DISCUSSING A RESEARCH PROGRAMME FOR THE IMPROVEMENT OF SCIENCE TEACHING

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ABSTRACT

A research programme for the improvement of science teaching is described, exemplified, and discussed. Briefly, the idea of the programme is that researchers in science education and teachers in schools should work together to design teaching sequences and to assess how they function in practice. Research results concerning pupils' everyday conceptions, as well as analyses of the conceptual structure of a given area and the reasons for teaching it, play an important role when working on a design. The most important product of the design phase is a detailed guide for teachers, which we look upon as a tool for further knowledge-building. In our paper we suggest that the idea of domain-specific theories is worth examining and developing. It might contribute to strengthening science education as an autonomous discipline.

1. PROBLEM

Research programmes are motivated and conducted according to various aims, e.g. developing and testing a theory, developing and applying a method, or attempting to solve a practical problem. Research is said to be theory-driven, method-driven, or problem-driven.

A common conception of the relation between research driven by theory and that driven by problems is that the former is more important and a prerequisite for the latter. Acquired theoretical insights are assumed to generate applied research that can lead to solutions of practical problems. In an analysis made by the National Research Council in the USA, however, this model is judged to be too limiting when it comes to setting up an educational research agenda (Bransford, Brown & Cocking, 2000). They emphasise research based on practical problems as a significant alternative model. These problems are made the subject of research, generating both results of practical use and contributions to the development of educational science. Current examples are the various design experiments completed or still going on in the USA (Kelley, 2003) and similar work in Europe, e.g. 'developmental research' (Lijnse, 1995) and 'teaching-learning sequences' (Méheut & Psillos, 2004).

Our research programme is problem-driven. We wish to help solve an urgent school problem, namely the lack of scientific understanding among the majority of pupils evident from assessments and other investigations in Sweden and abroad. If

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one does not understand, one tends to lose interest, and this is probably a contributory factor in the diminishing recruitment to science courses. An obstacle to progress is that results from science education research that could help to improve teaching do not reach the teachers.

2. OVERVIEW OF THE RESEARCH PROGRAMME

In Sweden there is no well developed tradition of systematically making use of the practical experience of teachers, while some countries base much of their school development on this (Stigler & Hiebert, 1999). Nor can it be said that we use research results in a systematic way to improve practice. Such results are expressed in scientific papers, and are often at a high level of abstraction. It takes time to understand them, and therefore they are difficult for a teacher to put into practice. Lijnse (2000) even goes so far as to declare that this is an impossible task for the teacher. This probably influences how teachers perceive the legitimacy of educational science.

The step from research results to practice is thus far from trivial. However, we think that it is possible to utilise both teachers' experience and research results to improve science teaching. Research-based changes in teaching practice cannot be forced upon teachers, but may be achieved by researchers working together with practising teachers (Baird & Northfield, 1992). An element of our research programme is, therefore, the cooperation between teachers and researchers. The strategy we have selected involves developing teaching sequences during a 'design phase', followed by a 'trial phase' in which the function of the sequence is studied in practice. The results obtained are used to improve the design.

The design process is creative work that does not necessarily follow a definite plan, but there are systematic elements. A number of aspects based on available research results and well-tried experience need to be taken into account and analysed during the work. These aspects are summarised on the periphery of the circle in Figure 1. Allowing the aspects to interact can generate new ideas and new insights. Our experience is that interactions between knowledge of pupils' everyday conceptions and their difficulties in understanding (the pupil's' 'starting-point'), on the one hand, and insights into the scientific content ('the character of the area'), on the other, can be productive.

The main result of the design phase is a set of goals and a draft for a teaching sequence. In addition to descriptions of lessons, it may comprise texts for pupils to read, problems to discuss, computer simulations, and so forth. All this is written down in the form of a teacher guide, which also includes background information, e.g. about the character of the area, reasons for teaching it, and what is known about the pupils' starting point. We look upon the guide as a tool for further knowledge building. When revised and published, it will be a major result of our work. The next step is to try the sequence under regular school conditions, evaluate it, and use the results achieved to revise the original draft. The process can be repeated several times.

There are a number of foci that can be set up for the research during the trial