

Microcomputer-based laboratory (MBL) in chemistry teaching

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Microcomputer-based laboratory (MBL) or computer assisted generation and manipulation of data, can be exploited widely in practical work. This article goes through aims set for practical work, and ideas in exploiting microcomputer-based laboratory equipment especially in inquiry-based work are offered.

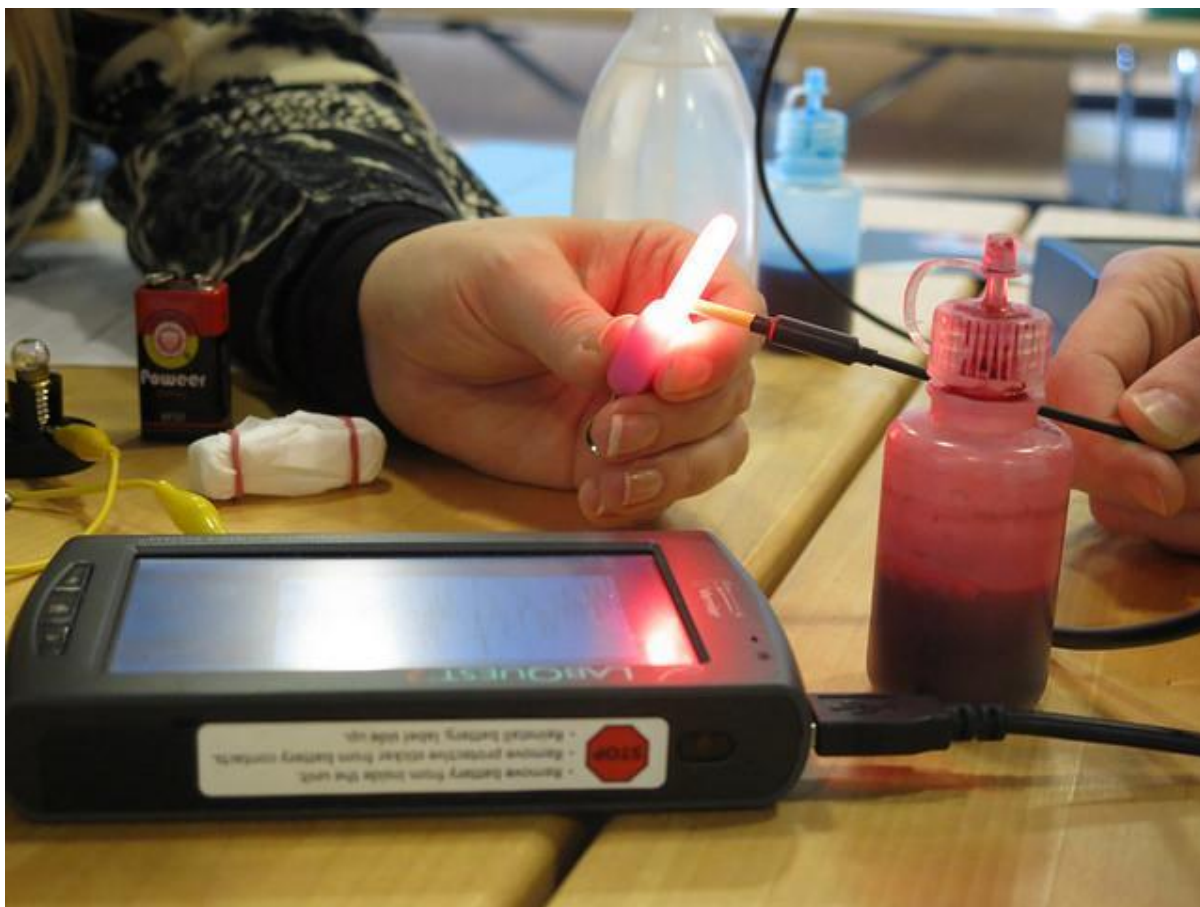
Practical work has been thought of as an important part of chemistry teaching for a long time, even though reasons for its favoring have varied during decades. The meaning of practical work in the classroom started to emphasize in the 1950s, when scientific process was raised as the model for arranging school teaching. The idea was that because researchers find new information by doing scientific experiments, it would be possible to learn concepts on natural sciences also in school by “discovering” them from the observations of practical work. In the 1980s and 1990s, the above presented model of scientific process was thought to present a much too straightforward and empiristical view on the nature of scientific research. At the same time, the idea of the scientific process being suitable model for practical work in schools was discarded. Instead, more versatile approaches towards practical work were promoted. The aim was that students would exploit both the data generated during the practical work and their previous knowledge while solving inquiry problems. (Hofstein & Kind, 2012).

In the 21st century, the science education researchers and the policy makers have set new aim for practical work: strengthening a student’s citizenship skills. The idea is that the duty of the school is to offer a student the readiness to participate in social actions. Against this aim, it is important that a student learns to understand how scientific information is produced. The ability to evaluate scientific claims is a part of citizenship skills (Hofstein & Kind, 2012). Among the traditional work that illustrates phenomena and aims at motivating the student, inquiry-based action that develops science process skills and the handling of information is needed. One useful tool for a teacher, who is thinking of using new kind of practical work, is microcomputer-based laboratory equipment.

Microcomputer-based laboratory equipment supporting practical work

Microcomputer-based laboratory equipment means electrical sensors and software, with which it is possible to generate data for example to computers, calculators or to mobile phones (Picture 1). Software that are intended to be used with microcomputer-based laboratory equipment, also help in handling and visualization of generated data. The most common sensor used in microcomputer-based laboratory equipment is possibly a pH sensor or a digital thermometer. Microcomputer-based laboratory equipment technology is suitable for supporting practical work, regardless of the targets set for practical work, as well as other tools

in a school laboratory. Often microcomputer-based laboratory equipment is recommended especially as a tool for inquiry-based work (e.g. Aksela, 2011; Tortosa, 2012).



Picture 1. An example of a sensor and a software of a microcomputer-based laboratory equipment device (Picture: University of Helsinki's LUMA Centre).

In inquiry-based activity, microcomputer-based laboratory equipment assisted practical work is just a part of a broader learning process. For example Aksela (2011, 2005) has observed a teaching cycle that exploits microcomputer-based laboratory equipment, peer teaching and mind map technology, to support the learning of concepts in chemistry, methods and higher-levels of thinking. Microcomputer-based laboratory equipment can be of use to us in more general practical work. It makes for example the observation of invisible phenomena, the quick repetition of measurements and fast manipulation of data and sharing of data possible. As in all teaching, in order to support microcomputer-based laboratory equipment, applicable pedagogy is always needed (for example Lavonen, Aksela, Juuti, & Meisalo, 2003; Nakhleh, 1994; Newton, 2000).

In the COMBLAB project, the aim was to support teachers of natural sciences in using inquiry-based activities and computer assisted production and handling of data. The Unit of Chemistry Teacher Education took part in an international project, held in 2012-2014. In this EU-funded project, new inquiry-based work was developed into teaching of chemistry, physics and

biology. Microcomputer-based laboratory equipment was used in the practical work parts of these activities. During the activities that were developed in the project, the students plan, carry out and report a small scale research with which they would be able to answer to the research problem given by the teacher. The role of microcomputer-based laboratory equipment in these activities is to offer a tool for collecting data and manipulation and as well to speed up the accomplishment of a practical work (see also Tolvanen & Aksela, 2014).

Using microcomputer-based laboratory equipment in chemistry teaching, demands support both to the teacher and a student. According to a questionnaire from 2008, almost half of the Finnish teachers would like to have further education on the using of microcomputer-based laboratory equipment (Aksela & Karjalainen). There is a want to use technology in teaching, but schools lack the necessary tools (Helppolainen & Aksela, 2015). A part of Finnish chemistry teachers would like to have more support on the incorporation of technology and teaching contents (Helppolainen & Aksela, 2015). Practical work demands as well the mastering of science process skills and the ability to teach these skills (Tolvanen, Aksela, Guitart & Urban-Woldron, 2014).

Using new technology can be challenging to the student as well, especially if they have to use it for the first time as a part of practical work that is anyway challenging. In the COMBLAB activities, the aim was to answer to this problem by including a practice phase, where students could be introduced to using devices and to the interpretation of graphs, while at the same time revising previously learned content. For example, the using of a pH sensor was practiced by creating a real time figure of the way pH changed when acid or base was added to water. Only after this, the students started working with the actual activity, where they had to research the differences between medicines for heartburn.

The aim of this article is to encourage all chemistry teachers to exploit microcomputer-based laboratory equipment as support for practical works. Inquiry and including new technology in teaching takes up time and energy at first, but for example the COMBLAB works offer good support for planning new activities. The activities developed in the COMBLAB project are freely available: <http://www.comblab.eu/en>

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