Data logging and remote data logging for science and technology classrooms

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Abstract

The paper presents activities and hands-on experience of the teacher training materials developed by the ICT for IST Project. The project involves a partnership of six universities in the EU and is funded within the Leonardo da Vinci programme of the Life Long Learning Programme of the European Commission. The project builds upon and expands the resources previously developed by the Information Technology for Understanding Science (IT for US) Project. The newly developed resource pack for teachers and teacher trainers includes a series of modules and streaming videos, containing classroom activities illustrating how on site data-logging, remote laboratory data-logging, modelling and video measurement in science teaching facilitate the type of thinking and discussion which leads to better 1/conceptual understanding, 2/social skills (including team work and networking) and 3/professional skills. Each module/video focuses on a single science topic and includes teachers' notes that support the implementation of the activities. They also include commentaries intended to develop teachers' pedagogical understanding of the new methods using ICT to investigate phenomena. The project resource pack is now evaluated (using multicriterial evaluation/SIM method) by teacher trainers and teachers in the Czech Republic, Austria, Poland, Cyprus, UK and Netherlands.

1 Introduction

1.1 Teaching and Learning Paradigm Shift

Contemporary problems in science education are closely connected to a general teaching and learning paradigm shift, which has become necessary in the few last years as a result of the reality of the globalized world together with the information revolution and ongoing knowledge society needs.
According to Derrick (2002), some general features can be recognized in this movement. Among them, the following seems to be the most important for science education:
A focus on uncertain (not exactly defined) situations
Much of the academic environment today, presents students with ready-made problems, but the reality is rarely that clearly defined. Today’s learners and teachers have to be more familiar and comfortable with uncertain situations.
A focus on conceptual understanding
Conceptual understanding is the ability to apply knowledge across a variety of instances or circumstances. Several strategies can be used to teach and assess concepts, e.g., inquiry, exposition, analogies, mnemonics, imagery, concept maps, and concept questions.
Uses a holistic, as opposed to discrete, approach
Much of the education and learning environment today is still divided into rigid academic disciplines, focused on discrete units of research. However, the holistic understanding of systems thinking and inter-disciplinary research approaches are seen as critical to achieving a more comprehensive understanding of the complex reality currently facing the world system.
Team work and virtual teams around the world

There are many arguments that collaborative learning (also computer-supported or mediated) enhances "team performance through tools for communicating each person's ideas, structuring group dialogue and decision making, recording the rationales for choices, and facilitating collective activities." (Derrick, 2002) Closely related to this point is the need for enhanced virtual and networked activity.

Blur the difference between mental and physical labour

The global system of production and distribution is based upon the blurring of the distinctions between mental and physical labour and the increase in the application of knowledge to the production process itself (Derrick, 2002). This change is so significant that it represents a fundamental shift for much of the world, and it is necessary to respect it in underlying teaching and learning strategies.

1.2 Contemporary problems in science teaching and learning

The general teaching and learning paradigm shift mentioned above is not yet reflected in contemporary teaching methods at many traditional teaching and learning environments.

Over the past couple of decades, science education researchers have studied the effectiveness of existing teaching and learning practices: conceptual understanding, transfer of information and ideas, beliefs about science and problem solving in science.

2.The role of laboratories in science education

There is no doubt, that in scientific education and mainly in the cognition of the real world, the lab - based activities play the most important role.

Nowadays laboratories 1/simulated labs (also called virtual labs), 2/ remote labs, and 3/computer mediated hands-on labs, generally called e-labs, offer a large variety of new techniques, learning environments and tools, reaching from project labs, modeling tools, interactive screen experiments, remotely controlled labs, etc. It is plausible to adopt the statement that these kinds of e-labs will be the typical learning environment for science students in the future.

2.1 Research results

Although there is still a lack of criteria for the evaluation of the effectiveness of the three new types of labs, the results of the comparative literature study (Ma, Nickerson, [6]), including more then 60 research studies, are very instructive. Ma and Nickerson discussed mainly 1/ Design skills 2/Conceptual understanding 3/Social skills (including team work and networking) 4/Professional skills.

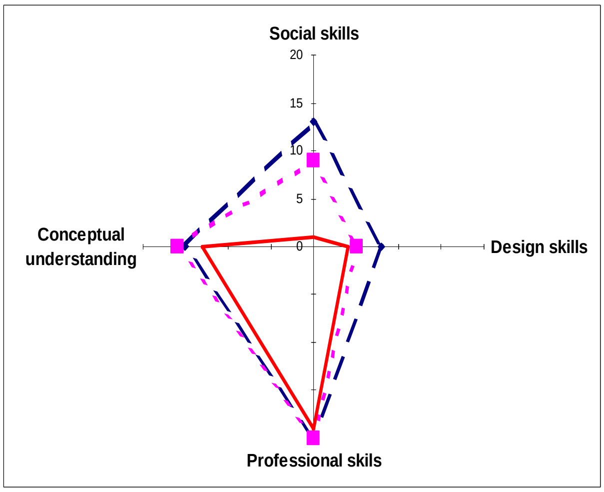

Fig.1: The educational goals of nowadays labs a/remote (solid) b/virtual (dotted) c/computer based hands on (dashed) - Ma, Nickerson 2006

In our research, based on both, qualitative and quantitative research methods, we focused on aspects, defined by AAPT (1977). We discussed mainly professional skills, including 1/ inquiry planning, 2/

design skills and 3/data processing and then also on 4/ conceptual understanding and 5/ social skills (including team work and networking).

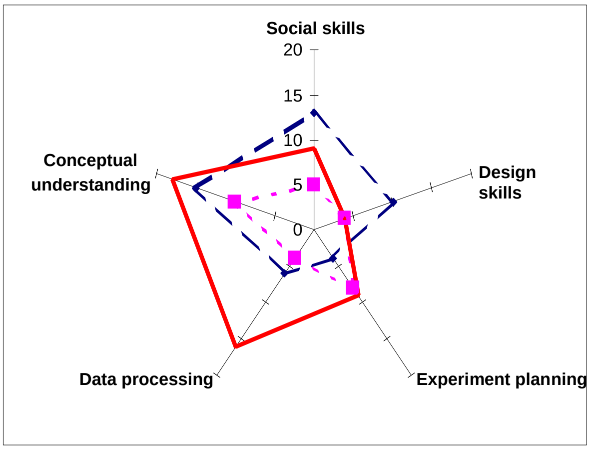

Fig.2 : The educational goals of nowadays labs a/remote (solid) b/virtual (dotted) c/computer based hands on labs (dashed)- Lustigova 2010

2.1.1 Remote laboratories

We found students in remote laboratories improved a lot their data processing skills and thanks to fastening of graphical visualization and to great potential of remote labs to recollect data and rerun experiment under many different settings (parameters changes), they also improved their conceptual understanding.
The students' data processing skills improved the most. Working on their own computers, not disrupted by co-workers and unknown laboratory landscape, they focused on the problem and reached significantly better results.

2.1.2 Hands on laboratories

The work in computer based hands on laboratories helped students to improve mainly their design skills and also teamwork and social skills. They really appreciated the help of coworkers during the experiment setup and also within data processing activities (what brought some negative connotations, mentioned later)
Comparing to remote laboratories, they did not improve their data processing skills as much as we expected. The interviews revealed, that those less skilled relayed on coworkers. Thus they did not improve their data processing skills at all. Also „average" team improvement was assessed as very low.

2.1.3 Virtual laboratories

Although physicists do not take it positively, virtual (or simulated) laboratories are often used by many teachers as an alternative to traditional hands on laboratories. The reasons are mainly economical and spatial. Also the comfort, they offer to both, students and teachers, play an important role. Our research results confirmed our awareness, those virtual labs, in a way they are offered to students do not have strong impact on students learning outcomes.
Students or overestimated (undergraduates) or underestimated validity and reliability of data, they obtained. Together with Corter, Nickerson, Esche at al in their study (2007) we agree that although simulations have been widely adopted in education, many if not most educators feel that they lack some important pedagogical characteristics.

3.Reflection in ICT for IST project

The above mentioned research results were reflected in designing, piloting and presenting teacher training activities, developed by the scientific team of ICT for IST European project. The project builds upon and expands the resources previously developed by the Information Technology for Understanding Science (IT for US) Project.
The newly developed resource pack for teachers and teacher trainers includes a series of modules and streaming videos, containing classroom activities and illustrating how on site data-logging in computer based hands on laboratories, remote laboratory data-logging, modeling (in virtual labs) and video measurement in science teaching facilitate the type of thinking and discussion which leads to better conceptual understanding and promoting better social and professional skills.

3.1 New e-learning strategy

This newly offered e-learning strategy in science education is actually copied from the method that sciences use in their cognitive work. It is based on the observations of phenomena in the real world, together with data logging, then the processing and interpretation of ensuing data and their presentation, and the effective search for relevant information and effective ways of classification and storing. Teachers are not bound by strict rules of the teaching unit; some unveiled problems are proposed to students for their own independent and project work.The learning process itself is based on the active participation of students, whose involvement is strengthened by dynamical simulations of the real phenomena, co-operative teamwork (both real and virtual), public presentations and the defense of achieved results, all either in real presence or in telepresence.

3.2 Multicriterial evaluation

The project resource pack is now evaluated (using multicriterial evaluation/SIM method) by teacher trainers and teachers in the Czech Republic, Austria, Poland, Cyprus, UK and Netherlands.

4.Acknowledgement

Project “Information and Communication Technologies for Innovative Science Teachers” (ICT for IST) is funded within the Leonardo da Vinci programme of the Life Long Learning Programme of the European Commission. The project involves a partnership of six universities in the Czech Republic, Austria, Poland, Cyprus, UK and Netherlands. More information and the project resource pack is available on http://ictforist.oeiizk.waw.pl/

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