Per Högström, 2009:
Lab work in secondary school science: teachers' objectives and how these are implemented

Department of Mathematics Technology and Science Education, Umeå University, Sweden. Studies in Science and Technology Education 28.

Abstract
Laboratory work is considered important for student achievements in science education. This thesis will contribute with increased knowledge about lab work in science education in Swedish secondary school. The main purposes are to describe secondary school science teachers' objectives for lab work and to describe how these objectives are implemented during laboratory exercises. The thesis shows and discusses, from a teacher perspective, the complexity involved in lab work.

The thesis is comprised of four papers based on empirical analysis of teacher interviews, laboratory manuals and laboratory exercises. Two interview studies identified which objectives the teachers consider important and compared these to international studies. Two case studies identified how the teachers' objectives are put forward during lab work and what factors are important for the implementation of objectives.

The results from the interview studies show that Swedish secondary school science teachers express general objectives including the development of students' understanding of concepts and phenomena, of their interest in science and ability to think and reflect upon lab work. This is to a large extent in accordance with objectives identified in international studies. However, when the teachers describe specific laboratory exercises they emphasize the activity and the laboratory skills. Some of the teachers describe lab work that includes scientific inquiry but not specifically, knowledge about the nature of science. Scientific inquiry was mostly used to develop interest in science and not to develop knowledge about how to systematically investigate phenomena in nature. The teachers express their objectives differently in different contexts. The laboratory manuals mostly put forward objectives to help students identify objects and phenomena and to learn facts, which is not always in accordance with the teachers objectives. Results from the case studies show that the teachers' objectives do not always correspond to the students' views of important things to learn. It is not obvious that lab work in itself makes students understand a certain scientific content, they need help to "see what is intended to be seen". Interactions between the teacher and the students are important to help students perceive the teacher's objectives. Many interactions have a starting point in the laboratory manuals, and if the objectives in the manual correspond to the teacher's objectives it makes it easier for both the students and the teacher to reach the intentions for the laboratory exercise. Implications for science teaching are discussed.

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Marianne Foss Mortensen, 2010:
Exhibit Engineering: A new research perspective.

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Abstract
Science museums define the objectives of their exhibitions in terms of visitor learning outcomes. Yet, exhibit designers lack theoretical and empirical research findings on which to base the creation of such educational environments. Here, this shortcoming is addressed through the development of tools and processes to guide the design of educational science exhibits. The guiding paradigm for this development is design based research, which is characterised by an iterative cycle of design, enactment, and analysis. In the design phase, an educational intervention is planned and carried out based on a hypothesised learning process and the means of supporting it. In the enactment phase, the educational intervention is implemented (i.e. the planned lesson is taught, or the museum exhibit is opened to the public). Finally, the analysis phase establishes causality between emergent characteristics of the learning outcomes and the design characteristics of the intervention. The analysis process can yield two types of outcomes: Suggestions for the refinement of the specific design in question, and "humble" theory, which is theory that can guide the design of a category of educational interventions and predict the learning outcomes that these interventions can precipitate.

Here, the design-based research approach is applied to a case: the biology exhibit *Cave Expedition*. In this approach, didactic theory is used as a tool to establish the relationship between content, medium and learner. The work proceeds in three steps: 1) an analysis of the design of *Cave Expedition*, using the notion of *museographic transposition* as a theoretical frame, 2) an analysis of the enactment of *Cave Expedition*, using the notion of *praxeology* as a tool to compare intended and observed visitor learning outcomes, and 3) a synthesis of the findings from the first two studies with findings from the literature to generate two types of results: a coherent series of suggestions for a design iteration of the studied exhibit as well as a more general normative model for exhibit engineering. Finally, another perspective on the generation of theoretical ideas for exhibit design is offered in a fourth and parallel research undertaking, namely the application of the notion of *cultural border-crossing* to a hypothetical case of exhibit design.

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