

Practical Work with Wind Energy

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Windmills - talking to each other over time and space

This paper was written in connection to a conference concerning 'Practical Work in Science Education', which took place at the 'Royal Danish School of Educational Studies' in Copenhagen, May 1998.

The teaching material described below was presented as a poster.

Abstract:

"Experiments with Wind" ("Forsøg med Vind") is a set of teaching materials designed as the basis of a practical, experimental approach to the theme of "Wind Energy" in the Nature/Technology - teaching in the first six forms of the Danish primary school ("the folk school").

The basic idea is that practical manual work involving the senses is important to the understanding of how nature works, to the formation of the individual's personal concepts, and to the linguistic development resulting from this.

The materials shown as a poster at the conference comprise a total of 14 different windmill models - some quite new and hitherto unknown - which the children themselves can make and experiment with. The teaching materials in focus are to be viewed as a contribution to a dialogue whose final aim is to clarify the best possible design of teaching materials which couple practical experimental work with theoretical insight and understanding.

Arguments

At conferences - even about Practical Work - we mostly are just talking.

At this conference the conclusion furthermore seems to be, that practical work is not useful at all in science education. Practical work takes time, is expensive and cannot be proved to be effective in teaching and learning.

Nevertheless, most people have the opinion, that practical work is good, and they

continue to argue for better conditions to do it in schools. The companies, who sell equipment, are also convinced.

I think the problem is that experiences from practical work are stored in the mind and the nerve system, deeply connected with the physical senses and feelings. Doing practical work does not necessarily involve verbal expressions. That's the reason why it is so difficult to prove the outcome of practical work. When a boy has learned to ride a bicycle it's still difficult to prove it by a verbal test. You have to put him on a bicycle and do a performance test. A big thing, but nothing much to write about in tables and statistics.

Another message from this conference is that science concerning nature subjects is unnatural for ordinary people.

I don't agree.

What is unnatural is the way we are doing it in schools.

And it is important to go on and keep trying to do things better.

Of course practical work does not have the same importance at all levels of science education.

When you are a grown up scientist most of your work is thinking. But your thinking is based on earlier experiences and achieves its reliability from confrontation with the practical world.

The Scandinavian word for science is "videnskab" or "vitenskap". A "videnskab" could be a trunk or a closet where you have your knowledge. But the verb version of the word "at skabe" means "to create". So the word "videnskab" then can be understood as "creating knowledge".

Mankind is creating knowledge, and that is not unnatural.

When children play, they are creating knowledge for themselves. That's why they have learned an awful lot already before they are attending school.

A grown up scientist then can be considered as a person who has got the privilege to go on playing, because he is still creating knowledge. Of course he is doing it more systematically in a grown up way and his research is very often depending on expensive equipment. Maybe that's why it seems to be unnatural. What we are doing in the schools in between - therefore - is important.

If we are pushing the grown up way of doing things too hard down in the early years of the schoolsystem, then it becomes unnatural. And the result is a fatal contradiction between the useful everyday concepts and the scientific concepts, which are felt not to be useful in everyday life. We have to work on a bridge between scientific concepts and everyday experiences.

Not everybody of course has to become scientists, but I think everybody could benefit from having lifelong knowledge creating abilities. And certainly it would be of great advantage for society.

You have to start early, and you have to do it smoothly.

In Denmark a new school subject, natur/teknik - Nature/Technology -, was introduced in 1994 in the school curriculum for grade 1 to 6. It is intended to be broadly based on themes from biology, physics, chemistry and geography, and also to have an experimental approach in the learning processes. Well, maybe it is not exactly the same as the basic meaning of the word science, but a little bit broader. It is also including the folkloristic and society descriptive part of geography, how people live and so on. And with that you can't do experiments, but only observe, compare and describe. That, of course, is also important.

In this new schoolsubject, Nature/Technology, there is still a lack of teaching materials with an experimental approach in teaching.

The material in consideration, "Forsøg med Vind" - "Experimenting with Wind", shown as a Poster at the conference about Practical Work in Science Education, represents an effort to reach an ideal design for doing this.

Somebody would say you don't need written materials at all when young people are learning by experimenting with the phenomena of the physical and biological world. You just have to get some equipment, funny toys, or to make out-door excursions, to find and learn from essential properties of the phenomena and processes of nature. You have to meet the real thing as close as possible - not only to read about it - if you want to develop an understanding of technology based on the phenomena of nature. Technology is not just the hardware of modern society, it's merely the ways of doing things.

Right, but it sounds very idealistic. When you are developing teaching materials, you have to do a lot of compromises. And you have to consider the differences between very young pupils, who meet a phenomena for the first time over to older pupils with some experiences, who also are able to do further studies by reading.

And maybe the teacher does not know much about the theme she's going to teach. Then the teacher should be provided with some good ideas and pedagogical advice, background knowledge and a warning: Don't force your students into tasks you haven't tried out yourself!

And even then: Don't be surprised when they come up with ideas you did not even think of.

Be happy with that: You haven't violated their imagination and curiosity! Work together with them.

Basically that is the concept of the teaching material "Forsøg med Vind". It is divided into two parts: Pages for the teacher and pages for the pupils. When buying the material, you get the permission to make as many copies of the pupils pages as you like. The pupils text is partly illustrated instructions in producing small windmill models and making them rotate, when blowing on them, walking around with them or placing them in the outdoor wind, - and partly historical and technological information about the use of windmills in society.

The teacher pages are mainly background knowledge covering scientific concepts and pedagogical advice about tutoring the pupils, about materials and tools in use and about arranging the workshop environment.

The windmill models can be made mainly out of unexpensive waste materials like corks, cardboard boxes, tubes and so on. You have to buy some iron wire, beads and glue, and from the beginning also some everyday tools like scissors, hammers, saws, awls and cutting nippers.

The learning outcome should be an understanding of the phenomena, for the youngest maybe just a feeling of the phenomena, an understanding of how the millwings have to be slightly twisted otherwise nothing will happen, for the oldest also an understanding of more sophisticated aerodynamical principles, and how the energy from the wind is transformed into rotation and further on into electricity. Experiences from practical work are the base for producing theoretical models of what's going on. Doing, observing, describing, making hypothesis, verifying. Through the working processes and discussions the pupils have to learn a systematic and grown up way of creating knowledge and develop their descriptive abilities without losing their imagination somewhere in the traditional classroom.

Although preliminary test versions of the teaching material "Forsøg med Vind" have been tested both in the schools and at inservice training of teachers, it has only been available for use in the school system for nearly one year. So it is too early yet to tell anything about how the final version works in practice. But it is my intention to establish contact with the users to get feedback for evaluation and follow up. Maybe some news about that will be ready for presentation at a later conference.

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