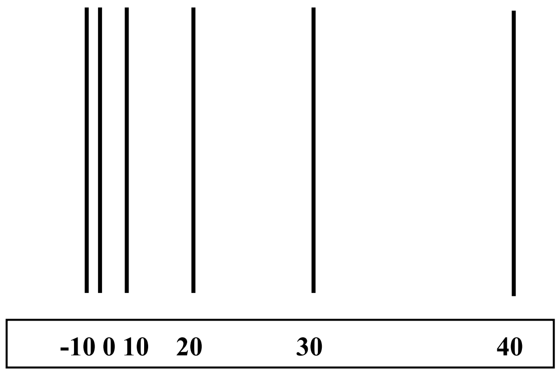
Selected problems to be solved (examples):

1/ The electric field is described in the following way:

1a



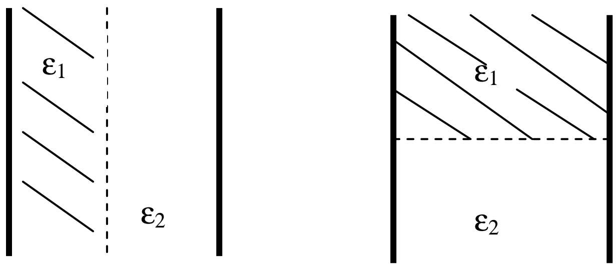
1b



Try to add vectors of electric intensity/force to all equipotential levels.
Try to describe in a graphic way (e.g. bar chart) the energy of this field

2/

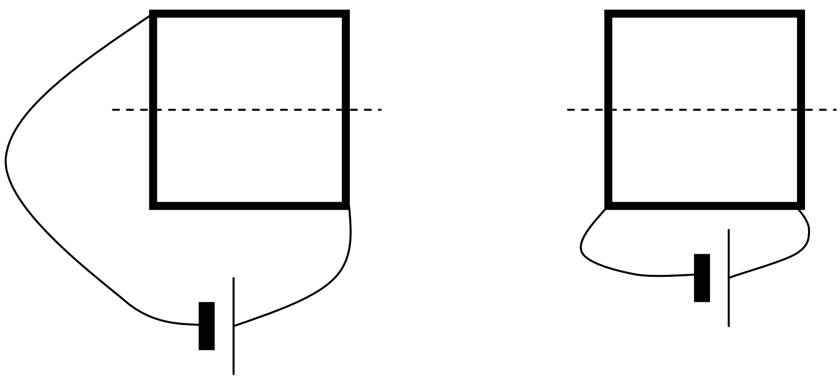
Two identical capacitors are filled in with two different dielectrics (relative permitivity ε_1 and ε_2) as shown on the following graphs.



Represent in a graphic way the potential in both capacitors, the vectors of electric intensity and discuss the charge on the place of contact of the two dielectrics.
Later we discussed the parallel and serious connection of capacitors and connected problems.

3/

Two identical wire squares are connected to voltage in the following way.



Find the vector of magnetic induction in the centre of the squares and on the axes. Discuss both different situations.

4. The online course on Modelling Instruction in Physics

For the next semester we have prepared an online course, focused on modelling instruction in physics education and aimed at the professional development of physics teachers, especially university teachers.
The short example from the supportive environment (course materials) on server Telmae (http://telmae.karlov.mff.cuni.cz) you can see on the following:

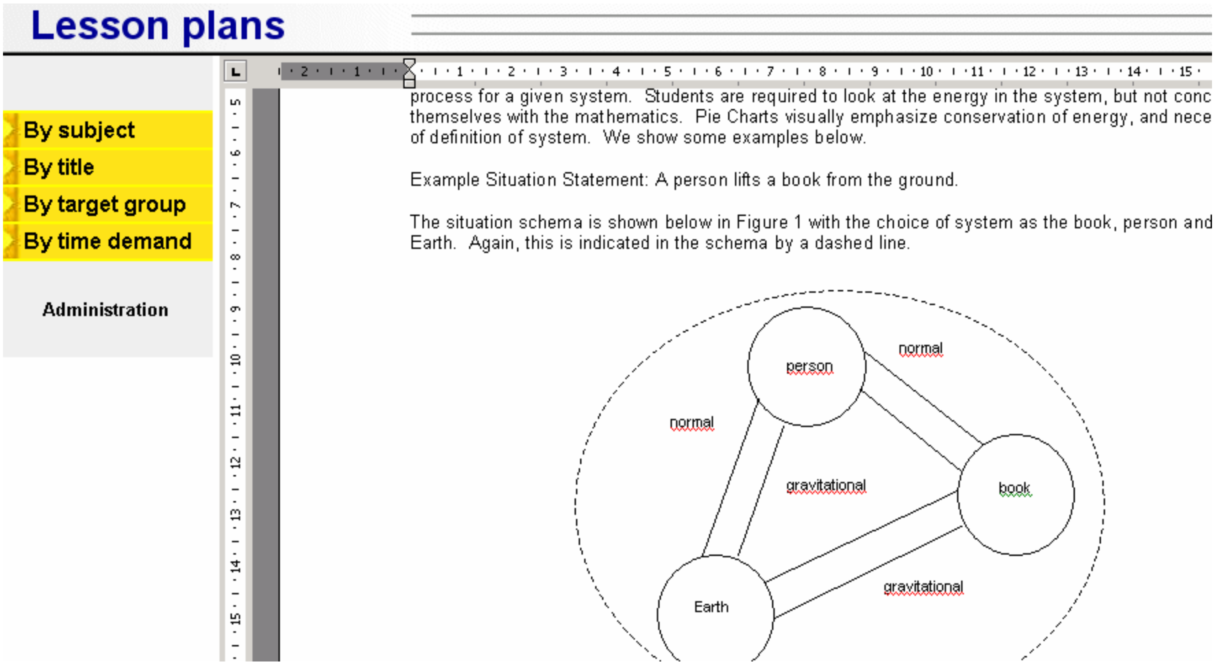


Fig 1. An example of the readings from the online course Modelling Instruction in Physics.

The author of all course readings is prof. Michael Politano, Marquette University, Milwaukee, Wisconsin, the co-operator of prof. Hestenes from ASU University, Phoenix, Arizona, USA.

References:

Stith James, H.: Inquiry Based Teaching and Learning: How effective?
http://perlnet.umephy.maine.edu/oldperl/modelingWS/WW8.html