

New Perspectives for Learning - Briefing Paper 4

Labwork in Science Education

Context of the Research

Within the broader issue of motivating young people to study science is the issue of the cost of practical activities in laboratories. Experiments through “labwork”, as science teachers know it, tend to be an expensive component of science education across Europe. It is also felt that labwork is not used effectively within the classroom.

This project based on seven European countries - Denmark, France, Germany, England, Greece, Italy and Spain - focused on the use of labwork in teaching biology, chemistry and physics - to students in academic science streams, in the years of upper secondary schooling and the first two years of undergraduate study. It examined the effectiveness of labwork and developed approaches designed to promote more effective teaching and learning outcomes.

This has resulted in twenty-three “labwork” case-studies from five European countries - where the teaching device is carefully chosen based on clear objectives and underlying principles. The case studies contain: -

- In-depth analyses of students’ thinking during standard labwork with the aim of improving the process of modelling.
- Observation of open-ended projects.
- Labwork sessions focused on unusual objectives like data handling, epistemological objectives and students using their own initiative.
- A comparison of labwork with and without computers, in order to emphasise the process of modelling.

Key Conclusions

The following conclusions were drawn: -

1. It was observed that there is considerable diversity in the organisation of science teaching in terms of: -
 - a) Whether science subjects are optional or compulsory.
 - b) The extent and nature of central control of the upper secondary science curriculum in terms of time allocations and assessment structures.

2. Although use of demonstrations by teachers in academic streams of upper secondary students is common in all countries, the amount of labwork does vary in the following ways: -
 - a) Regularly performed by upper secondary students. (Denmark, UK and France).
 - b) Depends on the wishes of individual teachers (Germany).
 - c) Rarely performed (in Italy in specific schools and in Greece only at university level).
3. At university level, labwork is commonly used in all countries and for all disciplines.
4. However, the objectives of labwork tend to be limited and lack variety, often only focusing on specific concepts.
5. Despite many teachers' wishes, open-ended project work is rarely practiced. The most frequent type of labwork tends to be in small groups of students working with real objects/materials following very precise instructions about methods and analysis given by a teacher or a written source (referred to as a 'labwork sheet').
6. This also results in labwork being mainly assessed by grading reports according to the quality of the students' descriptions of the way in which tasks were performed, data acquisition, discussion of the quality of data and interpretation of experimental results.
7. At upper secondary school, the students normally have to use standard procedures, to measure, and to report observations directly. They do not have to present or display or make objects, nor explore relationships between objects, to test predictions or to select between two or more explanations.
8. Even at university, it is rare for students to have to test a prediction made from a guess or a theory or to account for observations in terms of a law or theory, although sometimes in physics, students are asked to test a prediction made from a law.
9. The similarities both between disciplines and countries in terms of typical labwork is more than might be expected, given the differences in educational systems in each country.
10. From a survey carried out in all the countries, teachers considered the main objective of labwork as being able to "link theory to practice", with the objectives of "learning experimental skills" and "getting to know the methods of scientific thinking" also being rated. Experiments carried out by the students were seen as overwhelmingly useful for promoting all learning objectives of labwork.

11. However, based upon another survey directed at both teachers and students it was concluded that a positive attitude towards science is rarely promoted with labwork generally failing to address important scientific questions like how to: -
 - a) Recognise the validity of results.
 - b) Design an experiment.
 - c) Choose the relevant method to process data.

Key Recommendations

Specific recommendations from this study are:

1. Labwork should address a broader range of learning objectives than the range currently addressed. In particular, labwork rarely addresses epistemological objectives and teachers rarely make these objectives explicit when designing labwork activities, sequences of labwork or labwork sheets. Similarly, conceptual objectives, procedures to be learnt, data collection and processing are generally left implicit in the design of labwork.
2. Labwork should be better designed with more specific targets aimed at meeting clearly defined learning objectives. There should be fewer objectives for each labwork session and a more coherent overall organisation of labwork, which should lead to improvements in student learning.
3. There is a need to improve the design of assessment along side the design of more effective targeted labwork.
4. Improvements to labwork practices need to be addressed at teacher education level. In particular, teachers should be trained to identify effectiveness by better understanding of: -
 - a) What is learnt
 - b) What processes consciously go on in students' minds, when putting into operation procedures and methods as well as developing models and theories.

This should lead to an improved image of science and a better motivation for it.
5. Collaboration between researchers, teachers and policy-makers should be one of the key aims of research in Science Education in Europe over the next few years.

Further Information

Full title of study - "Improving Science Education: issues and research on innovative empirical and computer-based approaches to labwork in Europe" (April 1998).

[Full report](#), [Abstract](#), [Summary Partner details](#)

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